Yanchep Rail Extension: Part 2 – Eglinton to Yanchep

Environmental Review Document

Prepared for
Public Transport Authority

21 May 2019

EPA Assessment No. 2174

DOCUMENT TRACKING

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Project Number	18PER_11145
Project Manager	David Morley (08) 6218 2200 Level 1, Bishop's See, 235 St Georges Terrace Perth WA 6000
Prepared by	A. Buick, E. Colley, R. Hide, W. McGrath, D. Morley, R. Murray, R. Ovens, D. White
Reviewed by	J. Longstaff, D. Morley
Approved by	J. Longstaff
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EPA Assessment No. 2174

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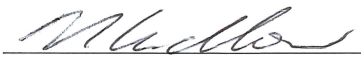
This document has been prepared by Eco Logical Australia Pty Ltd with support and contributions from the Public Transport Authority of Western Australia.

I hereby authorise this document to be submitted to the Department of Water and Environmental Regulation (EPA Services) on behalf of the Public Transport Authority of Western Australia.

Signature: 

Name: Miranda Ludlow

Position: Environmental Manager, Infrastructure Planning & Land Services

Date: 23 May 2019

Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on the environmental review for this Proposal.

The Public Transport Authority of Western Australia (PTA) is developing the Yanchep Rail Extension (YRE) Project as part of the Western Australian Government's METRONET vision. The YRE Project is an extension to the Northern Suburbs Railway (also known as the Joondalup line) in Perth's northern suburbs, 40 km north of the Perth central business district. The YRE Project is being assessed by the EPA under section 38 of the Environmental Protection Act 1986 in two parts:

- Part 1: Butler Station to Eglinton Station – includes the southern portion of the YRE Project to the north of Butler Station; and
- Part 2: Eglinton Station to Yanchep Station – includes the northern portion of the YRE Project to the north of the proposed Eglinton Station.

This Environmental Review Document (ERD) assesses the environmental impacts associated with Part 2 – Eglinton Station to Yanchep Station of the YRE Project (the Proposal). The ERD has been prepared in accordance with the EPA's Procedures Manual (Part IV Divisions 1 and 2). The ERD is the report by the proponent on their environmental review, which describes this Proposal and its likely effects on the environment.

The ERD is available for a public review period of 6 weeks from 27 May 2019, closing on 8 July 2019.

The proposal (EPBC 2018/8262) has also been determined to be a controlled action under the *Environmental Protection and Biodiversity Conservation Act 1999* and will be assessed by an accredited assessment under the *Environmental Protection Act 1986*.

Why write a submission?

The EPA seeks information that will inform its consideration of the likely effects of the Proposal, if implemented, on the environment. This may include relevant new information that is not in the ERD, such as alternative courses of action or approaches.

In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information.

Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*.

Why not join a group?

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group. If you form a small group (up to 10 people), please indicate the names of all participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, information in the ERD.

When making comments on specific elements of the ERD:

- clearly state your point of view and give reasons for your conclusions;
- reference the source of your information, where applicable; and
- suggest alternatives to improve the outcomes on the environment.

What to include in your submission

Include the following in your submission to make it easier for the EPA to consider your submission:

- your contact details – name and address;
- date of your submission;
- whether you want your contact details to be confidential;
- summary of your submission, if your submission is long;
- list points preferably by environmental factor so that issues raised are clear;
- refer each point to the page, section and, if possible, paragraph of the ERD; and
- attach any reference material, if applicable, making sure your information is accurate.

The closing date for public submissions is 8 July 2019.

The EPA prefers submissions to be made electronically via the EPA's Consultation Hub at https://consultation.epa.wa.gov.au.

Alternatively, submissions can be:

- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, Joondalup DC, Joondalup WA 6919; or
- delivered to: Environmental Protection Authority, 8 Davidson Terrace, Joondalup WA 6027.

If you have any questions on how to make a submission, please contact EPA Services at the Department of Water and Environmental Regulation on (08) 6364 7000.

Scoping checklist

Task No.	Required work	Section
Flora and vegetation		
1	Identify and characterise the flora and vegetation of areas that may be directly or indirectly impacted by the Proposal in accordance with Technical Guidance - *Flora and Vegetation Surveys for Environmental Impact Assessment*. This should include sampling more broadly to inform local and regional context and include conservation significant ecological communities whose buffers are intercepted by the Proposal. Where this has not been undertaken, previous surveys or extrapolation using aerial imagery may be used to inform local and regional context provided it is consistent with EPA Guidance. Floristic community types (FCTs) are to be determined through multivariate analysis. Demonstrate how surveys are relevant, representative and demonstrate consistency with current EPA policy and guidance. Ensure database searches and taxonomic identifications are up-to-date. *Note: Survey results and a demonstration of how the requirements have been met are to be included in the ERD. If multiple surveys have been undertaken to support the assessment, a consolidated report should be provided including the integrated results of the surveys. Where surveys were undertaken prior to scoping, justification should be provided to demonstrate that they are relevant and consistent with EPA Guidance. Where surveys have not been undertaken consistent with the EPA guidance provide a justification for any variation. Index of Biodiversity Surveys for Assessment (IBSA) data packages should be provided in accordance with EPA guidance.*	Section 5.3
2	Identify and describe the vegetation and significant flora species present and likely to be present within the development envelope and any areas that may be indirectly impacted by the Proposal beyond the development envelope recorded in 1 above. Undertake and provide an assessment of the significance of flora and vegetation in a local and regional context (refer to Environmental Factor Guideline – Flora and Vegetation for definition of significance). Include a quantitative assessment of levels of impact on significant flora, priority or threatened ecological communities, FCTs and all vegetation units. a. For significant flora, this includes: i. number of individuals and populations in a local and regional context; ii. numbers and proportions of individuals and populations directly or potentially indirectly impacted, and iii. numbers/proportions/populations currently protected within the conservation estate (where known). b. For significant ecological communities and all vegetation units this includes: i. the area (in hectares) and proportions directly or potentially indirectly impacted, and ii. proportions/hectares of the species, community or vegetation unit currently protected within conservation estate (where known).	Section 5.3

Task No.	Required work	Section
3	Identify and describe any flora species and ecological communities recorded during 1 above that are currently listed as Priority by the Department of Biodiversity, Conservation and Attractions or listed under the *Wildlife Conservation Act 1950* and the Commonwealth EPBC Act (including the Banksia woodlands of the Swan Coastal Plain Threatened Ecological Community). *Note: The State Government anticipates that the Biodiversity Conservation Act 2016 and associated regulations will come into effect early 2019, therefore it is likely the assessment of this Proposal may be undertaken in accordance with the species, ecological communities and key threatening processes listed under this legislation*	Section 5.3
4	Determine whether any vegetation identified in 1 above is consistent with the classification of any State or Commonwealth listed ecological community. If any vegetation is classified as a Priority or Threatened Ecological Community, present survey information consistent with the relevant guidelines set out below.	Section 5.3.2
5	Provide a map depicting the recorded locations of the significant flora, ecological communities and significant vegetation in 2 above in relation to the development envelope in accordance with the relevant guidelines set out below.	Section 5.3 and Figure 5-4
6	Assess the potential direct and indirect impacts of the construction and operational elements of the Proposal on identified environmental values in 2 above. Describe and assess the extent of any cumulative impacts within local and regional contexts as appropriate. Include a quantitative assessment of levels of impact on significant flora, significant ecological communities and all vegetation units. Include an assessment of the potential indirect impacts to the Banksia woodlands of the Swan Coastal Plain Threatened Ecological Community that may occur as a result of potential impacts (blowouts) to the Quindalup dune system.	Sections 5.4 and 5.5
7	Describe and justify any proposed avoidance and mitigation measures to reduce the potential impacts of construction and operation of the Proposal including revegetation.	Section 5.6 and Table 5-17
8	Include proposed management and/or monitoring plans that will be implemented pre- and post-construction to demonstrate and ensure residual impacts are not greater than predicted. Management and/or monitoring plans are to be presented in accordance with the EPAs instructions. *Note: The proposed Construction Environment Management Plan to avoid and mitigate impacts to the Banksia woodlands of the Swan Coastal Plain Threatened Ecological Community is to be consistent with the Department of Environment and Energy's (DoEEs) Environmental Management Plan Guidelines.*	Sections 5.5 and 5.6
9	Demonstrate how the Proposal has had regard to, and is not inconsistent with, relevant recovery plans, conservation advice and threat abatement plans, particularly for the Banksia woodlands of the Swan Coastal Plain Threatened Ecological Community.	Sections 5.5 and 5.6

Task No.	Required work	Section
10	Determine and quantify any significant residual impacts by applying the: a. Residual Impact Significance Model (page 11 of the WA Environmental Offsets Guideline) for all direct and indirect impacts, including an explanation of how the information and values within the model have been determined b. WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (2014), including the provision of supporting information, such as evidence of rehabilitation success c. the Commonwealth Offsets Assessment Guide including rationale for the values entered into the guide.	Sections 5.6 and 5.7
11	Where significant residual impacts remain, propose an appropriate offsets package with supporting information to demonstrate consistency with the WA Environmental Offsets Policy and Guidelines. Where residual impacts relate to EPBC Act listed threatened and/or migratory species propose an appropriate offset package consistent with the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*. Spatial data defining the area of significant residual impacts for each environmental value should also be provided (e.g. vegetation type, vegetation condition, specific fauna species habitat).	Section 12
12	Propose an appropriate offset package consistent with the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* for the predicted likely significant residual impact to the Banksia woodlands of the Swan Coastal Plain Threatened Ecological Community. Demonstrate how the proposed offset is consistent with each of the principles of the DoEEs policy in addition to providing a rationale for the values entered into the offset guide. Spatial data defining the area of significant residual impacts for each environmental value should also be provided (e.g. vegetation type, vegetation condition, specific fauna species habitat).	Section 12
Terrestrial fauna		
13	In accordance with the requirements of EPA Guidance: a. Conduct a Level 1 survey, incorporating existing regional terrestrial fauna surveys and databases. b. Surveys are to identify and characterise faunal assemblages and habitats (including water sources) present within and immediately adjacent to the Proposal area. c. Undertake Level 2 (targeted) surveys for identified significant fauna species that may be impacted directly and indirectly by the implementation of the Proposal. This should include sampling inside and outside the impact areas and consider cumulative impacts. *Note: Surveys, including targeted surveys, should include both Terrestrial Vertebrate Fauna and Short Range Endemic (and/or other significant) Invertebrate Fauna. Survey results and a demonstration of how the requirements have been met are to be included in the ERD. If multiple surveys have been undertaken to support the assessment, a consolidated report should be provided including the integrated results of the surveys. Reports for terrestrial vertebrates and short-range endemics should be provided separately. Where surveys were undertaken prior to scoping, justification should be provided to demonstrate that they are relevant and consistent with EPA Guidance. Ensure*	Section 6.3

Task No.	Required work	Section
	species database searches and taxonomic identifications are up-to-date. IBSA data packages should be provided in accordance with EPA guidance.	
14	Identify and describe the values and significance of fauna, fauna habitats and habitat connectivity within, and immediately adjacent to, the development envelope from 13 above that may be impacted directly and/or indirectly by implementation of the Proposal during both construction and operations. Describe the significance of these values in a local and regional context. Identify and quantify in absolute and relative terms, the areas of important or restricted habitats e.g. breeding habitat, foraging/feeding/dispersal habitat and habitats that are important to significant species (including nearby water sources) and the reasons for their importance (for example, proximity to breeding and foraging habitat). Support the discussion with the use of tables and figures to illustrate the extents of the habitats.	Section 6.3
15	Identify and describe any fauna species recorded during 13 above that are currently listed under the *Wildlife Conservation Act 1950* and/or the EPBC Act. Include the likelihood of occurrence of each identified species and discuss the habitats important to each identified species in detail on a species-by-species basis. Determine if nearby water sources are used by Carnaby's Cockatoo. Include a discussion of the expected direct and indirect impacts on each identified species. Include a discussion on the risk of indirect impact to nearby water sources as it relates to the potential to impact on Carnaby's Cockatoo. *Note: The State Government anticipates that the Biodiversity Conservation Act 2016 and associated regulations will come into effect early 2019, therefore it is likely the assessment of this Proposal may be undertaken in accordance with the species, critical habitat and key threatening processes listed under this legislation.*	Section 6.3.6
16	Identify any potential fauna movement corridors within, adjacent to or across the development envelope including, but not limited to, areas of intact native vegetation, using appropriate methods. Describe the methods undertaken.	Section 6.3.4
17	In accordance with relevant guidelines set out below, provide figures and maps illustrating fauna habitats, known recorded locations of significant vertebrate species and short-range endemic invertebrate species in relation to the Proposal impact areas, and any potential fauna movement corridors identified in 14 and 16 above in relation to the development envelope.	Figure 6-1, Figure 6-2 and Figure 6-3
18	Describe and assess the potential direct and indirect impacts (including mortality and fragmentation) of the construction and operational elements of the Proposal on fauna assemblages, identified significant fauna (including short-range endemic or other significant invertebrates), fauna habitats and habitat corridors identified in 14, 15 and 16 above. Describe and assess the extent of any cumulative impacts within local and regional contexts as appropriate.	Section 6.5
19	Quantify the extent of direct, indirect and cumulative impacts, including percentages, of habitat types to be disturbed or otherwise impacted.	Section 6.5
20	Demonstrate that no short-range endemic invertebrate fauna are restricted to the development envelope or that such species have been adequately surveyed outside of the development envelope.	Section 6.3.7
21	Outline the proposed management, monitoring and mitigation methods to be implemented to ensure impacts (direct and indirect) are acceptable and not greater than predicted.	Section 6.6

Task No.	Required work	Section
	Include proposed management and/or monitoring plans that will be implemented pre-and post-construction to demonstrate and ensure impacts are not greater than predicted. Management and/or monitoring plans are to be presented in accordance with the EPAs instructions. *Note: The proposed Construction Environment Management Plan to avoid and mitigate impacts to Carnaby's Cockatoo (Calyptorhynchus latirostris) (Endangered) and Western Quoll (Dasyurus geoffroii) (Vulnerable) is to be consistent with the DoEEs Environmental Management Plan Guidelines.*	
22	Provide maps and detailed justification for the location, dimensions, shape and number of proposed fauna underpasses/overpasses if any. Include and describe best practice design attributes of proposed fauna underpasses or overpasses to maximise effectiveness and minimise the risk of predation of fauna using the underpass/overpass.	Section 6.6.1
23	Demonstrate how the Proposal has had regard to, and is not inconsistent with, relevant recovery plans, conservation advice and threat abatement plans set out below	Section 6.5, 6.6 and 13
24	Predict the residual impacts to terrestrial fauna after considering and applying the mitigation hierarchy.	Section 6.5 to 0
25	Determine and quantify any significant residual impacts by applying the: a. Residual Impact Significance Model (page 11 of the WA Environmental Offsets Guideline) for all direct and indirect impacts, including an explanation of how the information and values within the model have been determined b. WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (2014), including the provision of supporting information, such as evidence of rehabilitation success c. the Commonwealth Offsets Assessment Guide including rationale for the values entered into the guide.	Sections 6.6 and 0
26	Where significant residual impacts remain, propose an appropriate offsets package with supporting information to demonstrate consistency with the WA Environmental Offsets Policy and Guidelines. Where residual impacts relate to EPBC Act listed threatened and/or migratory species propose an appropriate offset package consistent with the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*. Spatial data defining the area of significant residual impacts for each environmental value should also be provided (e.g. vegetation type, vegetation condition, specific fauna species habitat).	Section 12

Task No.	Required work	Section
27	Propose an appropriate offset package consistent with the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* for the predicted likely significant residual impact to Carnaby's Cockatoo. Demonstrate how the proposed offset is consistent with each of the principles of the Department of Environment and Energy's policy in addition to providing a rationale for the values entered into the offset guide. Spatial data defining the area of significant residual impacts for each environmental value should also be provided (e.g. vegetation type, vegetation condition, specific fauna species habitat). *Note: For the area of the Proposal that will clear 4.07 ha of foraging habitat for the Carnaby's Cockatoo from an environmental offset that has been approved for another approval under the EPBC Act (EPBC 2011/6021 Landcorp – Eglinton/South Yanchep Residential Development – 45 km North-West of Perth, Western Australia) develop an offset package to compensate for both the impact of the proposed action as well as the original action for which the offset was a condition of approval. The offset package should demonstrate how the proposed offset will achieve both objectives.*	Section 12
Subterranean fauna		
28	In accordance with EPA guidance, conduct a Level 1 (basic) subterranean fauna survey, including a desktop study that incorporates existing regional subterranean fauna surveys and databases.	Section 7.3.1
29	In accordance with EPA guidance, undertake Level 2 (detailed) surveys in all areas of impact to identify and characterise subterranean fauna and subterranean fauna habitat, at a local and regional scale, that may be impacted directly and indirectly by the implementation of the Proposal. This should include sampling inside and outside the impact areas and consider cumulative impacts. *Note: Where surveys have not been undertaken consistent with the EPA guidance provide a justification for any variation. If previous surveys are relied on for context, justification should be provided to demonstrate that they are relevant and consistent with EPA Guidance. If multiple surveys have been undertaken to support the assessment, a consolidated report should be provided including the integrated results of the surveys.*	Section 7.3.1
30	If further geotechnical investigations identify any karstic features such as sinkholes or caverns, or subterranean fauna, surveys may be required to be undertaken in accordance with 28 and 29 above. *Note: If surveys are not undertaken justification should be provided to demonstrate that subterranean fauna and habitats will not be significantly impacted on from construction of the Proposal.*	Section 7.3.1 and 7.3.3
31	Describe the characteristics of subterranean fauna habitat that may be impacted directly and indirectly by implementation of the Proposal during both construction and operations, and describe the significance of these values in a local and regional context. Include relevant geological and hydrological information to determine habitat suitability and connectivity, including inside and outside the impact areas.	Section 7.3

Task No.	Required work	Section
32	Provide figure(s) and maps showing the extent of subterranean fauna habitat in relation to the Proposal and species distributions.	Section 7.3.2 and 7.3.3; Figure 7-2 and Figure 7-3
33	Describe and assess the extent of direct, indirect and cumulative impacts as a result of implementation of the Proposal during both construction and operations to subterranean fauna, taking into consideration the significance of fauna and fauna habitat.	Section 7.5
34	Demonstrate that no subterranean fauna species are restricted to the development envelope or that such species have been adequately surveyed outside of the development envelope.	Section 7.3.1
35	Quantify the extent of direct, indirect and cumulative impacts, including percentages, of habitat types to be disturbed or otherwise impacted.	Section 7.5
36	Outline the proposed management, monitoring and mitigation methods to be implemented to ensure residual impacts (direct and indirect) are not greater than predicted.	Section 7.6
37	Predict the residual impacts from the Proposal on subterranean fauna after considering and applying the mitigation hierarchy.	Section 7.5.1, to 7.5.4
38	Determine and quantify any significant residual impacts by applying the: a. Residual Impact Significance Model (page 11 of the WA Environmental Offsets Guideline) for all direct and indirect impacts, including an explanation of how the information and values within the model have been determined b. WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (2014), including the provision of supporting information, such as evidence of rehabilitation success c. the Commonwealth Offsets Assessment Guide including rationale for the values entered into the guide.	Section 7.6
39	Where significant residual impacts remain, propose an appropriate offsets package with supporting information to demonstrate consistency with the WA Environmental Offsets Policy and Guidelines. Spatial data defining the area of significant residual impacts for each environmental value should also be provided (e.g. vegetation type, vegetation condition, specific fauna species habitat).	Section 12
Landforms		
40	Characterise the Quindalup parabolic dune system in terms of variety, integrity, ecological importance, scientific importance, rarity and social importance.	Table 8-1
41	Describe and assess the significance of potential direct, indirect and cumulative impacts to the Quindalup parabolic dune system within and directly adjacent to the development envelope. Include an analysis of the nature, magnitude and duration of the impacts (temporary and permanent). Discuss cumulative impacts including the impacts from other existing and potential approvals/developments.	Sections 8.4 and 8.5

Task No.	Required work	Section
42	Apply the mitigation hierarchy. Discuss how the Proposal has been designed to avoid and minimise impacts to the geomorphology and structure of the Quindalup parabolic dune system through the design and location of infrastructure. Detail proposed specific monitoring, management and mitigation measures.	Section 8.6
43	Predict the residual impacts and the significance from the Proposal on the Quindalup parabolic dune system after considering and applying the mitigation hierarchy.	Section 8.6 and Table 8-5
Inland waters		
44	Identify and describe the environmental values and significance of hydrological and soil characteristics within the development envelope and immediately adjacent to the development envelope.	Section 9.3
45	Identify the indicative location of abstraction bores for water requirements and identify and discuss any associated impacts of groundwater abstraction including from drawdown.[1]	Section 9.5.1 and Table 9-1
46	Analyse, discuss and assess the potential impacts (direct and indirect) from construction and operation of the Proposal on water quantity and quality in relation to the environmental values identified in 44 above including but not limited to the P3 PDWSA, Wellhead Protection Zones, native vegetation, Aquatic Root Mat Community in Caves of the Swan Coastal Plain and Loch McNess.	Section 9.5
47	Predict the extent, severity and duration of potential impacts to the environmental values identified in 44 above, including changes to local and regional groundwater flows and levels, drawdown and local water quality[1].	Section 9.5
48	Demonstrate the pathways for adopting best practice water sensitive urban design principles in the design of the infrastructure and also in stormwater and drainage components to ensure hydrological regimes and groundwater quality are maintained. Attention should also be given to PDWSA and Wellhead Protection Zones. Provide maps and justification of the indicative locations of stormwater/drainage infrastructure.	Section 9.6.1
49	Discuss any mitigation and management measures, including proposed management and/or monitoring plans that will be implemented pre-and post-construction to demonstrate that residual impacts are not greater than predicted. Management and/or monitoring plans are to be presented in accordance with the EPAs instructions.	Section 9.6
Social surroundings		
Noise and vibration		
50	Undertake noise and vibration monitoring and modelling as appropriate along the proposed alignment to determine ambient noise levels (including vibrational noise) in areas of noise sensitive receptors, including in areas used for recreational purposes.	Section 10.3.4

[1] In May 2019, the PTA modified the Proposal to remove the requirement for groundwater abstraction.

Task No.	Required work	Section
51	Undertake a screening assessment and if required a detailed noise and vibration assessment in accordance with relevant guidelines to predict future noise and vibration levels resulting from the Proposal on sensitive receptors, including recreational values as appropriate. Justify the use of any parameters used to model impacts from noise and vibration along the proposed alignment including cut and fill design considerations. Consideration should be given to planned areas of higher density and mixed-use development in proximity to the proposed station, for example, multi-storey residential dwellings should be considered as well as single storey dwellings.	Section 10.3.4
52	Identify relevant noise and vibration mitigation measures for identified sensitive receptors in 50 above and describe any proposed mitigation to reduce the potential impacts of construction and operation of the Proposal. Provide maps of and justification for the location and number of any proposed mitigation infrastructure.	Section 10.6.3 and Table 10-2
53	Include any proposed management and/or monitoring plans for noise and vibration that will be implemented pre- and post-construction to demonstrate and ensure the EPAs objectives can be met.	Table 10-2
54	Identify and describe the potential residual impacts (direct and indirect) that may occur following implementation of the proposed mitigation measures and determine the significance of the residual impacts of noise and vibration on the identified sensitive receptors in 51 above with reference to the residual impact model set out in the WA Environmental Offsets Guidelines. *Note: if noise and vibration monitoring and modelling has previously been undertaken specify the modelled parameters including the proposed railway design, areas of cut and fill and where the railway is proposed to be "at grade".*	Section 10.5.3
Dust		
55	Characterise current, pre-construction dust emissions at sensitive receptors along the proposed alignment that could be impacted by dust emissions during construction of the Proposal.	Section 10.5.4 and Other matters required by DoEE for assessment of impacts under the EPBC Act
56	Identify and describe the potential sources and impacts (direct and indirect) of dust for the sensitive receptors in 55 above that may arise from construction of the Proposal.	Section 10.5.4
57	Describe and assess any proposed mitigation measures to avoid or minimise the identified sources of direct and indirect impacts from dust in 55 above.	Section 10.6.2and Table 10-2

Task No.	Required work	Section
58	Include any proposed management and/or monitoring plans for dust that will be implemented pre- and post-construction to demonstrate and ensure the EPAs objectives can be met. Management and/or monitoring plans are to be presented in accordance with the EPAs instructions.	Section 10.6.2, Table 10-2 and Other matters required by DoEE for assessment of impacts under the EPBC Act
59	Identify and describe the potential residual impacts (direct and indirect) that may occur following implementation of the proposed mitigation measures and determine the significance of the residual impacts on the identified sensitive receptors of dust.	Sections 10.5.4 and 10.6.2
Bushfire		
60	Characterise the current, pre-construction risk of bushfire to people, property and infrastructure in designated bushfire-prone areas along the proposed alignment that could be impacted by bushfire during construction and operation of the Proposal in accordance with relevant guidelines.	Section 10.5.2
61	Identify and describe the potential sources of and impacts (direct and indirect) from bushfire that may arise as a result of construction and operation of the Proposal.	Sections 10.3.3 and 10.5.2
62	Identify and describe the proposed bushfire risk reduction strategies that will be implemented pre- and post-construction.	Sections 10.5.2 and 10.6.4
63	Predict the residual bushfire risk after considering implementation of the proposed bushfire risk reduction strategies.	Sections 10.5.2 and 10.6.4

A checklist setting out how matters required to be addressed under Schedule 4 of the EPBC Regulations have been addressed is included at Appendix B.

Executive summary

Introduction

The Public Transport Authority of Western Australia (PTA) is developing the Yanchep Rail Extension (YRE) Project as part of the Western Australian Government's METRONET vision. The YRE Project is an extension to the Northern Suburbs Railway (also known as the Joondalup line) in Perth's northern suburbs, 40 km north of the Perth central business district (CBD).

The YRE Project forms an integral component of Perth's long term public transport network, providing essential transportation services to the rapidly expanding northern coastal suburbs and delivering the better sustainability outcomes envisioned by the Western Australian Government's Perth and Peel@3.5million plan (DPLH and WAPC 2018a).

Background and context

A passenger railway line in the Eglinton and Alkimos area has been contemplated via the planning system for the past two decades. Provision for a railway in the northwest corridor exists in the Metropolitan Region Scheme (MRS), which provides the legal basis for planning the Perth metropolitan region (DPLH 2018). Several amendments to the MRS have been made with respect to transport corridors around the Butler, Eglinton and Alkimos areas, resulting in the current 'Railways' reservation. Amendment to the MRS has also realigned the railway reservation, resulting in reduced requirement to disturb remnant vegetation and achieving early avoidance for the Proposal.

The most recent extension to the Northern Suburbs Railway was from Clarkson Station to Butler Station, which opened in 2014.

The YRE Project is being assessed by the Environmental Protection Authority (EPA) under section 38 of the *Environmental Protection Act 1986* (EP Act) in two parts:

Part 1: Butler Station to Eglinton Station - includes the southern portion of the YRE Project, which extends north of the existing Butler Station to north of and including the proposed Eglinton Station; and Part 2: Eglinton Station to Yanchep Station - includes the northern portion of the YRE Project which extends north of the proposed Eglinton Station to north of and includes the proposed Yanchep Station.

The PTA referred Part 2: Eglinton Station to Yanchep Station (the Proposal) to the EPA Services on 25 August 2018 and the EPA determined that the Proposal would be formally assessed, with the level of assessment set as Public Environmental Review (PER) with a six week public review period. The EPA subsequently issued the Environmental Scoping Document (ESD) which sets out the matters to be addressed in the Environmental Review Document (ERD).

This ERD assesses the environmental impacts associated with Part 2 – Eglinton Station to Yanchep Station of the YRE Project (the Proposal). Potential impacts are considered in the context of the preliminary key environmental factors identified by the EPA in its decision to assess the Proposal.

This ERD is now published for a period of six weeks, during which time the public is invited to comment on the ERD. At the close of the public review period the EPA will conduct its own assessment of the Proposal and prepare an assessment report which will be provided to the Minister for the Environment, who will decide whether the Proposal may be implemented and, if so, the conditions of approval.

The PTA also referred the Proposal to the Commonwealth Department of the Environment and Energy (DoEE) and the delegate for the Minister for the Environment determined that the Proposal is a Controlled Action under section 75 of the *Environment Protection and Biodiversity Act 1999* (EPBC Act), requiring further assessment and approval. The relevant Matter of National Environmental Significance (MNES) is 'Listed threatened species and communities'. The Proposal will undergo an accredited assessment in which the Commonwealth will rely on the outcomes of the assessment conducted by the Western Australian Government to inform its consideration of approval under the EPBC Act. The significance of the impacts from the Proposal to MNES is addressed separately in this ERD (**Section 13**) with respect to the relevant EPBC Act guidance.

Overview of the Proposal

The Proposal includes the construction of approximately 7.2 km of narrow gauge dual track railway from north of the future Eglinton Station, heading generally north before terminating north of the proposed Yanchep Station (Figure ES 1). The new station at Yanchep will include intermodal interchanges for bus services, 'park and ride', 'kiss and ride', active mode facilities and associated infrastructure.

The majority of the railway will be constructed in cuttings averaging approximately 6 m below surrounding ground level, which will reduce noise to surrounding urban areas and provide grade separation to enable local roads to pass overhead.

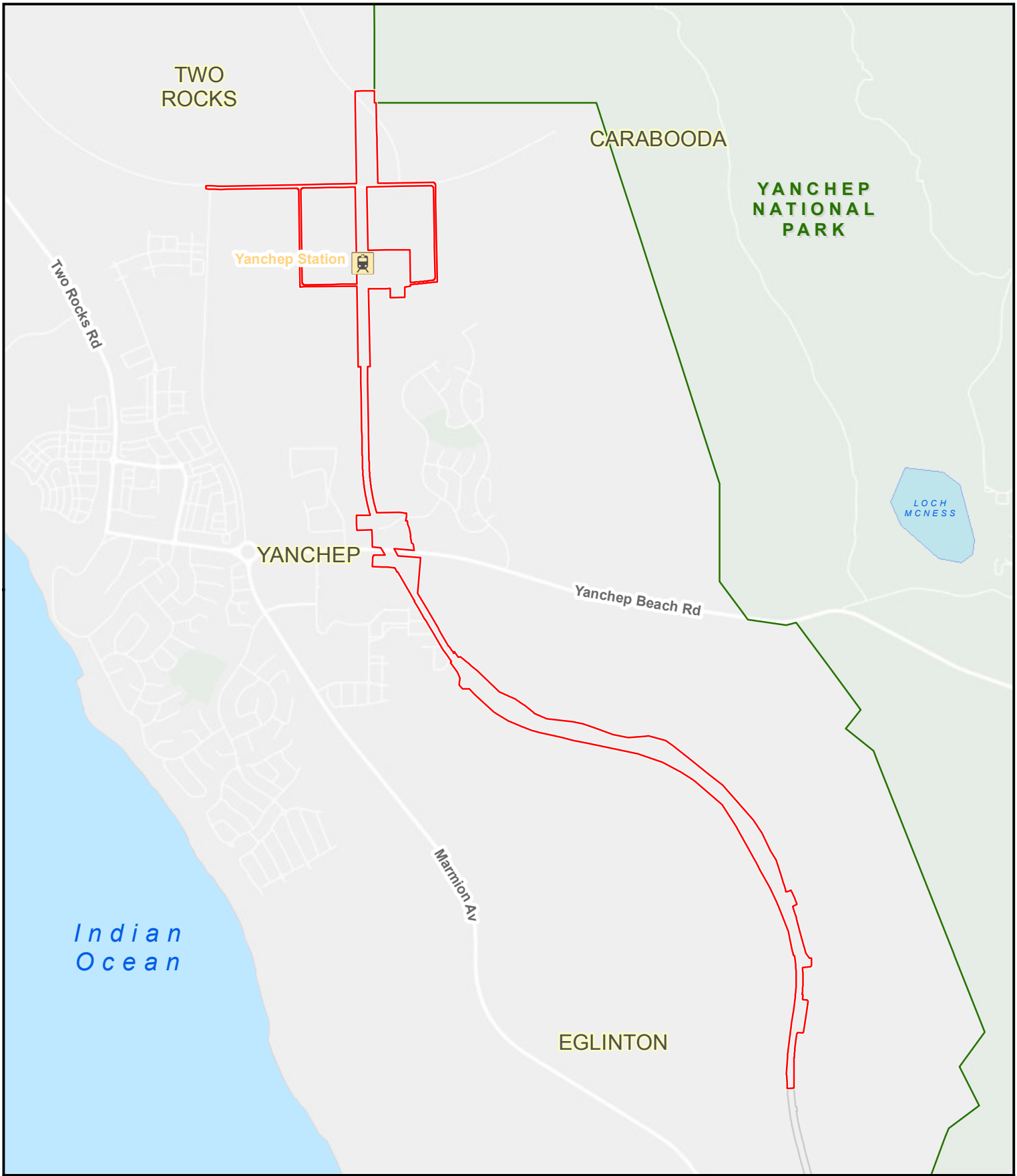
The Proposal also includes permanent infrastructure for maintenance and emergency vehicle access, drainage, overhead electrification for traction, signalling, communications and other services, access roads and pathways, and access control (e.g. fences and gates). A Principal Shared Path (PSP) will also be constructed alongside the railway (outside the railway corridor fencing) to provide station access for pedestrians and cyclists. A summary of the Proposal and the proposed extent of physical and operational elements is provided at Table ES 1 and Table ES 2.

Table ES 1: Summary of the Proposal

Item	Details
Proposal title	Yanchep Rail Extension: Part 2 – Eglinton Station to Yanchep Station
Proponent name	Public Transport Authority of Western Australia
Short description	The PTA proposes to extend a future connection of the Northern Suburbs Railway by 7.2 km, from north of the future Eglinton Station to the suburb of Yanchep in the City of Wanneroo. The Proposal is to construct and operate the rail extension and one new intermodal (rail, bus, 'park and ride', 'kiss and ride, walk and cycle) transit station at Yanchep. It will include the construction and operation of a Principal Shared Path (PSP) and access roads.

Table ES 2: Location and proposed extent of physical and operational elements

Element	Location	Proposed extent
Physical elements		
Railway	The proposed railway extension will begin from a future connection with the Northern Suburbs Railway, north of the future Eglinton Station, generally following the land reserved 'Railways' in the MRS before terminating approximately 900 m north of the future Yanchep Station.	7.2 km of dual track railway generally in cuttings approximately 6 m below surrounding ground level within an area of approximately 60.31 ha (total area of permanent rail infrastructure including Yanchep Station.)
Yanchep Station	Located approximately 1.6 km to the north of Yanchep Beach Road.	A railway station and associated facilities including intermodal rail, bus, 'park and ride', 'kiss and ride' and active mode facilities.
Construction and access areas	At locations of proposed future urban development or roads reserved in the Metropolitan Region Scheme (MRS) or as detailed within other approved or draft local structure plans.	Approximately 12.57 ha.
Road bridges	At Yanchep Beach Road, 'Tokyu 3' Road and Toreopango Drive as shown on Figure 2-4.	Three road bridges approximately 30 m wide, including a 3 m wide PSP.
Operational elements		
Railway	The railway will begin from a future connection with the Northern Suburbs Railway, north of the future Eglinton Station, generally following the land reserved 'Railways' in the MRS before terminating approximately 900 m north of the future Yanchep Station.	Rail services will operate between the future Eglinton Station and Yanchep Station up to 24 hours per day, 7 days per week.
Yanchep Station	Located approximately 1.6 km to the north of Yanchep Beach Road.	Rail and bus services may operate from Yanchep Station up to 24 hours per day, 7 days per week.



Yanchep Rail Extension (Part 2)
Figure ES-1 Location of the Proposal

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Surface Water Feature
- Proposed Station

Date Printed: 12/12/2018
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Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
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Environmental impact assessment

The EPA identified the following preliminary key environmental factors relevant to the environmental assessment of the Proposal:

- Flora and vegetation
- Landforms
- Terrestrial fauna
- Subterranean fauna
- Inland waters
- Social surroundings.

Table ES 3 summarises the potential impacts to these environmental factors arising from implementation of the Proposal, together with the proposed mitigation and the predicted environmental outcome following mitigation. A Construction Environment Management Plan (CEMP) has been prepared for the Proposal and is appended to this ERD.

Offsets provide compensation for environmental impact and are only required where it is determined that after avoidance, minimisation, and best-practicable rehabilitation a significant residual impact is still likely to occur. Using the residual impact significance model (Government of Western Australia 2014), offsets for significant residual impacts arising from the Proposal are considered necessary for the following:

- Permanent loss of:
    - 0.05 ha of *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) Swan Coastal Plain (SCP).
    - 8.03 ha of the Commonwealth listed Banksia dominated woodlands of the Swan Coastal Plain (SCP) Woodlands TEC.
    - 28.82 ha of Bush Forever Site 289 (Ningana Bushland), including of 18.07 ha of native vegetation in Degraded or better condition.
    - 56.31 ha of Carnaby's Cockatoo habitat, including 2.13 ha of potential breeding habitat, and 45 potential breeding trees.

The clearing of 0.05 ha of SCP 26a will require a direct offset that involves the maintenance of or improvement in quality of an existing area of SCP 26a and/or reduction in the risk of loss over time. The proposed direct offset is the acquisition and/or securing of land that has no existing conservation tenure and transfer to the conservation estate. This would be supported by funding of conservation works to maintain or enhance the quality of the area comprising SCP 26 a.

An environmental offset for the clearing of 8.03 ha of the Commonwealth listed Banksia Woodlands TEC is proposed as the potential impact exceeds the thresholds for referral under the Commonwealth guidance for the TEC in accordance with the significant impact guidelines (DoE 2013). Direct offsets are proposed involving the maintenance or improvement in quality of an existing area of Banksia Woodlands TEC and/or reduction in the risk of loss over time. The proposed direct offset is the acquisition and/or securing of land that has no existing conservation tenure and transfer of the land to the conservation estate supported by funding of conservation works to maintain the quality of the area comprising Banksia Woodlands TEC. This will be provided through a land acquisition offset (discussed in Section 12).

An offset ratio in accordance with Government of Western Australia (2010) will apply to the area of Bush Forever of Degraded or better conservation significance to calculate the total area of Bush Forever to be offset. Consequently, the area subject to a Bush Forever offset is 23.48 ha (Section 12.6). On-ground conservation management that represents works beyond what is currently being undertaken in Ningana

Bushland, the Bush Forever site impacted by the project, is proposed as the Bush Forever offset. The PTA proposes to increase the conservation significance of a minimum of 23.48 ha within Ningana Bushland. However, the area subject to active management of threatening processes is 69.59 ha, which is the total area of Degraded vegetation within Ningana Bushland outside the Development Envelope. This is considerably more than the minimum 23.48 ha commitment.

The clearing of 56.31 ha of Carnaby's Cockatoo habitat, including 2.13 ha of potential breeding habitat and 45 potential breeding trees requires one or more direct offsets that involve the maintenance of or improvement in quality of an existing area of Carnaby's Cockatoo habitat and/or reduction in the risk of loss over time. The proposed direct offset for Carnaby's Cockatoo habitat is the acquisition and/or securing of land that has no existing conservation tenure and transfer to the conservation estate supported by funding of conservation works to maintain the quality (as a measure of quality) of foraging and breeding habitat. This will be provided through land acquisition of a site to be determined by the DBCA.

Due to the presence of the Aquatic Root Mat Community in Caves of the Swan Coastal Plain TEC outside the development envelope in the Yanchep National Park, the PTA modified the Proposal in May 2019 to remove the requirement for groundwater abstraction.

A summary of the potential impacts, proposed mitigation and outcomes of the implementation of the Proposal is provided in Table ES 3.

Table ES 3: Summary of 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	• Environmental Factor Guideline: Flora and Vegetation (EPA 2016a). • Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b).

Potential impacts	• Vegetation clearing within the development envelope resulting in loss of Threatened Ecological Communities (TEC), Priority Ecological Communities (PEC), threatened or conservation significant flora species, Bush Forever and fragmenting ecological linkages.
	• Increased vehicle and personnel access resulting in:
	  o Introduction and/or spread of Declared Pests and other weed species
	  o Introduction and spread of *Phytophthora* dieback into vegetation.
	• Degradation of adjacent remnant vegetation through the contamination of surface water and groundwater, alteration of surface hydrology and increased sedimentation, dust emissions and fragmentation of vegetation.

Mitigation	**Avoid** • The development envelope was modified during the design phase to avoid direct impacts to Bush Forever site No. 130 and Bush Forever site No. 288. • Construction and access areas have been selected to coincide with proposed future urban development cells or roads to intentionally avoid direct impacts to vegetation which may have otherwise been able to be retained within future public open space (POS) reservations.

	Minimise
	• The development envelope will be demarcated to prevent clearing outside of approved areas.
	• Clearing will be minimised to as low as reasonably practicable.
	• Should batters be of a suitable gradient and material and not required for operational infrastructure purposes, they will be stabilised with planting of locally endemic species where possible and/or bioengineering controls.
	• Measures to prevent the distribution of declared pests and other weed species offsite and prevent introduction of *Phytophthora* dieback to the surrounding vegetation as detailed below:
	  ○ Inspection of all vehicles and machinery at exit and entry locations to be free of weeds and soil prior to entering the development envelope.
	  ○ Manage any newly identified declared weeds within the development envelope in accordance with the BAM Act and subsidiary regulations.
	  ○ If practicable, conduct ground disturbance activities in dry months to reduce the risk of spreading disease.
	  ○ Avoid topsoil movement from uninterpretable areas to uninfested areas;
	  ○ Require that any materials brought into the development envelope are dieback free.
	  ○ Install a temporary fence or appropriate buffer to prevent access to surrounding vegetation.
	  ○ Require all personnel to complete a site induction that will include hygiene training with regards to weed and dieback hygiene management requirements, the environmental implications of the introduction and spread of dieback and obligations to follow the CEMP.
	• Best practice WSUD will be incorporated in the design to protect existing hydrological regimes, as detailed in Section 9.
	• Fuel and other chemicals stored in correctly labelled containers and used in designated areas only.
	• Disposal of hazardous materials in accordance with regulatory requirements.
	• Provision of spill kits at the designated storage and use areas.
	• Provision of training where required, in the safe use, handling and disposal of hazardous materials.
	• Implementation of the PTA's standard spill response framework for rail corridors to manage potential indirect impacts to surface and groundwater quality.
	• Installation of drainage diversion around chemical storage areas.
	• Implementation of drainage controls to prevent offsite discharge of runoff.
	• Spill response procedures and training.
	• Storage of fuels or chemicals in bunds capable of storing 110% of the capacity of the largest storage tank.
	• Secondary spill containment around tanks (with a perimeter bund) with sufficient freeboard capacity to contain all captured rainwater from a 20-year average return interval, 72-hour storm.
	• No dewatering or abstraction of groundwater are proposed for this Proposal.

	• Spill kits to be located in storage and refuelling areas. • Stormwater and surface water management measures and controls will be designed with consideration of best practice WSUD principles.

Outcomes	The direct residual impacts of the Proposal are predicted to be:
	• Permanent loss of:
	  ○ A total of 49.17 ha of native vegetation in Excellent to Degraded condition.
	  ○ 28.82 ha of Bush Forever site No. 289. (Ningana Bushland).
	  ○ Up to 33 individuals of conservation significant flora within the development envelope. This includes individuals of two Priority 3 (poorly known taxa) taxa and two Priority 4 (Rare, Near Threatened and other taxa in need of monitoring) taxa.
	  ○ Threatened and Priority ecological communities:
	  ▪ A total of 0.05 ha of *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) SCP;
	  ▪ 8.76 ha of Banksia dominated woodlands of the SCP IBRA Region PEC, of which 8.03 ha is also representative of the Banksia dominated woodlands of the SCP TEC;
	  ▪ A total of 13.68 ha of Northern Spearwood shrublands and woodlands ('community type 24') PEC; and
	  ▪ A total of 2.13 ha of Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC.
	• Fragmentation of Bush Forever site 289 and severing of an associated regional ecological linkage (Link No. 0).
	• Indirect impacts relating to the risk of introduction and/or spread of weeds or *Phytophthora* dieback into vegetation adjacent to the development envelope and risk to vegetation as a result of accidental contamination will be successfully mitigated using established management practices.
	With the exception of impacts to two TECs and regionally significant bushland within Bush Forever, the impacts of the Proposal are not considered significant. An Offsets Strategy is proposed to counterbalance the following significant residual impacts:
	• Permanent loss of:
	  ○ 0.05 ha of *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) SCP;
	  ○ 8.03 ha of Commonwealth EPBC Act listed Banksia dominated woodlands of the SCP TEC; and
	  ○ 28.82 ha of Bush Forever Site No. 289 (Ningana Bushland) of which 18.07 ha is regionally significant bushland in Degraded or better condition.
	Given the application of the Offsets Strategy to offset significant residual impacts, and the PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects, the PTA considers that the EPA's objective for flora and vegetation will be met.

Terrestrial fauna	

EPA objective	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.
Policy and guidance	• Environmental Factor Guideline: Terrestrial Fauna (EPA 2016c). • Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna (EPA 2016d). • Technical Guidance: Terrestrial Fauna Surveys (EPA 2016e). • Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna (EPA 2016f).
Potential impacts	• Vegetation clearing resulting in the loss of terrestrial fauna habitat. • Injury/mortality to terrestrial fauna. • Vegetation clearing resulting in the fragmentation of terrestrial fauna habitat. • Degradation of adjacent terrestrial fauna habitat. • Disturbance to fauna from noise and vibration. • Change in feral animal abundance and/or movement.

Mitigation	**Avoid** • Development envelope was modified during the design phase to avoid the direct impacts to Bush Forever Site No. 130, Bush Forever Site No. 288 and nearby parks and reserves potentially containing fauna habitat. • 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 Local Structure Plan, to avoid direct impacts to native vegetation which may have otherwise been able to be retained within future POS reservations. **Minimise** • Implementation of a CEMP that will include the following measures as a minimum: o Restrict clearing to the approved development envelope to avoid over-clearing and to minimise indirect impacts to adjacent remnant vegetation and Carnaby's Cockatoo habitat. o SRE management measures including: ▪ weed management measures; ▪ dieback management actions; ▪ revegetation using locally endemic species and replacement of topsoil will allow any eggs/larvae/dormant stages of some SRE's to recolonise previously cleared areas; ▪ dust control; ▪ chemical and hydrocarbon storage and management; and ▪ managing changes to surface hydrology as far as practical and preventing additional water discharge into non-impact areas during construction. o Undertake progressive clearing to allow fauna to move away from clearing activities. o Pre-clearing survey for potential nesting Black Cockatoos prior to construction works. o Accurately delineating the approved clearing boundary to provide accuracy to the limits of the allowable clearing lines. o Further contingency measures to be developed in consultation with DBCA and implemented to avoid or minimise impacts to significant fauna if identified during searches. o Fuel and other chemicals will be stored in correctly labelled containers and used in designated areas only. o Disposal of hazardous materials in accordance with regulatory requirements. o Provision of spill kits at the designated storage and use areas; and o Provision of training where required, in the safe use, handling and disposal of hazardous materials. o Manage and minimise construction noise in accordance with *Environmental Protection (Noise) Regulations 1997 Regulation 13 – "Construction Sites".* o Should the batters be of a suitable gradient and material and not required for operational infrastructure purposes, they will be stabilised with planting of locally endemic species where possible and/or bioengineering controls.

	Species selection will be considerate of creating habitat for Carnaby's Cockatoo in areas further than 10 m from the proposed railway. o Installation of two fauna crossings (an underpass and an overpass) to maintain the local east-west habitat connectivity for the long-term movement in Ningana Bushland. o Implementation of NVMP to address the potential noise and vibration social impacts during the operation of the railway line. These mitigation measures are also applicable to terrestrial fauna, including: ▪ regular inspections of the rail condition and rail rectification / grinding by the PTA to remove excessive roughness or corrugation which may develop over time; and ▪ installing ballast matting adjacent to all existing and approved future residential developments to address experiences with structure-borne regenerated noise issues (rumbling) as trains passed by. **Rehabilitation** • Fauna injured during fauna habitat clearing will be rehabilitated by a wildlife carer, where practicable.
	The residual impacts of the Proposal in relation to terrestrial fauna are predicted to be: • Permanent loss of o A total of 61.68 ha of terrestrial fauna habitat, consisting of 47.45 ha of high value and 14.23 ha of medium value habitat. o 28.82 ha of Bush Forever Site No, 289 (Ningana Bushland). o 56.31 ha of Carnaby's Cockatoo habitat, consisting of 22.56 ha of high value and 33.75 ha of medium value foraging habitat, including 2.13 ha of potential breeding habitat, and 45 potential breeding trees. • Fragmentation of fauna habitat within Bush Forever Site No. 289 (Ningana Bushland). • Injury and/or mortality of fauna during clearing activities and construction and operation of the proposed railway. • Change in feral animal movements and behaviour as a result of the introduction of fauna crossings.
Outcomes	The project will result in the direct loss of up to 61.68 ha of fauna habitat. The clearing loss associated with the DE is estimated to contribute a 3.90% reduction in fauna habitat at a local scale; and a 0.11% and 0.01% at a region and subregional scale. Of the current extent remaining, there is 42.98% within conservation areas at a local scale and 74.60% and 44.81% within conservation areas at regional and bioregional scales. Therefore, the potential for impacts to fauna habitat are not considered significant, with the exception of potential impacts to Carnaby's Cockatoo habitat, which the PTA is proposing an Offsets Strategy to offset this potential impact. The potential for impacts to fauna as a result of habitat fragmentation have also been considered and the PTA is proposing the mitigate the potential impacts through the installation of two fauna crossings (an underpass and an overpass) to maintain the local east-west habitat connectivity for the long-term movement in Ningana Bushland. Given the PTA proposes to manage other potential impacts to fauna through the implementation of a CEMP, the application of an Offsets Strategy to manage significant residual impacts, the installation of two fauna crossings and the PTA's past performance in

	implementing appropriate mitigation measures as part of the construction and operation of railway projects, the PTA considers that this Proposal can be managed to meet the EPA's objective for terrestrial fauna.
Subterranean fauna	
EPA objective	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.
Policy and guidance	• Environmental Factor Guideline: Subterranean Fauna (EPA 2016g). • Technical Guidance: Subterranean Fauna Survey (EPA 2016h). • Technical Guidance: Sampling Methods for Subterranean Fauna (EPA 2016i).
Potential impacts	• Permanent loss of subterranean fauna habitat due to excavation and construction activities. • Alteration of surface and subsurface hydrology from vegetation clearing, excavations, construction of roads, building and other hardstand areas during construction may alter surface water infiltration and sedimentation, impacting subterranean fauna habitat. • Groundwater contamination due to spills during construction and/or operation, impacting habitat for subterranean fauna. • Fragmentation of subterranean fauna habitat and loss of ecological connectivity. • Vibration-related impacts due to construction and railway operation.
Mitigation	**Avoid** • No excavation and disturbance works will occur below groundwater level. • The Proposal has been realigned to avoid disturbance in high karst risk areas associated with high value subterranean fauna habitat. **Minimise** • Implementation of a CEMP that will include the following action items and measures: o Prior to the commencement of construction activities, a further detailed geotechnical investigation will be undertaken to supplement and validate the preliminary baseline findings. o Actions to address the discovery of significant caves or voids during excavation. o Clearing/disturbance to remain within approved development envelope. o Fuel and other chemicals will be stored in correctly labelled containers and used in designated areas only. o Chemical and fuel storage measures such as bunds that can capture 110% of the volume of the container. o Disposal of hazardous materials to be in accordance with regulatory requirements. o Provision of spill kits at the designated storage and use areas. o Provision of training where required, in the safe use, handling and disposal of hazardous materials. o Implementation of best practice Water Sensitive Urban Design (WSUD) principles in detailed design.

	○ The stormwater management approach for the Proposal will facilitate at-source infiltration to maintain the predevelopment hydrological regime and control the quality of stormwater recharged to the groundwater aquifers. **Rehabilitation** • Not applicable.
Outcomes	The predicted outcomes of the Proposal in relation to subterranean fauna include: • Predicted direct residual impacts will involve minimal loss of low value troglofauna habitat and no loss of stygofauna habitat. • The Proposal has a low likelihood of impact to both stygofauna and troglofauna due to the shallow depth of excavation (approximately 5 metres within Tamala limestone). • There will be no significant residual impacts to subterranean fauna from contamination of groundwater from railway operation. Through the implementation of the EPA's mitigation hierarchy, the residual impacts of potential direct and indirect impacts of the Proposal to subterranean fauna are as low as reasonably practicable and are not expected to be significant. Given the PTA proposes to manage potential impacts to subterranean fauna through the implementation of a CEMP and the PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects, the PTA considers that this Proposal can be managed to meet the EPA's objective for subterranean fauna.
Landforms	
EPA objective	To maintain the variety and integrity of significant physical landforms so that environmental values are protected.
Policy and guidance	• Environmental Factor Guideline: Landforms (EPA 2018a)
Potential impacts	• Permanent loss or alteration of shape of parabolic dune formations within the development envelope due to cut and fill works during construction. • Permanent alteration of the stability of the dune system as a result of earthworks such as cutting, leading to dune erosion, blowouts or sand deposition outside of the development envelope. • Permanent alteration to approximately 17.54 ha of parabolic dune formations.
Mitigation	**Avoidance** • Not applicable. **Minimise** • Implementation of a CEMP which will include the following measures: ○ Clearing restricted to the approved development envelope. ○ Implement structural controls to minimise excavation by using retaining walls. ○ Minimise excavation and development footprint within Bush Forever Site No. 289 by raising vertical alignment of the railway in this area to reduce disturbance to the landform, including battering the excavation or using retaining walls, informed by the geotechnical investigation and detailed engineering design to avoid blowouts of adjacent dune formations.

	○ Monthly visual inspections for evidence of erosion of parabolic dune formation outside the development envelope (inspections of first 10 m outside development envelope). ○ Stabilise affected parabolic dune formations by the planting of locally endemic flora species or bioengineering controls, as practicable. **Rehabilitation** • Not applicable.
Outcomes	The predicted outcomes of the Proposal in relation to landforms include: • The permanent alteration of approximately 17.54 ha of the Quindalup dune system with direct removal of portions of the Q1 and Q2 phase parabolic dunes. • With the inclusion of mitigation measures outlined in the previous section, the indirect potential impacts to the Quindalup dune system are considered unlikely to occur as a result of the Proposal. Impacts are considered to be as low as reasonably practical and are not considered significant. Given the PTA proposes to manage potential impacts to landforms through the implementation of a CEMP and the PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects, the PTA considers that this Proposal can be managed to meet the EPA's objective for landforms.
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). • Statement of Planning Policy No. 2.7 Public Drinking Water Source Policy (Government of Western Australia 2003).
Potential impacts	• Changes to surface water flow paths and recharge locations or infiltration rates during rainfall events, as a result of alteration of landscape from construction earthworks, vegetation clearing or construction and operation of hardstand areas. • Water pollution impacts to Perth Coastal and Gwelup UWPCA (P3) from construction activities and/or chemical and hydrocarbon spills.
Mitigation	**Avoid** • Avoidance of Water Corporation's existing Production Bores and the groundwater bores of other users. • Avoidance of Wellhead Protection Zones where practicable. • Storage of unnecessary types and volumes of hazardous materials will be avoided where practicable. **Minimise** • Best practice WSUD principles will be incorporated in the design including: ○ The stormwater management approach for the railway and station infrastructure will be to maintain the existing local hydrological flows and protect groundwater quality. ○ 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 of WSUD infrastructure will be undertaken by the PTA on an as-required basis. ○ The volume of water directed to drainage basins will be minimised through maximising infiltration at source within the railway corridor open drains. • Stormwater systems will incorporate WSUD to facilitate infiltration at source • Implementation of the CEMP to minimise the risk of contamination, including: ○ Installation of drainage diversion around chemical storage areas. ○ Implementation of drainage controls to prevent offsite discharge of runoff. ○ Spill response procedures and training. ○ Storage of fuels or chemicals in bunds capable of storing 110% of the capacity of the largest storage tank. ○ Secondary spill containment around tanks (with a perimeter bund) with sufficient freeboard capacity to contain all captured rainwater from a 20-year average return interval, 72-hour storm. ○ Spill kits located in storage and refuelling areas. • Implementation of the PTA's standard spill response framework for operational rail corridors. **Rehabilitation** • Not applicable.
Outcomes	The predicted residual impacts of the Proposal on inland waters are: • No change to surface water features and minor change to rainfall runoff and recharge patterns within the development envelope. • Minor contamination risk that can be appropriately managed, with no significant residual impact to inland water quality. Through the implementation of the mitigation hierarchy, the residual impacts of the Proposal to inland waters are not expected to be significant at a local or regional scale. Given the PTA proposes to manage potential impacts to ground and surface water through the implementation of a CEMP and the PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects, the PTA considers that this Proposal can be managed to meet the EPA's objective for inland waters.
Social surroundings	
EPA objective	To protect social surroundings from significant harm.
Policy and guidance	• Environmental Factor Guideline: Social Surroundings (EPA 2016j). • PTA's Noongar Standard Heritage Agreement. • SPP 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning (Government of Western Australia 2009) and accompanying guidelines. • 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) (Standards Australia 1990). • A Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Site Remediation and other Related Activities (DEC 2011).

	• SPP 3.7: Planning in Bushfire Prone Areas (DoP and WAPC 2015) and associated Guidelines for Planning in Bushfire Prone Areas v 1.3.
Potential impacts	• Disturbance or damage to artefacts or other items of Aboriginal cultural significance. • Bushfire resulting in damage to people, property or infrastructure. • Noise and vibration disturbance to sensitive receptors from Proposal construction and railway and station operation. • Dust disturbance to sensitive receptors as a result of clearing and construction.
Mitigation	**Avoid** • No heritage places listed on the State Register of Heritage Places or the City of Wanneroo's Scheme Heritage List were identified within the development envelope. **Minimise** • A monitor will be on-site during clearing and initial groundworks at the Yanchep station sites, to identify and manage potential artefacts or objects of Aboriginal cultural significance. • Bushfire risk management actions and a full risk assessment will be provided in a Bushfire Risk Management Plan (BRMP) pre-construction as per the requirements of SPP 3.7 and the Guidelines for high-risk land uses. The BRMP will reference the requirements of the Bushfire Management Strategy (PTA 2018). • BRMP to be prepared in accordance with Australian and New Zealand Standard *AS/NZS ISO 31000:2018 Risk Management–Principles and Guidelines* (SA & SNZ 2018). • Implement the CEMP including: o In the event that out of hours construction is required, any works will be undertaken in accordance with an out of hours noise management plan approved by the City of Wanneroo. o Water carts and hydromulch will be applied to minimise dust generation. o Vehicle speed limits will be enforced for all unsealed roads and tracks. o Wind break fencing will be installed to prevent dust in high risk areas, during the construction phase. o Monitor daily weather forecasts. o Where practicable, in high wind conditions, construction activities may be limited, to avoid dust generation. • Implement the NVMP to minimise potential noise impacts to sensitive receptors, including: o Installing noise mitigation infrastructure where required. • The PTA will undertake rail maintenance to reasonably maintain the operational performance of the relevant railway infrastructure and reduce wear to train wheels. This will involve regular inspection of the rail condition and rail rectification/grinding to remove excessive roughness or corrugation which may develop over time. • Develop and implement limestone crushing protocol should limestone crushing onsite be required. **Rehabilitation** • Not applicable.

Outcomes	The predicted residual impacts of the Proposal on social surroundings are: • Potential disturbance to previously unidentified Aboriginal artefacts. • Residual bushfire risk and therefore potential for impacts to people, property and infrastructure will remain while the railway assets and infrastructure remain in proximity to bushfire prone vegetation. With the proposed minimisation measures and appropriate management, it is considered these risks and impacts can be managed to as low as reasonably practical. • No exceedance of noise or vibration criteria during construction or operation. • Further mitigation of noise may occur as future subdivisions are developed and façade noise control packages are implemented. • Potential minimal, short-term nuisance dust. Through the implementation of the EPA's mitigation hierarchy, the residual impacts of the Proposal to social surroundings are considered to be as low as reasonably practicable and not significant. Given the PTA proposes to manage potential impacts to social surroundings through the implementation of a CEMP and the PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects, the PTA considers that this Proposal can be managed to meet the EPA's objective for social surroundings.

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Abbreviations

Abbreviation	Description
BRMP	Bushfire Risk Management Plan
CEMP	Construction Environment Management Plan
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
DBCA	Department of Biodiversity, Conservation and Attractions
DFES	Department of Fire and Emergency Services
DoE	Department of the Environment
DoEE	Department of the Environment and Energy
DMIRS	Department of Mines, Industry Regulation and Safety
DPIRD	Department of Primary Industries and Regional Development
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
ELA	Eco Logical Australia
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPA Services	Environmental Protection Authority Services
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERD	Environmental Review Document
ESA	environmentally sensitive area
ESD	Environmental Scoping Document
GDE	groundwater dependent ecosystem
IBRA	Interim Biogeographic Regionalisation for Australia
LSP	Local Structure Plan
MNES	Matter of National Environmental Significance
MRS	Metropolitan Region Scheme
NSHA	Noongar Standard Heritage Agreement
NVMP	Noise and Vibrations Management Plan
NW	northwest
OHNMP	Out of Hours Noise Management Plan
PASS	potential acid sulfate soil(s)

Abbreviation	Description
PEC	Priority Ecological Community
PER	Public Environmental Review
Perth CBD	Perth Central Business District
PMST	Protected Matters Search Tool
POS	Public Open Space
PSP	Principal Shared Path
PTA	Public Transport Authority of Western Australia
SCP	Swan Coastal Plain
SPP 2.8	State Planning Policy 2.8: Bushland policy for the Perth Metropolitan Region
SRE	short range endemic
STEM	Strategic Transport Evaluation Model
SWALSC	South West Aboriginal Land and Sea Council
TEC	Threatened Ecological Community
ULDO	Urban Land Development Outlook
UWPCA	Underground Water Pollution Control Area
UXO	Unexploded Ordnance
WAPC	Western Australian Planning Commission
WC Act	*Wildlife Conservation Act 1950*
WHPZ	Wellhead protection zones
WoNS	Weeds of National Significance
WQPN	Water Quality Protection Notes
WSUD	Water Sensitive Urban Design
WWF	World Wildlife Fund
YRE Project	Yanchep Rail Extension Project

1 Introduction

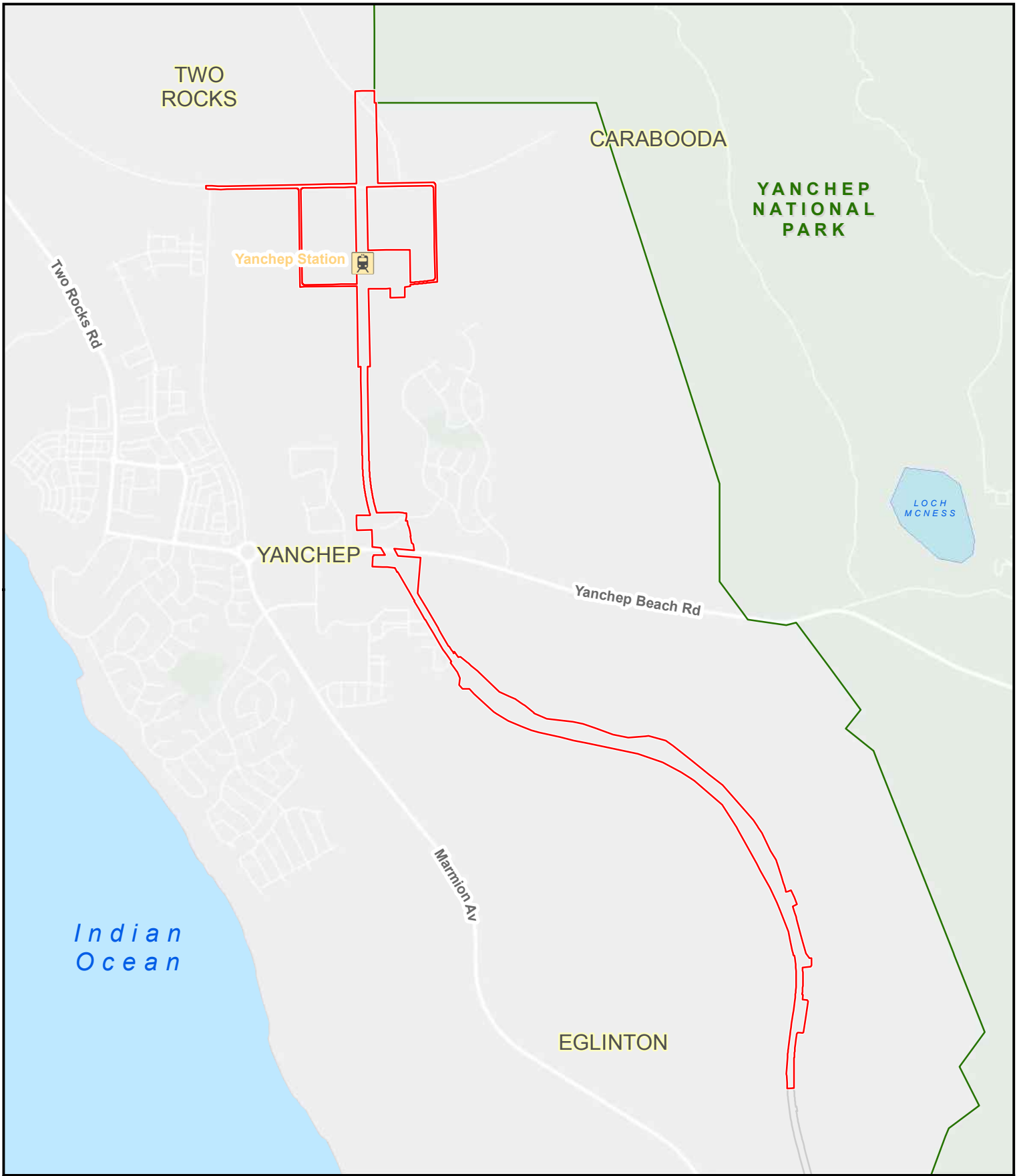
The Public Transport Authority of Western Australia (PTA) is developing the Yanchep Rail Extension (YRE) Project as part of the Western Australian Government's METRONET vision. The YRE Project is an extension to the Northern Suburbs Railway (also known as the Joondalup line) in Perth's northern suburbs, 40 km north of the Perth Central Business District (CBD). The YRE Project includes 14.5 km of railway beyond the existing Butler Station, new stations at Alkimos, Eglinton and Yanchep, and associated infrastructure.

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 northwest Sub-region, stimulating new employment opportunities, vibrancy, higher density land use and better sustainability outcomes envisioned by the Western Australian Government's Perth and Peel@3.5million plan (Department of Planning, Lands and Heritage [DPLH] and Western Australian Planning Commission [WAPC] 2018a).

The YRE Project is being assessed by the Environmental Protection Authority (EPA) under section 38 of the *Environmental Protection Act 1986* (EP Act) in two parts:

- Part 1: Butler Station to Eglinton Station: includes the southern portion of the YRE Project, which extends north of the existing Butler Station and generally follows the land reserved 'Railways' under the Metropolitan Region Scheme (MRS) before terminating to the north of the proposed Eglinton Station. The Part 1 Proposal includes a contingency for a turnback facility to be constructed to the north of the Eglinton Station, to allow for the turning of two six-car trains should Part 2 of the YRE Project not proceed.
- Part 2: Eglinton Station to Yanchep Station: includes the northern portion of the YRE Project which extends north of the proposed Eglinton Station and generally coincides with the land reserved 'Railways' under the MRS before terminating within the northern section of the Yanchep City Local Structure Plan (LSP). The Part 2 development envelope includes a turnback facility to the north of the Yanchep Station to allow for the turning and stowage of trains (**Figure 1-1**).

This ERD assesses the environmental impacts associated with Part 2 – Eglinton Station to Yanchep Station of the YRE Project (the Proposal). The assessment of Part 1 will not be discussed further in this ERD.



Yanchep Rail Extension (Part 2)
Figure 1-1 Location of the Proposal

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Surface Water Feature
- Proposed Station

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1.1 Purpose and scope of this document

This ERD covers the environmental impacts of YRE Part 2 from north of the future Eglinton Station to the proposed Yanchep Station in the City of Wanneroo (the Proposal).

The purpose of this ERD is to describe and assess the significance of the environmental impacts that have the potential to occur as a result of the construction and operation of the Proposal. Impacts are considered in the context of the preliminary key environmental factors identified by the EPA in its decision to assess the Proposal at a Public Environmental Review (PER) level of assessment.

The potential environmental impacts of YRE Part 1 were addressed in a separate assessment.

The structure of this ERD follows the template for an ERD provided in the *Instructions on how to prepare an Environmental Review Document* (EPA 2018c).

1.2 Proponent

The PTA is the proponent of this Proposal. The PTA's details are provided in **Table 1-1**.

Table 1-1: Proponent identification

Item	Detail
Proponent	Public Transport Authority of Western Australia
ABN	61 850 109 576
Address	Public Transport Centre West Parade Perth WA 6000
Contact	Miranda Ludlow miranda.ludlow@pta.wa.gov.au (08) 9326 3972

1.3 Environmental impact assessment process

The *Environmental Protection Act 1986* (EP Act) is Western Australia's primary environmental legislation. Part IV of the EP Act provides for the consideration and assessment of Proposals that may or will have a significant impact on the environment. The impact assessment process is administered by the Environmental Protection Authority Services (EPA Services) unit within the Department of Water and Environmental Regulation (DWER). EPA Services provides support to the Environmental Protection Authority (EPA), which is an independent statutory body established under the EP Act.

The PTA referred the Proposal to EPA Services under section 38 of the EP Act on 25 August 2018. On 12 September 2018, the EPA determined that the Proposal would be formally assessed, with the level of assessment set as Public Environmental Review (PER) and including a six-week public review period. The EPA subsequently prepared an Environmental Scoping Document (ESD) which sets out the matters to be addressed in the ERD (EPA 2018d; Appendix A).

This ERD is now published for a period of six weeks, during which time the public is invited to comment on the ERD. Refer to the **Invitation to make a submission** section at the beginning of this document for guidance on how to make a submission and the closing date for submissions.

After the public review period, the EPA will conduct its own assessment of the Proposal, taking into account the ERD, any submissions received and the PTA's responses to any submissions received. The EPA also takes into account relevant policies and guidelines and may seek advice from relevant government agencies. The EPA will prepare an assessment report recommending whether or not the Proposal should be implemented and, if recommending approval, any conditions that should apply. The EPA's report will be made public and is subject to appeal. After the appeal period has concluded, the EPA's assessment report will be provided to the Minister for the Environment, who will decide whether the Proposal may be implemented and, if so, the conditions of approval.

1.4 Other approvals and regulation

1.4.1 Land tenure

The Proposal will be constructed primarily within the 'Railways' reservation defined in the MRS and adjacent to land where residential construction has been progressed or land has been zoned for future urban development and associated uses. Notwithstanding approvals required under other acts, the construction of the railway has been enabled by the *Railway (METRONET) Act 2018*, which also authorises related works (including access) on non-railway land.

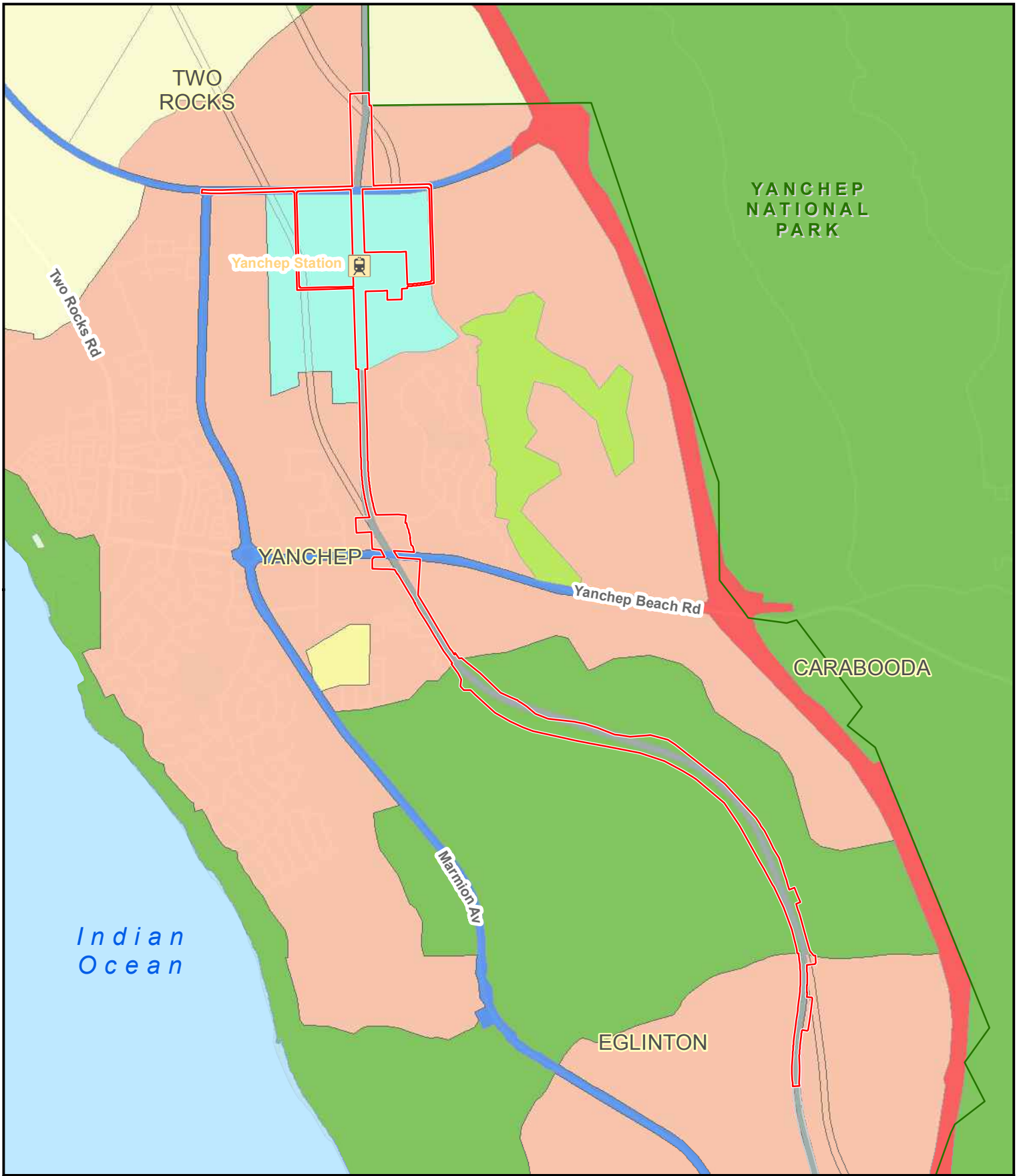
The development envelope occurs on land for which reservations, zoning and notice of delegation has been made under the MRS (**Table 1-2**, **Figure 1-2**). Approximately 30% of the development envelope is reserved 'Railways' and 19% 'Parks and Recreation', while 40% is zoned 'Central City Area' or 'Urban' under the MRS. These portions of the Proposal generally relate to the train station and associated infrastructure as well as temporary features such as access tracks and laydown areas that are required only during construction of the Proposal. These lands are held variously by the Crown (vested in other government agencies) and private developers. The PTA is consulting with land managers and private developers as required to obtain access for preliminary investigations and/or construction.

Table 1-2: MRS designations within the development envelope

MRS description	Area (ha)	Area (%)
Reserves and zones		
Reservations		
Railways	21.95	30.12%
Parks and recreation	18.68	25.63%
Other regional roads	3.28	4.53%
Subtotal (reservations)	***43.93***	***60.28%***
Zones		
Central city area	14.69	20.16%
Urban	14.26	19.56%
Subtotal (zones)	***28.95***	***39.72%***
Total	**72.86**	**100%**
Notice of delegation		
Bush Forever*		
Within 'Railways'	10.14	35.2%
Within 'Parks and recreation'	18.68	64.8%
Subtotal (Bush Forever)	***28.82***	***100%***

Source: RPS (2018a)

*Bush Forever Areas are an overlay that occurs across other reservations and zones.



Yanchep Rail Extension (Part 2)
Figure 1-2 MRS Zoning

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Proposed Station

MRS Zoning
- Central city area
- Other regional roads
- Parks and recreation
- Primary regional roads
- Private recreation
- Public purpose
- Railways
- Rural
- Urban
- Urban deferred
- Waterways

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1.4.2 Other approvals

To facilitate preliminary geotechnical investigations for the YRE Project, the PTA applied for a clearing permit under Part V of the EP Act. Clearing permit CPS 7843/1 was issued by the DWER on 31 August 2018 for the clearing of 6.56 ha of native vegetation for the purposes of geotechnical and unexploded ordnance (UXO) investigations only. The clearing permit is valid until 2029, and some clearing has already commenced. The 6.56 ha of clearing authorised by this clearing permit is for the YRE Project as a whole and has not been resolved into components for each of YRE Parts 1 and 2. Accordingly, the impact assessment in this ERD ignores any clearing impacts authorised under CPS 7843/1 except in the determination of offsets (discussed in Section 12), where the significant residual impacts that require offsetting will be adjusted by a final Offsets Strategy to avoid double counting of clearing impacts already accounted for under the clearing permit.

Other regulatory processes outside of the EP Act will apply to the Proposal. Table 1-3 summarises the other approvals that may be required under Western Australian legislation.

Table 1-3: Other approvals

Potential Proposal activities	Type of approval	Legislation regulating the activity	Regulatory agency
Clearing of native vegetation for geotechnical and unexploded ordnance surveys	Clearing permit	*Environmental Protection Act 1986* (Part V)	DWER
Disturbance of sites of Aboriginal heritage significance	Section 18 notice	*Aboriginal Heritage Act 1972*	DPLH[1]
Development of the Proposal (including station, car parks, public transport interchange) outside of the 'Railways' reservation	Development application	*Planning and Development Act 2005*	City of Wanneroo or WAPC[2]
Storage and handling of hazardous materials during construction	Licence	*Dangerous Goods Safety Act 2004*	DMIRS[3]
Crushing of excess limestone during construction	Licence	*Environmental Protection Regulations 1987*	DWER
Construction activities required 'out of hours' (i.e. between 7.00 p.m. and 7.00 a.m., or at any time on Sundays and public holidays)	Out of Hours Noise Management Plan (OHNMP)	*Environmental Protection (Noise) Regulations 1997*	City of Wanneroo

Adapted from RPS 2018a. Note that not all activities will necessarily be required.

1. DPLH = Department of Planning, Lands and Heritage.

2. WAPC = Western Australian Planning Commission.

3. DMIRS = Department of Mines, Industry Regulation and Safety.

1.4.3 Commonwealth environmental approvals

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the principal federal environmental legislation protecting Matters of National Environmental Significance (MNES). The EPBC Act is administered by the Commonwealth Department of the Environment and Energy (DoEE).

The Proposal was referred to DoEE on 14 August 2018 (EPBC reference 2018/8262). On 14 November 2018, the delegate for the Minister for the Environment determined that the Proposal is a controlled action under section 75 of the EPBC Act, requiring further assessment and approval. The relevant MNES (the controlling provisions) is 'Listed threatened species and communities' (Section 18 and 18A of the EPBC Act). The DoEE identified species and communities with the potential to be significantly impacted by the Proposal including but not limited to:

- Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (Endangered).
- Carnaby's Cockatoo (*Calyptorhychus latirostris*) (Endangered).
- Western Quoll (*Dasyurus geoffroii*) (Vulnerable).

The Proposal will undergo an accredited assessment in which the Commonwealth will rely on the outcomes of the assessment conducted by the Western Australian Government to inform its consideration of approval under the EPBC Act. The significance of the impacts from the Proposal to MNES is addressed separately in this ERD (Section 13) with respect to the relevant EPBC Act guidance.

Other relevant EPBC Assessments

Developments within the Alkimos Eglinton District Structure Plan area have previously been referred to the DoEE for consideration under the EPBC Act, and have now all been approved. The following developments are relevant to the Proposal:

- Landcorp - Eglinton / South Yanchep Residential Development (EPBC 2011/6021) which was assessed on Preliminary Documentation and approved on 16 June 2013.
- Part Lot 9010 and Lot 9031, Yanchep Beach Road, Yanchep (EPBC 2016/7642) which was determined as not a controlled action on 11 April 2016.

The location of the abovementioned developments are shown in **Figure 1-3**.

A portion of the YRE Part 2 development envelope overlaps an area already assessed for impacts to Carnaby's Cockatoo foraging habitat under EPBC 2011/6021. Additionally, the overlap includes an offset established by the proponent of EPBC 2011/6021 for significant residual impacts of that development to Carnaby's Cockatoo. These issues are discussed further in relation to this Proposal's offset requirements in Section 12.

Yanchep Rail Extension (Part 2)
Figure 1-3 EPBC Act Referals and Approvals Relevant to the Proposal

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- EPBC Assessment Boundary
- National Park
- Proposed Station

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Reference: Perth and Peel Urban Land Development Outlook (ULDO) 2016/2017 Staging (DOP-096)

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2 The Proposal

This section describes the Proposal and provides context for its development.

2.1 Background

The growth of Perth's northern suburbs has been subject to various planning processes over recent decades. Public transport servicing new and proposed urban development in the northwest corridor has been identified as key to supporting this growth to improve connectivity, encourage equitable and affordable access within the metropolitan area and alleviate dependence on road transport.

There have been several key strategic planning documents identifying a passenger railway line to Yanchep, including:

- The draft Directions 2031 and Beyond (DoP and WAPC 2010).
- The draft Perth and Peel Green Growth Plan (DPC 2015).
- Perth and Peel @3.5million The Transport Network (DoT, PTA and Main Roads 2018).
- Perth and Peel @3.5million (DPLH and WAPC 2018a).

In a planning context, provision for a railway in the northwest corridor has long existed in the MRS. First introduced in 1963, the MRS is the legal basis for planning the Perth metropolitan region, defining the future use of land by dividing it into broad zones and reservations (DPLH 2018). From time to time, the MRS is amended to account for changing planning needs. In recent years, several amendments to the MRS have been made with respect to transport corridors around the Butler, Eglinton and Alkimos areas, resulting in the current 'Railways' reservation in the current MRS **Figure 1-2**.

The most recent extension to the Northern Suburbs Railway was from Clarkson Station to Butler Station. Since the Butler extension opened in 2014, urban development has continued in Butler and extended into adjacent suburbs to the north including Alkimos, Eglinton and Yanchep. Extension of the Northern Suburbs Railway from Butler to new stations at Alkimos, Eglinton and Yanchep (the YRE Project, as defined in Section 1) is now required to support these growth areas as part of the State Government's METRONET vision.

The PTA proposed Part 2 of the YRE Project from north of Eglinton Station to the suburb of Yanchep in the City of Wanneroo. Part 2 is proposed as an extension from Part 1 (see Section 1). As described in Section 1.3, the Proposal was considered likely to have significant impacts on the environment and so was referred to the EPA under section 38 of the EP Act in August 2018. After deciding to assess the Proposal at a level of 'Public Environmental Review', the EPA prepared an ESD setting out the matters to be addressed in this ERD. This ERD responds to the ESD.

2.2 Justification

The planning of a railway through Eglinton and Yanchep originally commenced in planning processes responsible for determining the land uses associated with future urban development of the northwest corridor. While these early planning stages do not strictly form part of this Proposal, they are important and necessary context for the basis of this assessment in considering how previous planning decisions are inherent in, or built into, the design of this Proposal. Accordingly, decisions made during historical planning processes have influenced the extent and type of impacts the Proposal may have on the environment. While amendments to planning schemes have resulted in some greatly improved environmental outcomes for the Proposal (e.g. by large-scale avoidance of impacts to areas of ecological

significance), it is important to recognise that the same processes also place limitations on the PTA's ability to further minimise impacts at the detailed Proposal design level. More recently and critically, the EPBC Act approvals granted to surrounding developments as described in Section 1.4.3 and planning approvals under Western Australian planning processes (i.e. LSPs, subdivision plans and development approvals) have resulted in the Proposal being confined to the 'Railways' reservation defined in planning schemes, which is the basis for this Proposal's development envelope. The impact assessments presented in this document should therefore consider the context and implications of these factors.

The following subsections provide a brief background into the various processes (planning and others) that have shaped the development of the Proposal and its potential environmental impacts, including:

- Planning processes such as the MRS amendments and associated lower level structure plans.
- Avoidance and minimisation of impacts through planning and other processes.
- Approval of surrounding urban developments.
- Engineering constraints in railway construction and operations.

2.2.1 Planning for a railway

A passenger railway line in the Eglinton and Yanchep area has been contemplated via the planning system for the past two decades. This section provides a brief overview of how the planning process has made formal provisions for a railway line through amendments to the MRS and adoption of lower level structure plans.

Amendment 787 to Town Planning Scheme No.1

This amendment was initiated in 1997 to ensure that zonings of the Yanchep-Two Rocks area under Town Planning Scheme No. 1 reflected the zoning already given statutory effect by the gazettal in September 1996 of Amendment 975/33 to the MRS.

The Chairman of the EPA decided that Town Planning Scheme 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. In 1999 the EPA concluded that the rezoning could be implemented to meet the EPA's objectives provided that the recommended conditions were imposed and enforced. Planning approval required that Environmental Conditions were incorporated into the City of Wanneroo's Town Planning Scheme 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.

MRS Amendment 1029/33: Alkimos–Eglinton and the Alkimos Eglinton District Structure Plan

WAPC initiated Amendment 1029/33 to the MRS in 2000 to rationalise zones and reservations in the Alkimos and Eglinton localities to correspond with the Alkimos-Eglinton District Structure Plan (DSP), the area traversed by the Proposal. MRS Amendment 1029/33 was subject to formal assessment by the EPA at the level of Environmental Review. The Environmental Review was required as the proposed land use changes was recognised to potentially have significant impacts on a number of environmental factors.

The Alkimos Eglinton District Structure Plan encompasses approximately 2,600 ha of land. Key elements of the plan include:

- Preservation of over 500 ha of the coastal dunal system and environmentally significant landform.
- Two east-west green linkages between the coast and major regional open space systems.

In 2005, the EPA recommended several modifications to the 'Parks and Recreation' reservation to increase its area and its incorporation of several values including occurrences of Swan Coastal Plain (SCP) 26a and ecological linkage functions.

The EPA indicated that it supported a realignment of the railway reservation as part of a future amendment to the MRS to avoid the fragmentation of the geoheritage and landform values associated with the Alkimos dune system. It was agreed by all stakeholders that changes to the railway alignment would be the subject of a separate MRS Amendment.

MRS Amendment 1192/57: Northern Suburbs Railway and Romeo Road Realignment

MRS Amendment 1192/57 provided for the realignment of the reservation for the Northern Suburbs Railway further west, approximately parallel to and midway between the Mitchell Freeway and Marmion Avenue, in Alkimos and Eglinton, following a railway alignment definition study to avoid the fragmentation of the geoheritage and landform values associated with the Alkimos dune system.

MRS Amendment 1192/57 was referred to the EPA for assessment under Section 48a of the EP Act. In May 2010 the Chairman of the EPA considered that the likely environmental impacts of the scheme amendment were not so significant as to warrant formal environmental assessment.

The final gazetted 'Railways' reservation following MRS Amendment 1192/57 represents the general alignment of the YRE development footprint for the YRE Project, which includes this Proposal (see Figure 1-2).

2.2.2 Approval of surrounding urban developments

As described in Section 1.4.3, a railway was included as part of the developments within the Alkimos Eglinton District Structure Plan area that were referred under the EPBC Act. One development included a proportion of the Proposal and adjacent land and the other is entirely adjacent to the Proposal (see **Figure 1-3**). These developments were referred under the EPBC Act between 2011 and 2016, one receiving approval in 2013 and the other considered not to have a significant impact on MNES (not a controlled action).

In many cases, urban development adjacent to the development envelope have received necessary planning approvals under Western Australian planning processes sufficient for some earthworks to commence. In some areas, construction has commenced or is complete.

It is important to recognise that the approvals relating to the surrounding urban developments highly constrain the YRE Project and the alignment of the 'Railways' reservation. Even where construction adjacent to the development envelope has not commenced, planning and approvals for surrounding land uses are sufficiently advanced such that the 'Railways' reservation is effectively limited to its current alignment.

2.2.3 Project alternatives

The PTA considered a range of alternative alignments and construction methods at various stages in the YRE Project's planning. GHD conducted an early alignment definition study in 2005 which resulted in one recommended alignment, which is similar to the preferred alignment outlined in this ERD. (GHD 2005).

Following a detailed review of the alignment proposed by GHD, the PTA amended the alignment through Bush Forever Site 289 (Ningana Bushland) as the GHD proposed alignment would have impacted on houses constructed since 2015.

The PTA revisited four options in 2018 as part of the environmental planning phase of the Proposal.

- Option 1: At grade construction along the referred alignment.
- Option 2: At grade construction along the alternative alignment.
- Option 3: Tunnel bore construction along the referred alignment.
- Option 4: Viaduct (bridges) construction along the referred alignment.

The referred and alternative alignments are shown on Figure 2-1. The referred alignment is generally equivalent to the development envelope for this Proposal.

The PTA was unable to accept Options 2, 3 and 4 due to engineering constraints, environmental impacts through larger infrastructure footprints, additional noise, and operational performance of the proposed railway. Options 3 and 4 were ruled out as they were prohibitively expensive. Option 2 has slightly more favourable environmental outcomes than Option 1; however the same determining factors that led to rejection of alternative options during the earlier planning stages were still significant issues for carrying this option forward. Option 2 was also estimated to be slightly more expensive than Option 1, as well as having unfavourable planning outcomes.

For a more detailed discussion of the four options and a comparison of their advantages and disadvantages, please refer to Section 11.1.

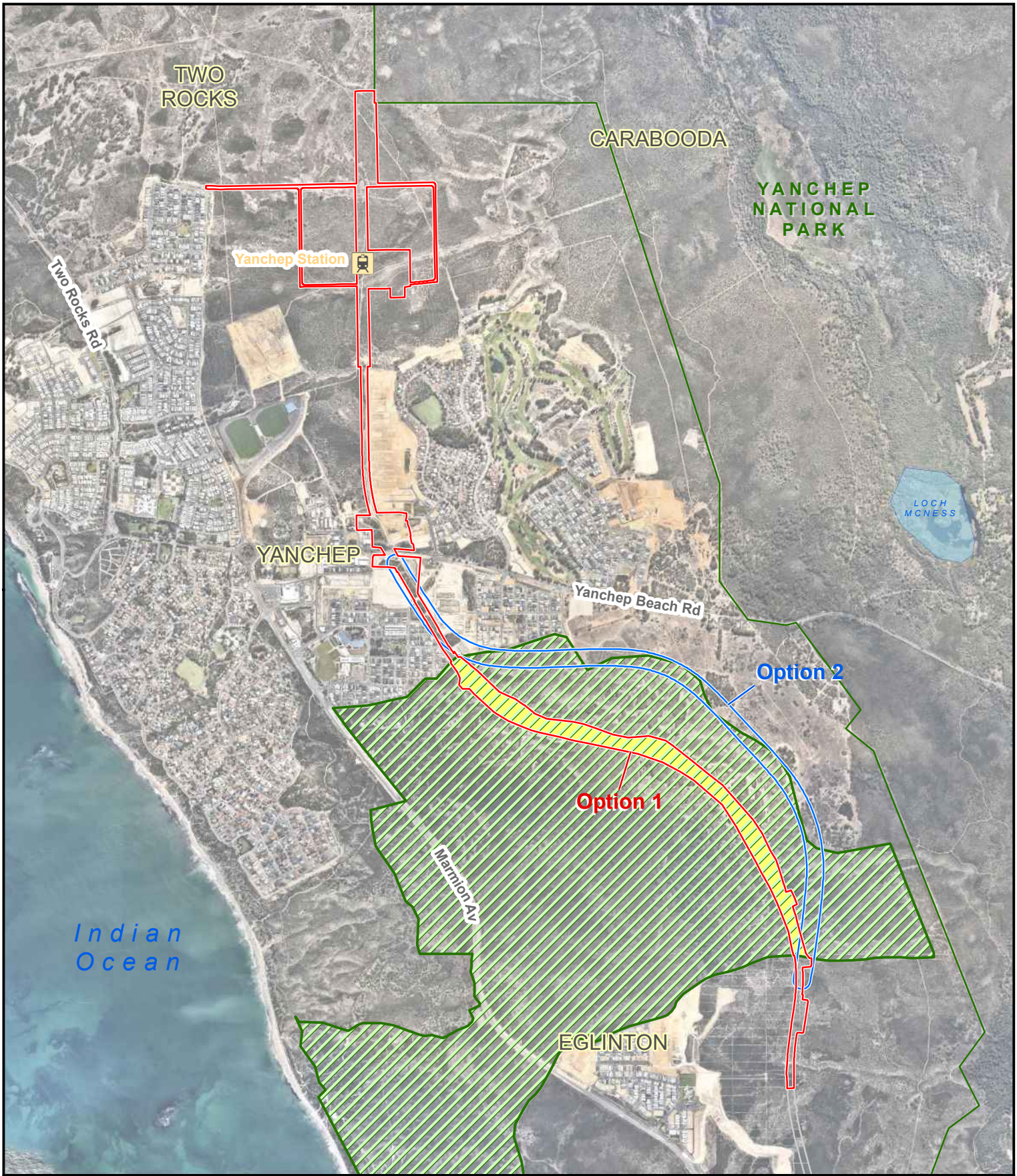
2.2.4 Minimisation of impacts through avoidance

Outside of Ningana Bushland, opportunities to amend the development envelope beyond the MRS 'Railways' reservation are limited due to already constructed and/or approved urban developments. 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:

- The northern extent of the development envelope was modified to reduce clearing of native vegetation and avoid direct impacts to Bush Forever site 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 1-2), 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 points of entry into Ningana Bushland for the 'Railways' reservation, however the development envelope has been positioned to:
    - Minimise impacts to the Quindalup dune system; and
    - Maximise the size and viability of the two portions of Ningana Bushland which would result should the Proposal be approved.

- Selection of a development envelope containing approximately 29% of previously disturbed land to minimise the clearing of remnant native vegetation.
- Realignment of the development envelope to pass through an area of planted, non-native Eucalyptus vegetation to minimise clearance of native vegetation.
- Access tracks within Ningana Bushland have been negotiated and planned to accommodate PTA, Principal Shared Path's (PSP) disability access standards, Department of Biodiversity Conservation and Attractions (DBCA) and Department of Fire and Emergency Services (DFES) operational requirements, thereby eliminating potential duplication of access tracks and PSPs of different construction standards. The proposed earthworks design through Ningana Bushland includes a PSP on one side of the railway which also meets the PTA and DBCA operational requirements. An additional access track on the other side of the railway meets PTA, DBCA and DFES requirements. This has resulted in a reduction of native vegetation clearing required.
- The development envelope and volumes of sand to be excavated within Ningana Bushland were reduced by raising the vertical alignment of the railway through this site to be, reducing native vegetation clearing and the potential impacts to flora and fauna habitat and landforms.

A Construction Environment Management Plan (CEMP) will be implemented to further minimise impacts (ELA 2019; Appendix P).



Yanchep Rail Extension (Part 2)
Figure 2-1 Alternative Alignment

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Surface Water Feature
- Bush Forever Site 289
- Proposed Station
- Option 1: Referred Alignment
- Option 2: Alternative Alignment Indicative Development Envelope

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2.3 Proposal description

The Proposal described in this document is Part 2 of the YRE Project from north of the future Eglinton Station to the proposed Yanchep Station in the City of Wanneroo (the Proposal), approximately 40 km north of the Perth CBD (Figure 2-2). The Proposal includes the construction of approximately 7.2 km of narrow gauge dual track railway from approximately 700 m north of the future Eglinton Station, heading generally north before terminating north of the proposed Yanchep Station. The new station at Yanchep will include intermodal interchanges for bus services, 'park and ride', 'kiss and ride', active mode facilities and associated infrastructure.

The majority of the proposed railway will be constructed in cuttings averaging approximately 6 m below surrounding ground level, which will reduce noise to surrounding urban areas and provide grade separation to enable local roads to pass overhead. See Figure 2-3 for a longitudinal cross-section of the Proposal, which compares a highly undulating existing surface elevation with the proposed formation level on which the railway tracks are laid. As adjacent urban developments are commenced, the elevation of surrounding land is expected to be altered from its current state. The PTA anticipates that the Proposal will generally be 6 m below completed adjacent urban developments and at-grade through Ningana Bushland.

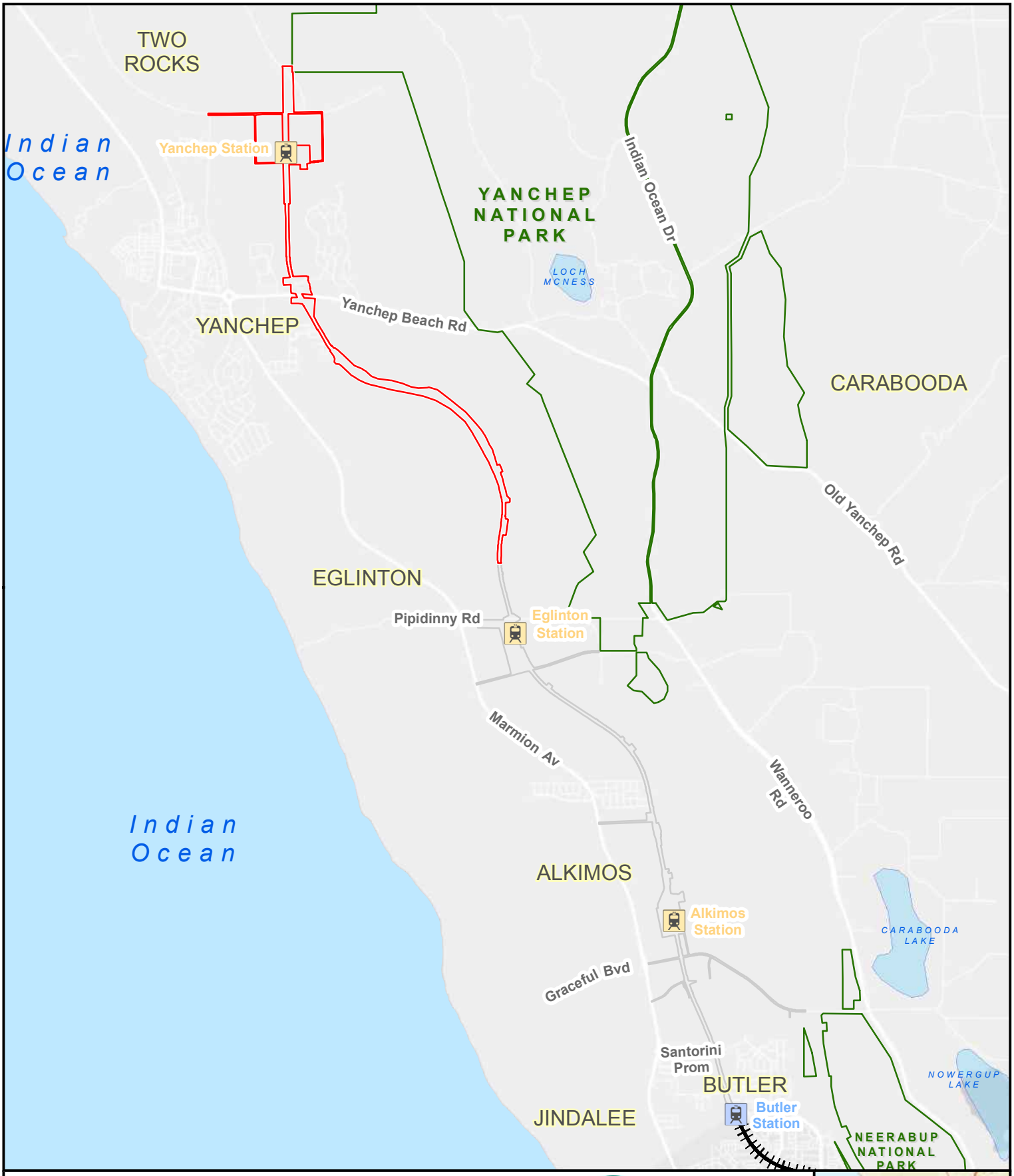
The Proposal also includes permanent infrastructure for maintenance and emergency vehicle access, drainage, overhead electrification for traction, signalling, communications and other services, access roads and pathways, and access control (e.g. fences and gates). A PSP will also be constructed alongside the railway (outside the railway corridor fencing) to provide transport facilities for pedestrians and cyclists. In Ningana Bushland, the PSP will be located on the western side of the railway, while an access track will be included on the eastern side.

Table 2-1 formally identifies the Proposal and proponent and provides a short description of the Proposal. Further details of the proponent's identity were provided in Section 1.2.

Table 2-2 sets out the key physical and operational elements of the Proposal and the locations and proposed extents of these elements. The 72.86 ha development envelope is comprised of each of the four physical elements set out in **Table 2-2**, representing the boundary within which all construction activity will occur. For this Proposal, the entire development envelope is proposed to be cleared for permanent infrastructure including the railway, Yanchep Station and associated infrastructure (**Table 2-2**). The Proposal's development envelope is presented in Figure 2-4.

Table 2-1: Summary of the Proposal

Item	Details
Proposal title	Yanchep Rail Extension: Part 2 – Eglinton Station to Yanchep Station
Proponent name	Public Transport Authority of Western Australia
Short description	The Public Transport Authority proposes to extend a future connection of the Northern Suburbs Railway by 7.2 kilometres, from north of the future Eglinton Station to the suburb of Yanchep in the City of Wanneroo. The Proposal is to construct and operate the rail extension and one new intermodal (rail, bus, 'park and ride', 'kiss and ride, walk and cycle) transit station at Yanchep. It will include the construction and operation of a Principal Shared Path and access roads.



Yanchep Rail Extension (Part 2)
Figure 2-2 YRE Project in Local Setting

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Surface Water Feature
- Proposed Station
- Existing Station
- Existing Railway

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Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
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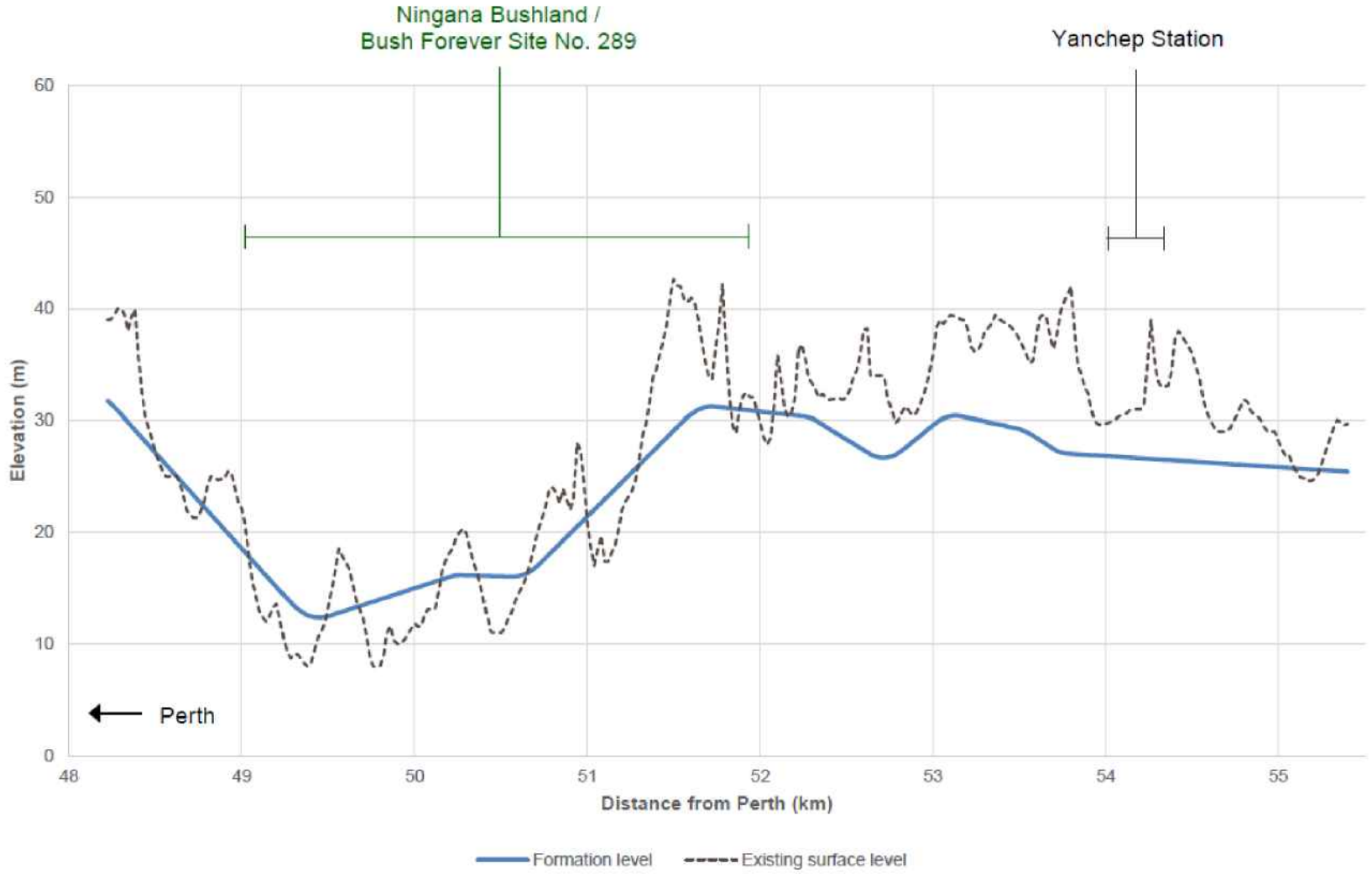

Yanchep Rail Extension (Part 2)
Figure 2-3 Longitudinal Cross-section of the Proposal

Public Transport Authority

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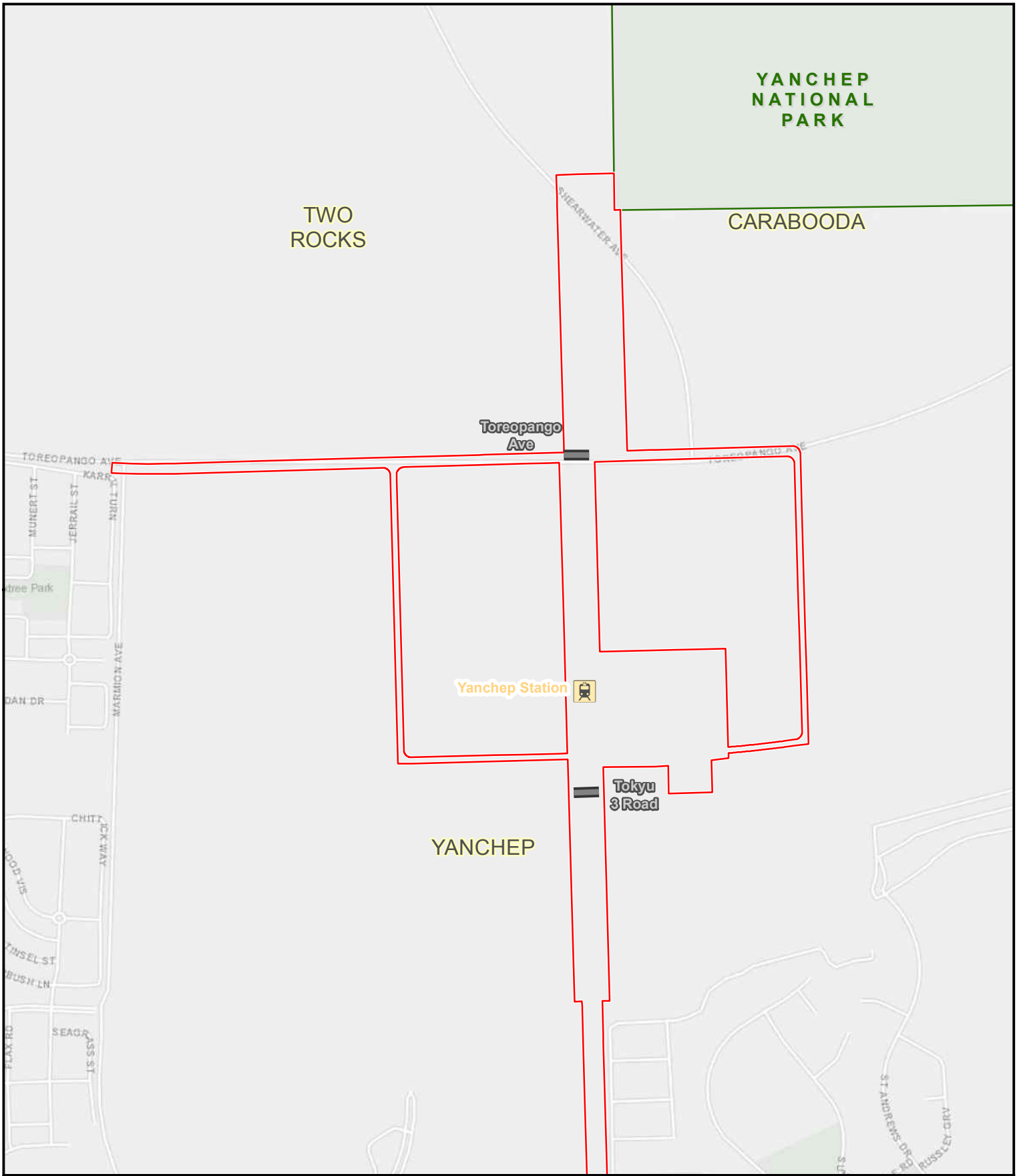
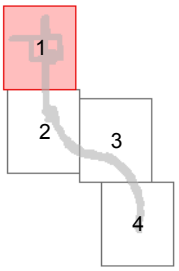


Yanchep Rail Extension (Part 2)
Figure 2-4 Proposal Alignment

Public Transport Authority

Legend

- Development Envelope
- National Park
- Proposed Station
- Road Bridge Location (Indicative)



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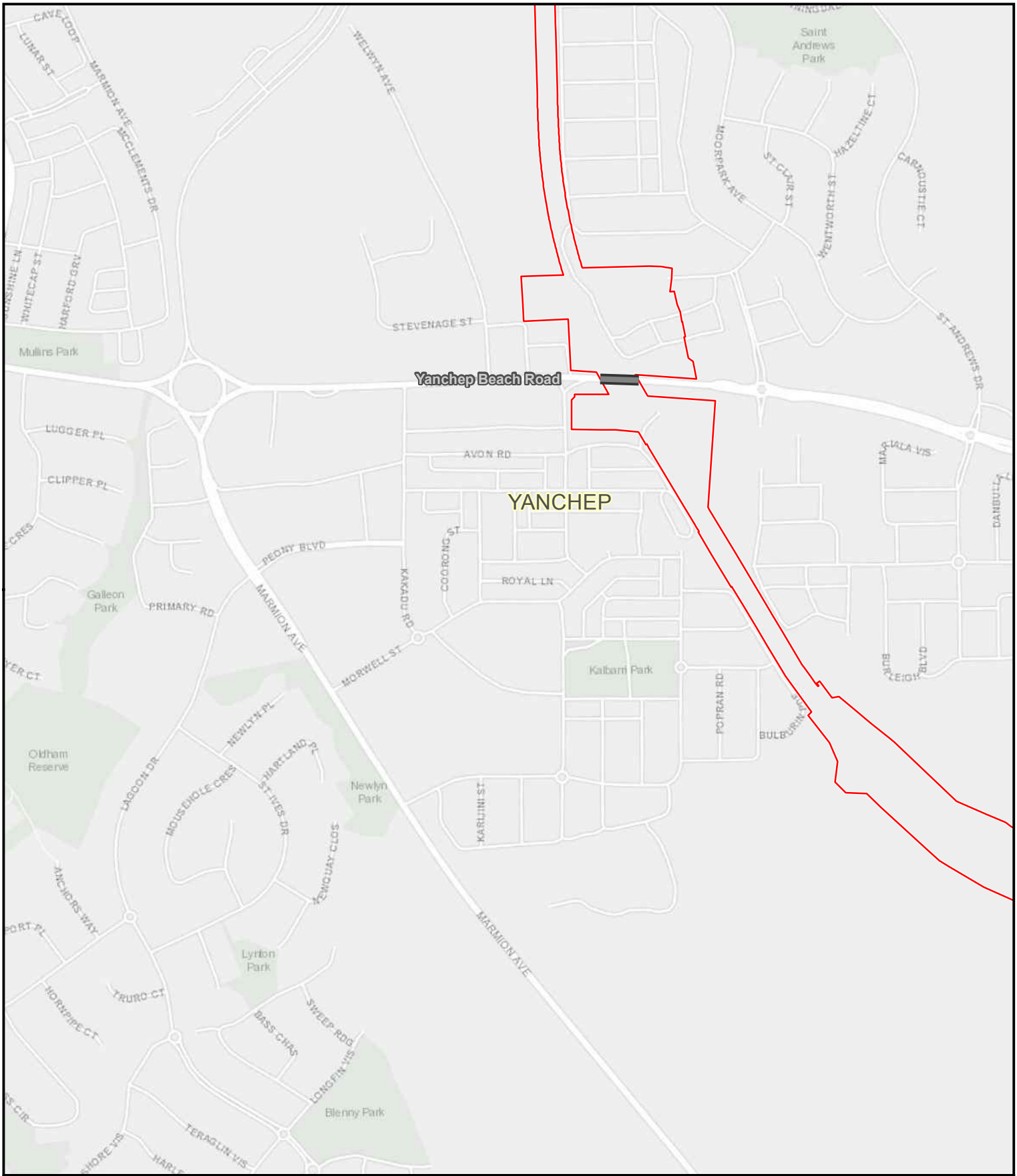
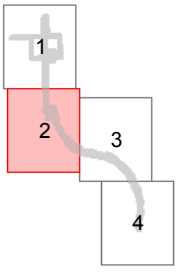


Yanchep Rail Extension (Part 2)
Figure 2-4 Proposal Alignment

Public Transport Authority

Legend

- Development Envelope
- Road Bridge Location (Indicative)



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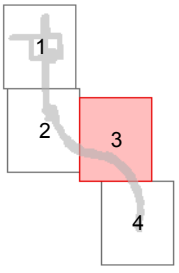
Yanchep Rail Extension (Part 2)
Figure 2-4 Proposal Alignment

Public Transport Authority

Legend

- Development Envelope
- National Park



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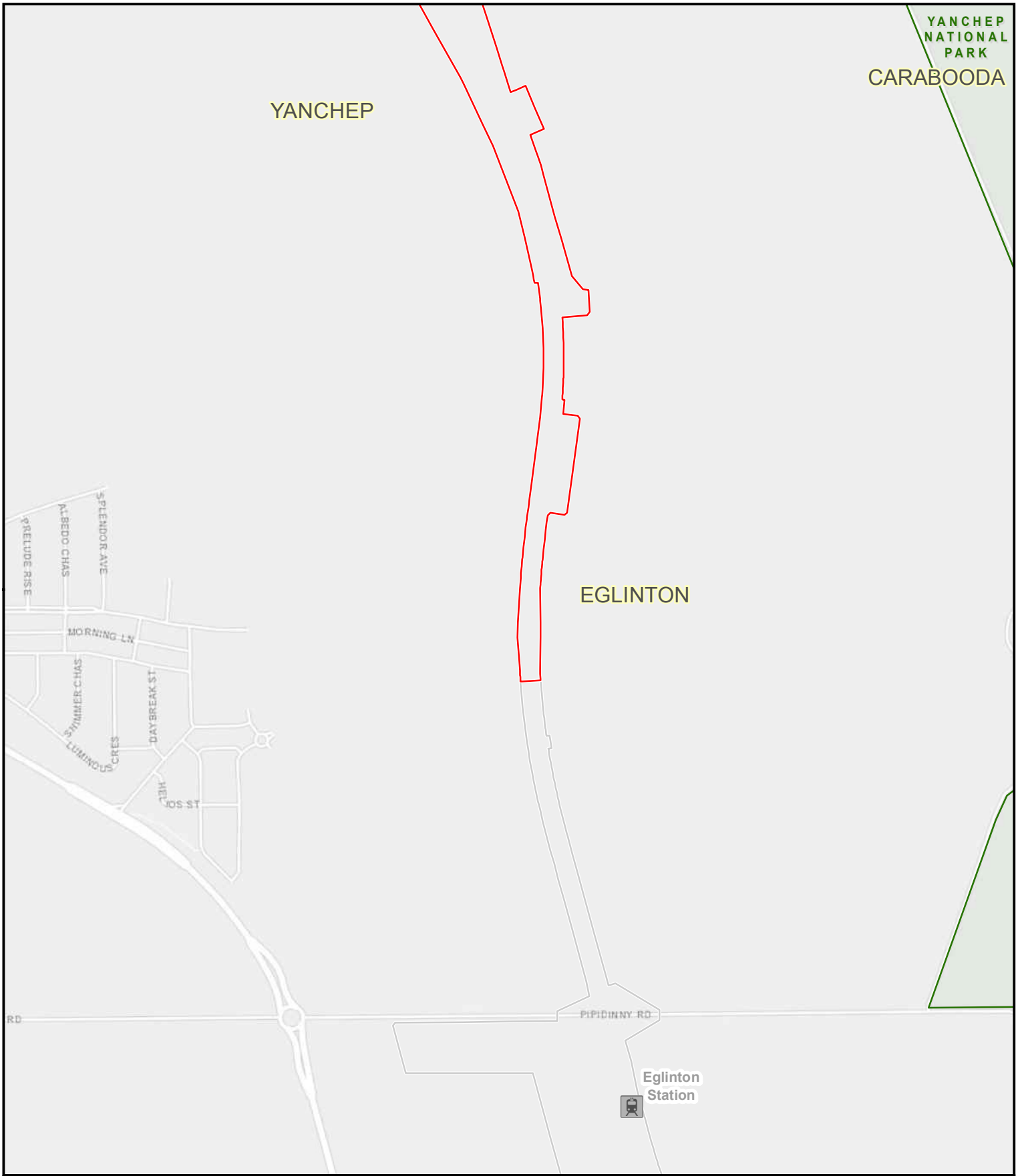

Yanchep Rail Extension (Part 2)
Figure 2-4 Proposal Alignment

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Proposed station (YRE Part 1)

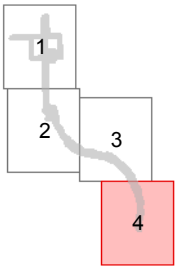

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Table 2-2: Location and proposed extent of physical and operational elements

Element	Location	Proposed extent
Physical elements		
Railway extension	The railway will begin from a future connection with the Northern Suburbs Railway, north of the future Eglinton Station, generally following the land reserved 'Railways' in the MRS before terminating approximately 900 m north of the future Yanchep Station.	7.2 km of dual track railway generally in cuttings approximately 6 m below surrounding ground level within an area of approximately 60.31 ha.
Yanchep Station	Located approximately 1.6 km to the north of Yanchep Beach Road.	At-grade railway station and associated facilities including intermodal rail, bus, 'park and ride', 'kiss and ride' and active mode facilities.
Construction and access areas	At locations of proposed future urban development or roads reserved in the Metropolitan Region Scheme (MRS) or as detailed within other approved or draft Local Structure Plans.	Approximately 12.57 ha.
Road bridges	At Yanchep Beach Road, 'Tokyu 3' Road and Toreopango Drive as shown in Figure 2-4.	Three road bridges approximately 30 m wide, including 3 m wide PSP.
Operational elements		
Railway	The railway will begin from a future connection with the Northern Suburbs Railway, north of the future Eglinton Station, generally following the land reserved 'Railways' in the MRS before terminating approximately 900 m north of the future Yanchep Station	Rail services will operate between the future Eglinton Station and Yanchep Station up to 24 hours per day, seven days per week
Yanchep Station	Located approximately 1.6 km to the north of Yanchep Beach Road.	Rail and bus services may operate from Yanchep Station up to 24 hours per day, seven days per week

2.4 Local context

The local context for the region was described in RPS (2018a) and is replicated below.

2.4.1 Land use

The majority of the development envelope is undeveloped and characterised by coastal dune formations and associated native vegetation. Approximately 49.17 ha (or 67.49%) of the development envelope's 72.86 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.

Access tracks and firebreaks also intersect the development envelope. More recently a portion of the development envelope, within the Yanchep City LSP area, has been cleared as part of the approved construction and development of the adjacent housing estates.

2.4.2 Conservation areas

Approximately 28.82 ha (or 4.48%) of the 640.83 ha Bush Forever site 289 (Ningana Bushland) has been included within the development envelope. Within Ningana Bushland, 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 1-2).

Outside of the development envelope, approximately 1.46 ha of land currently reserved for 'Railways' will remain within Ningana Bushland. To assist in addressing the long-term protection of Ningana Bushland it is intended that the 1.46 ha of 'Railways' reservation outside the development envelope is amended to be reserved for 'Parks and Recreation'.

2.5 Surrounding land context

The surrounding context for the region was described in RPS (2018a) and is replicated below.

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. The development envelope intersects the future Yanchep Strategic Metropolitan Centre, which is zoned Central City Area in the MRS (**Figure 1-2**).

2.5.1 Surrounding land uses

Over half 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 2-5**).

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 envelope, including the clearing of native vegetation from large areas of land, and changes to landforms resulting from earthworks prior to construction of buildings and other infrastructure.

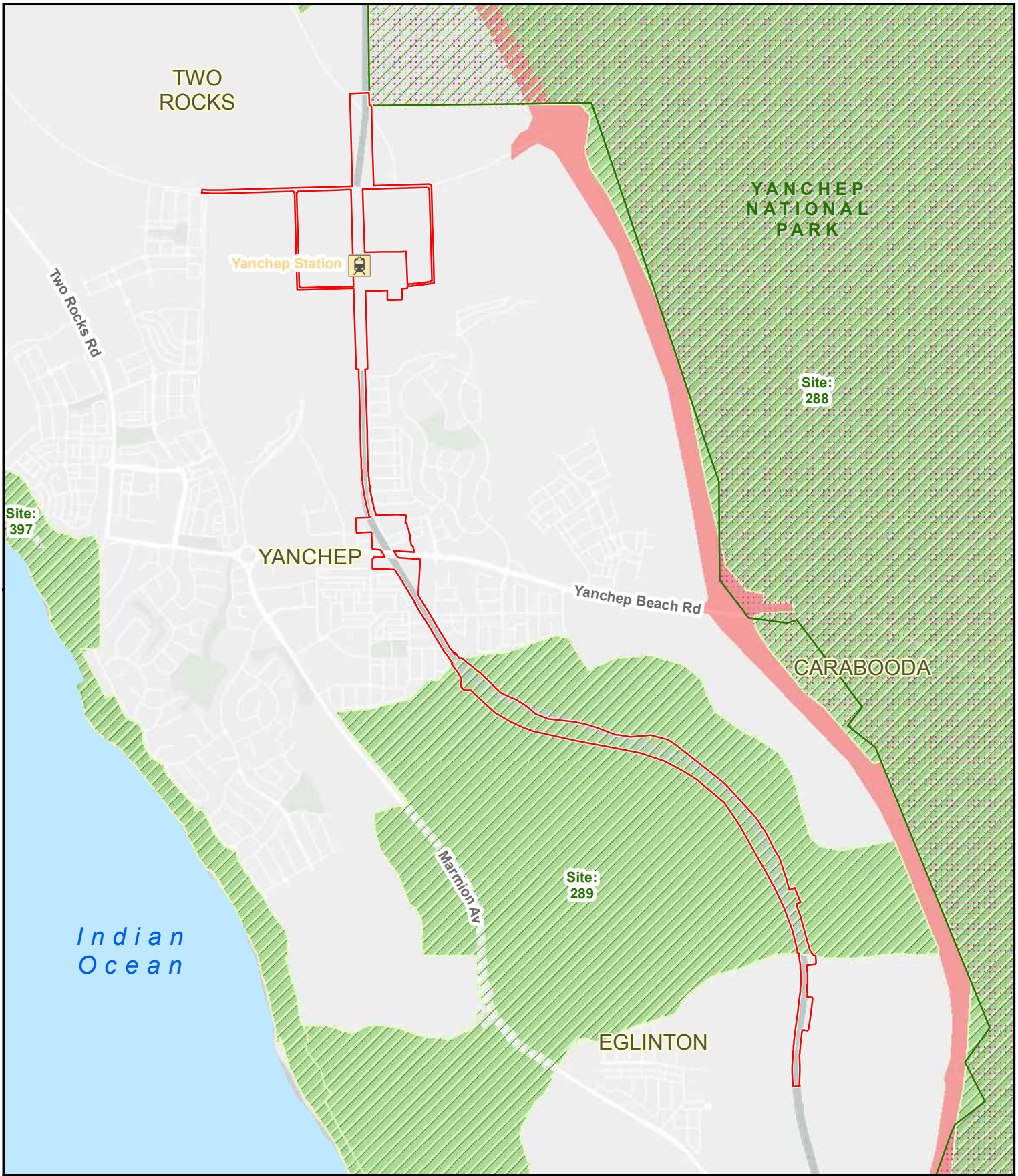
GHD (2018a) identifies that the development envelope intersects future urban development areas subject to the Urban Land Development Outlook 2016/17 (ULDO) (DPLH and WAPC 2017). The ULDO data indicates that of the land within 1 km of the development envelope approximately 366 ha will support likely future residential/commercial development within the next five years, with approximately 160 ha (43.65%) having current conditional approval (GHD 2018a; **Table 2-3**). Further, the ULDO data indicates that of the land within the northwest Sub-region approximately 1,350 ha will support future residential/commercial development over the next five years, with approximately 848 ha (62.8%) having current conditional approval (GHD 2018a; **Table 2-3**, **Figure 2-6**).

Table 2-3: Future residential, commercial and industrial development

Development type	Staging	Extent of land within 1 km of development envelope (ha)	Extent of land within the northwest 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 (5-10 years)	–	27.23
	Long term (10+ years)	–	680.77
Total		**995.71**	**7,257.49**

Source: GHD 2018a
Perth and Peel Urban Land Development Outlook 2016/17 - staging (DOP-096), Perth and Peel Urban Land Development Outlook 2016/17 - Industrial (DOP-097). Note: the areas presented in this table do not consider the overlap with the Part 1 and Part 2 project areas.

Further discussion on future development and its use in cumulative impact assessment is provided in Section 4.3.



Yanchep Rail Extension (Part 2)
Figure 2-5 Existing and Surrounding Land Uses

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Proposed Station
- DBCA Legislated Lands and Waters
- Bush Forever Site
- Parks and recreation
- Primary regional roads
- Railways

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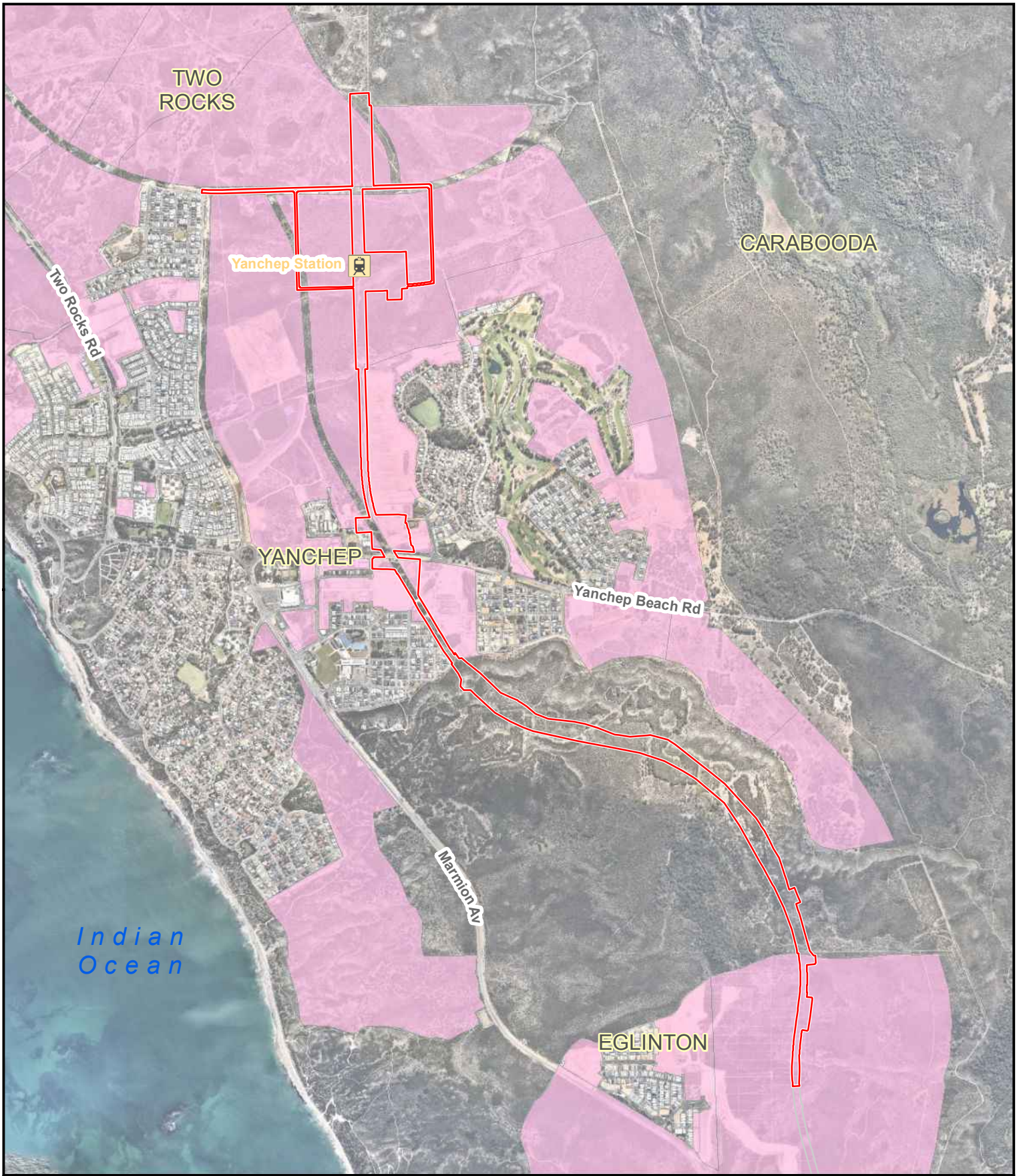

Yanchep Rail Extension (Part 2)
Figure 2-6 Urban Land Development Outlook

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Short, Medium and Long-term (0-10+ years) Urban Land Development Outlook
- Proposed Station

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Reference: Perth and Peel Urban Land Development Outlook (ULDO) 2016/2017 Staging (DOP-096)

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2.5.2 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. Marmion Avenue is reserved as "Other Regional Roads" under the MRS.

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. South of Bush Forever site No. 288: Yanchep National Park and Adjacent Bushland, Wanneroo Road is reserved as "Primary Regional Roads" under the MRS.

The 72.86 ha development envelope for this Proposal is located directly to the north of the 70.22 ha Part 1 development envelope for the YRE Project.

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 2-5**).

2.5.3 Conservation areas

Local conservation areas

The 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 designation as Bush Forever areas. Approximately 593 ha of land within 1 km of the development envelope is designated as Bush Forever area under the MRS.

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 2-5**). This site is 640.83 ha in extent and contains 551.5 ha of bushland comprised of woodland, heath, shrubland and grassland communities (Government of Western Australia 2000). Bush Forever site No. 288: Yanchep National Park and Adjacent Bushland is 2,902 ha in extent and contains 2,706 ha of bushland.

Regional conservation areas

The following Bush Forever sites are located less than 4 km from the development envelope (**Figure 2-5**):

- 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 Ningana Bushland.
- Bush Forever site No. 129: Bernard Road Bushland, Carabooda is located approximately 3.1 km to the southeast of the development envelope.
- Bush Forever site No. 130: Link between Yanchep and Neerabup National Parks is located approximately 3.4 km to the southeast of the development envelope.

Yanchep National Park is located approximately 1 km to the east of the development envelope (**Figure 2-5**). Further afield, the Gnangara-Moore River State Forest is located north and east of Yanchep National Park, approximately 3 to 4 km from the development envelope. Neerabup National Park is approximately 6 km southeast of the development envelope, east of Butler.

2.6 Sub-regional context

The subregional context for the region was described in RPS 2018a with respect to the northwest Sub-regional Planning Framework Area and is replicated below.

Approximately 43,000 ha or 55% of the northwest 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 2-7 depicts reserved land containing key environmental and landscape features, which informed the planning framework for the northwest Sub-region. **Figure 2-7** indicates the lands reserved for 'Railways' in the context of the lands reserved for "Parks and Recreation" under the MRS.

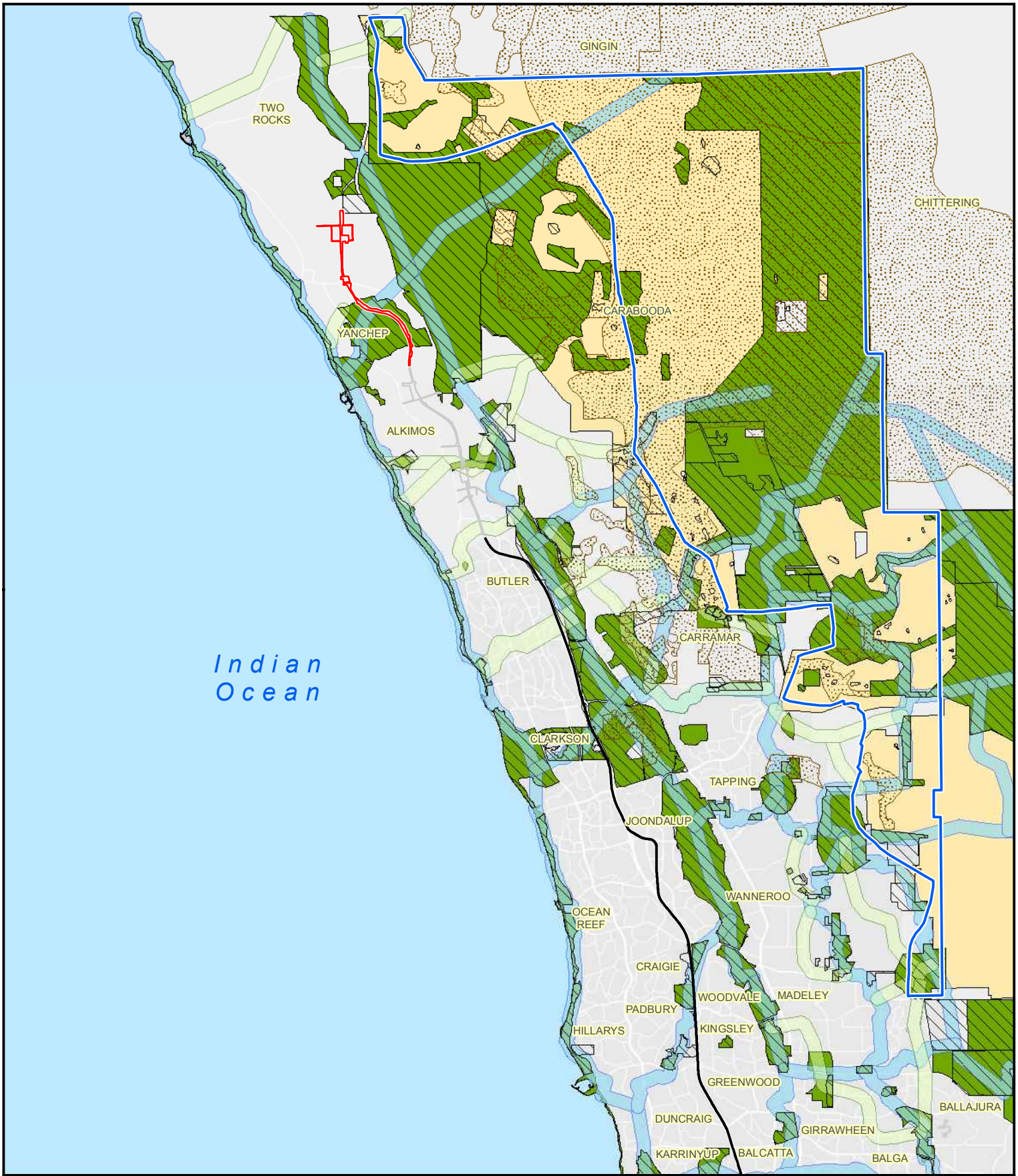
The key protected environmental features within the northwest Sub-region include:

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

Figure 2-7 identifies the full extent of Bush Forever delegations and 'Parks and Recreation' reserves in the northwest Sub-region. Approximately 27,459 ha of the land within the northwest Sub-region is delegated as Bush Forever area under the MRS.

Figure 2-7 also identifies the regional ecological linkages which informed the planning framework for the northwest Sub-region. The northwest Sub-region regional ecological linkages run from north to south adjacent to the west and east of the 'Railways' reservation.

The City of Wanneroo's Local Biodiversity Plan 2018/19 – 2023/24 identifies a regional ecological linkage that runs east-west across Ningana Bushland (City of Wanneroo 2018). Ecological linkages are discussed and shown later in Section 5.3.7.



Yanchep Rail Extension (Part 2)
Figure 2-7 North-west Sub-region Key Environmental and Landscape Features

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Existing Railway
- Water Catchment Protection
- Raw Materials
- Bush Forever
- Local Ecological Linkage
- Regional Ecological Linkage
- Parks and recreation
- State forests

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2.7 Regional context

The regional context was described in RPS 2018a with respect to the Swan Coastal Plain (SCP) Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the SCP IBRA region and is replicated below.

The development envelope and the northwest Sub-region (DPLH and WAPC 2018b) lie within the broader IBRA region of the SCP. The SCP is comprised of the Dandaragan Plateau (SWA1) and SCP (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 northwest Sub-region are situated within the 1,333,901 ha SWA2 subregion, which is described as (Mitchell, Williams and Desmond 2002):

> *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) 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 2018a).

3 Stakeholder engagement

3.1 Key stakeholders

The PTA has consulted extensively with key stakeholders during preliminary planning for the YRE Project and in the refinement of the development envelope. The key government and community stakeholders consulted by the PTA are shown in **Table 3-1**.

Table 3-1: Key stakeholders for the YRE Project

Stakeholder	Project role / interest
Commonwealth Government	
Department of the Environment and Energy	Assessment and approval of proposed actions significantly impacting on MNES under the EPBC Act
State Government	
Department of Water and Environmental Regulation	• Environmental assessment under the EP Act • Assistance with implementation of Water Sensitive Urban Design (WSUD) principles • Assistance with noise and vibration assessment and mitigation options
Environmental Protection Authority	• Environmental advice under the EP Act
Department of Biodiversity Conservation and Attractions	• Environmental offset advice • Advice on detailed vegetation assessments and Bush Forever
Department of Planning, Lands and Heritage	• Land acquisition and MRS Amendment • Liaison with other landowners • Aboriginal heritage • Interface for wider infrastructure requirements
Western Australian Planning Commission	Rezoning and development application approval(s)
Water Corporation	Assistance with location of production bores and wellhead protection Zones (WHPZ)
Local Government	
City of Wanneroo	• Advocacy and community relations • Rezoning and development application approval(s)
Local Community	
South West Aboriginal Land and Sea Council (SWALSC) (on behalf of the Whadjuk people)	• Compliance with the state government's Noongar Standard Heritage Agreement (NSHA) • Coordination of Aboriginal heritage surveys
Whadjuk working group	• Compliance with the NSHA • Coordination of Aboriginal heritage surveys

Stakeholder	Project role / interest
Property developers	Project definition and delivery
Urban Bushland Council	Community organisation
Quinns Rocks Environmental Group	Community group

3.2 Stakeholder engagement process

A Communications and Stakeholder Engagement Plan 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.

Community relations activities contained within the Communications and Stakeholder Engagement Plan 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, City of Wanneroo 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.

A dedicated METRONET website (http://www.metronet.wa.gov.au/) has been established to provide a detailed overview of the YRE Project, allow interested parties to enquire about METRONET and register for project updates.

3.3 Stakeholder consultation

Specific consultation with non-government stakeholders and response to issues are identified in **Table 3-2**.

Table 3-2: Consultation and response to issues

Stakeholder	Date	Issues/topics raised	Proponent response/outcome
Rail construction industry	13 September 2017	Briefing provided to the Rail Construction Industry on METRONET, including the YRE Project.	Nil.

Stakeholder	Date	Issues/topics raised	Proponent response/outcome
Quinns Rocks Environmental Group	17 November 2017 21 September 2018	Review of the environmental context of the YRE Project. Concerns related to Lot 200 Alkimos Drive "Parks and Recreation" reservation, which relates to Part 1 and fragmentation of Bush Forever site No. 289: Ningana Bushland, Yanchep/Eglinton.	The PTA committed to undertaking additional consultation with the Quinns Rocks Environmental Group to inform detailed design for the YRE Project. PTA notes that concerns relating to Ningana Bushland are considered in this ERD.
Whadjuk working group	2017	Aboriginal heritage consultation and survey in consultation with consultant anthropologist Rory O'Connor.	The Whadjuk representatives nominated by SWALSC pursuant to the NSHA provided support for the YRE Project, subject to conditions.
	23 October 2017	Additional inspection by the Whadjuk Working Group of the proposed YRE station sites and associated facilities in consultation with Rory O'Connor.	The Whadjuk representatives supported the development and recommended that monitors should be present both for scrub clearance and for initial ground disturbance at the station sites.
Water Corporation	December 2017	Advice on Water Corporation production bores and Wellhead protection zones that could be impacted by the Proposal.	Water Corporation provided spatial data and advice and requested consultation is ongoing as the YRE Project progresses.
City of Wanneroo	7 December 2017	Briefing on the YRE Project.	Supportive of and enthusiastic about the Proposal, as are their residents. Discussed potential offset options and management, and applicable local government policy.
Urban Bushland Council	7 December 2017 14 February 2018	Review the environmental context of the YRE Project. Key consideration related to clearing of native vegetation within Bush Forever site No. 289: Ningana Bushland, Yanchep/Eglinton. Additional METRONET briefing also delivered at the Urban Bushland Council's general meeting on 14 February 2018.	The PTA committed to undertaking additional consultation with the Urban Bushland Council to inform detailed design for the YRE Project. PTA notes that concerns relating to Ningana Bushland are considered in this ERD.
Industry briefing – 309 attendees	18 July 2018	Employment and supply opportunities.	Nil.

Stakeholder	Date	Issues/topics raised	Proponent response/outcome
Community Information Session - Oldham Park Clubrooms, 91 Lagoon Drive, Yanchep – 190 stakeholders	21 July 2018	General presentation on METRONET and the YRE Project.	Local community generally supportive of the Proposal.
Community Information Session - Pop-up Library, Turnstone Street, Alkimos 49 stakeholders attended.	31 July 2018	General presentation on METRONET and the YRE Project	Local community generally supportive of the Proposal.
Community Information Session - Alkimos Showcase Event - at the Lighthouse Play Centre, Alkimos. 400 to 450 stakeholders attended.	19 August 2018	General presentation on METRONET and the YRE Project.	Local community generally supportive of the Proposal.
South West Aboriginal Land and Sea Council (SWALSC)	5 October 2018	Briefed SWALSC on METRONET and the draft METRONET Aboriginal Engagement Strategy.	PTA to further consult with SWALSC to seek general acceptance of the METRONET Aboriginal Engagement Strategy. METRONET to present the strategy to the Whadjuk Working Party.
City of Wanneroo	7 December 2018	Briefed City of Wanneroo on METRONET and the YRE project.	City of Wanneroo was supportive of the development as the residents of City of Wanneroo is very enthusiastic and supportive. City of Wanneroo is eager for the development to progress.

4 Environmental principles and factors

4.1 Principles

The five principles of environmental protection set out in the EP Act have been considered during the development of the Proposal. **Table 4-1** (adapted from RPS 2018a) provides a description of how this Proposal has considered each of the principles.

4.2 Preliminary key environmental factors

The preliminary key environmental factors for this Proposal were determined by the EPA in its decision under section 39 of the EP Act to formally assess the Proposal. The preliminary key environmental factors are:

- Flora and vegetation;
- Landforms;
- Terrestrial fauna;
- Subterranean fauna;
- Inland waters; and
- Social surroundings.

These factors are addressed separately in Sections 5 to 10. Other environmental factors are considered in Section 11.

Table 4-1: Consideration given to environmental principles

Principle	Description of principle	Consideration given to principle in this Proposal
1. 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; and (b) an assessment of the risk-weighted consequences of various options.	The Proposal has been underpinned by key strategic planning documents and MRS Assessments to support district structure planning in the Alkimos-Eglinton localities and the alignment of the current 'Railways' reservation. The strategic planning framework and complementary environmental assessments have been augmented by additional environmental investigations undertaken to inform the detailed design of LSPs and support environmental assessment under the EPBC Act. The detailed design for the development envelope has been informed by more than 6 years of detailed environmental investigation. Modifications to the development envelope have been made to avoid and minimise environmental impacts, where practicable to do so. The PTA has also maintained close correspondence with relevant government agencies to minimise any uncertainty surrounding the environmental impact of the Proposal. Detailed design plans, when coupled with the development and implementation of the CEMP and PTA standard operating procedures, will largely avoid or minimise impacts to the identified environmental factors within the development envelope.

Principle	Description of principle	Consideration given to principle in this Proposal
2. The principle of intergenerational equity	The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	The Proposal has been designed to address the EPA's objectives for the identified environmental factors, with mitigation measures provided to reduce residual environmental impacts and offsets proposed to compensate for unavoidable significant residual impact. The Proposal responds to the growing need for an accessible, environmentally sensitive and economically sustainable means of public travel in the northwest Sub-region. At a local scale, the Proposal will result in denser urban development around station precincts, making more sustainable and active forms for travel such as walking and cycling more attractive. The resulting reduced reliance on cars and other road transport will lead to lower emissions and less traffic congestion in the local area. On a larger scale, a shift towards the use of mass transit such as this Proposal will lead to lower emissions and less traffic congestion generally. The assessment contained in this report demonstrates that the Proposal can be implemented to avoid significant impacts on the health, diversity or productivity of the environment for the benefit of future generations.

Principle	Description of principle	Consideration given to principle in this Proposal
3. Principles relating to improved valuation, pricing and incentive mechanisms	(1) Environmental factors should be included in the valuation of assets and services. (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 life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	Environmental factors were considered when evaluating design options for the Proposal. The PTA has assessed the relevant environmental factors and has iteratively modified the development envelope of its preferred development option during planning, to minimise environmental impacts. Avoidance of significant environmental attributes and ongoing management costs have been considered by the PTA in the detailed design for the Proposal.
4. The principle of the conservation of biological diversity and ecological integrity	Conservation of biological diversity and ecological integrity should be a fundamental consideration.	The Proposal is primarily comprised of land reserved under the MRS for the purpose of 'Railways'. The construction and access areas have been selected to coincide with proposed future urban development or roads either reserved by the MRS, or as detailed within approved and draft LSPs, to avoid direct impacts to native vegetation. Detailed flora and vegetation and terrestrial fauna field surveys 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, with the development envelope modified to reduce impacts to land reserved for 'Parks and Recreation' under the MRS.

5. 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.	In developing the Proposal, the PTA has been considerate of the principle of waste minimisation including the destination and use of removed materials. In general, waste will be minimised during construction by adopting the hierarchy of waste controls: avoid, minimise, reuse, recycle and safe disposal As the railway will be constructed predominantly in a cutting, it is estimated that the Proposal will generate large volumes of excess sand and limestone. The total volume of excess fill is dependent on final detailed design, taking into consideration the following: • depth and location of cut along the alignment; • location of batters along the alignment and their ratios; • location and length of bridges in place of fill in undulating landscape through Ningana Bushland; • length and location of retaining/sheet pile walls in place of batters, where practicable; and • location and depth of fill along the alignment. A desktop contamination investigation considered implications of the recent amendments to the *Environmental Protection Amendment Regulations 2018* and the Landfill Waste Classification and Waste Definitions 1996 (as amended 2018) and identified the majority of the YRE corridor to contain materials that will meet the definition of Clean Fill, subject to visual inspection, removal of any illegally dumped materials and management of any unexpected finds of contamination (Golder Associates 2018). There is one location with an inferred intensive agricultural historical land use that is subject to further soil testing and assessment to clarify its reuse potential (Golder Associates 2018). Following correspondence with DWER, the PTA understands that it is up to the producer of the material to make their own assessment on whether such material meets the definition of Clean Fill or Uncontaminated Fill and that the DWER will not make a determination. The PTA's objective is to reuse all excess fill which is determined to meet the criteria suitable for reuse.

Principle	Description of principle	Consideration given to principle in this Proposal
		In keeping with the principle of waste minimisation, the PTA proposes to: • stockpile excess fill at an offsite location, managing potential dust emissions in accordance with the PTA's Environmental Management System; • provide small volumes of excess fill to the City of Wanneroo as required for use in their dune nourishment program; • sell the remaining volumes of excess fill to Main Roads Western Australia, Landcorp and urban developers as required for use as fill within construction and urban development sites within the area.

Source: adapted from RPS (2018a)

4.3 General considerations for impact assessment

This section sets out some general considerations that apply to the information presented in each of the key environmental factor sections.

4.3.1 Information supporting the referral and this assessment

This document adapts and adds to the information previously provided in the referral of this Proposal to the EPA under section 38 of the EP Act and in order to meet the request for additional information made by the EPA in the ESD. The referral was prepared by RPS with the support of GHD and a number of other specialist consultants. This ERD, which has been prepared by Eco Logical Australia (ELA), combines substantial amounts of information presented in the earlier documents. It also includes some additional material and analysis. Only the material considered central to the impact assessment (e.g. to meet the information requirements set out in the EPA's Instructions on how to prepare an Environmental Review Document (EPA 2018c) and to address the EPA's Proposal specific requests contained within the ESD) has been carried forward from the earlier documents into this document. The Environmental Impact Assessment prepared by RPS (RPS 2018a) as part of the referral to the EPA is available with the referral documentation published on the EPA's website at http://www.epa.wa.gov.au.

4.3.2 Interpretation of previous studies

A number of different studies have been conducted to inform this ERD. Many studies relied upon for this assessment were conducted for the YRE Project as a whole and cannot be readily separated into parts. Key studies conducted for the YRE Project as a whole include those addressing:

- Dieback;
- Short-range endemic fauna;
- Subterranean fauna;
- Hydrology;
- Noise and vibration;
- Aboriginal heritage; and
- Site contamination (Preliminary Site Investigation).

Where information in this document applies to the YRE Project and is not specific to YRE Part 2, this has been noted. Sections 5 to 10 each contain a subsection listing previous studies and reports relevant to the environmental factor, including the area covered by those studies and reports.

There may be small discrepancies between numbers and values appearing in various specialist studies and assessments supporting this Proposal. Different studies may use different study areas. Earlier studies may contain earlier versions of the development envelope or other Proposal layout. Different geospatial systems and map projections can produce variations in calculated areas and values. Some values have been rounded and the total may not exactly match the sum of the rounded numbers.

4.3.3 Impacts authorised for preliminary investigations

As discussed in Section 1.4.2, PTA has obtained clearing permit CPS 7843/1 for preliminary geotechnical and UXO investigations for the YRE Project as a whole. The impact assessment in this ERD does not include any clearing impacts as these have been authorised under CPS 7843/1. However, the impacts authorised under the CPS 7843/1 will be considered in determining offsets (see Section 13), where the significant residual impacts that require offsetting will be adjusted to avoid double counting of clearing impacts already accounted for under the clearing permit.

4.3.4 Spatial scales of assessment

Assessment of impacts for each environmental factor has been undertaken using a range of geographic scales. The most common scales used are:

- Local – within 1 km of the development envelope;
- Regional – within the City of Wanneroo and City of Joondalup local government areas (also referred to as 'northwest Sub-region'); and
- Bioregional – within the SCP IBRA subregion of the SCP IBRA region.

4.3.5 Cumulative impacts and future development

Cumulative impacts are considered in the sections on each environmental factor. From an impact assessment perspective, cumulative impacts include those from foreseeable developments. These can be related projects such as YRE Part 1 or unrelated projects such as urban development by third parties.

As described in Section 2, the northwest corridor is expected to undergo significant urban development over the next few decades. While this scale of development is planned in a general sense, there are many factors that could influence the extent to which urban development proceeds over longer time horizons. These include changes in planning policy, broader economic conditions or future environmental conditions. In consultation with EPA Services, the PTA has determined that reasonably foreseeable cumulative impacts are the environmental impacts from projects and Proposals that are known to be proceeding or can with a reasonable degree of confidence be expected to proceed.

Not all urban developments are necessarily subject to EPA assessment prior to proceeding, and the MRS is not necessarily a reliable indicator of the timing of future development. To account for all reasonably foreseeable developments and not just those considered by the EPA or provided for by the MRS, PTA has referred to the ULDO 2016/17, which is published by DPLH and WAPC (DPLH and WAPC 2017). The ULDO "covers [the] Perth and Peel [regions] and includes scheme amendments, developer intentions, structure planning in progress, subdivision applications and approvals, and local government development applications and approvals" (DPLH and WAPC 2017). The ULDO is intended to give staging and "spatial context to future land development over the short, medium and longer term".

The future developments in ULDO have varying degrees of certainty of proceeding. For the most part, the PTA has chosen for the purposes of cumulative impact assessment to consider developments falling across the entire ULDO forecast period. Discussion of cumulative impacts in this ERD therefore considers all ULDO staging categories shown in **Table 2-3** as a whole, namely:

- Short term (0-5 years) with current conditional approval;
- Short term (0-5 years);
- Medium term (6-10 years); and
- Long term (10+ years).

While there is less certainty about future developments in the long term category, the use of the entire ULDO forecast period as opposed to only immediate development in the short term (0-5 years) category is a conservative approach consistent with the precautionary principle, i.e. the impacts of the Proposal are unlikely to be understated. Given the nature of this Proposal, the construction of the railway may also result in future projects being brought forward. Using the entire ULDO forecast period better accounts for developments that currently be classified in a later ULDO staging category but may be brought forward. In any case, it is important to note that the ULDO data is a forecast based on a range of assumptions, and is therefore subject to change. More information about the ULDO data, including a figure illustrating where future developments are expected, is provided in Section 2.5.1.

5 Flora and vegetation

5.1 EPA objective

The EPA's objective for flora and vegetation is to protect flora and vegetation so that biological diversity and ecological integrity are maintained (EPA 2018e).

5.2 Policy and guidance

The following policies and guidance are relevant to the flora and vegetation factor:

- Environmental Factor Guideline: Flora and Vegetation (EPA 2016a); and
- Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b).

The *Biodiversity Conservation Act 2016* (BC Act) commenced 1 January 2019, replacing the *Wildlife Conservation Act 1950* (WC Act) and the *Sandalwood Act 1929*. Threatened flora taxa listed as Specially Protected under the WC Act as at 31 December 2018 are recognised as Threatened under the BC Act. Threatened ecological communities (TECs) previously endorsed by the Minister for Environment as at 31 December 2018 are now formally listed as TECs under the BC Act. The PTA notes that technical studies undertaken for this Proposal prior to 2019 may refer to the acts in force at the time, however they have been reviewed to ensure this ERD considers values consistent with the BC Act. Priority flora taxa and priority ecological communities (PECs) continue to be listed by the DBCA.

5.3 Receiving environment

5.3.1 Previous studies

The PTA has undertaken six flora and vegetation surveys and desktop assessments for the YRE Project and development envelope. The flora and vegetation values considered in this ERD have primarily been derived from the GHD (2018b) Biological Assessment report, with additional information presented in the GHD Biological Factors report (2019).

GHD (2018b; 2019) reported on vegetation within to the development envelope and immediately adjacent land only. This adjacent land was confined to a 100 m buffer of the development envelope through Bush Forever Site No. 289 (Ningana Bushland). The area mapped by GHD within the buffer but outside of the development envelope is referred to in this impact assessment as the 'additional survey area'.

A survey by ELA covering Ningana Bushland (to the extent it occurs within Lot 105 Marmion Avenue Yanchep) provides additional context for potential impacts to Ningana Bushland (ELA 2018;Appendix O).

Two Phytophthora Dieback (*Phytophthora cinnamomi*) assessments were also undertaken for the development envelope by Glevan Consulting (2011; 2017).

Table 5-1 summarises the flora and vegetation investigations undertaken for the Proposal.

Table 5-1: Summary of technical investigations for flora and vegetation

Survey/Investigation	Survey area, type and timing	Study standard/guidance and limitations
GHD (2012) *Northern Suburbs Railway Alignment Butler to Yanchep Environmental Investigation*	**Survey area:** A portion of Part 2 development envelope comprising 22.4 ha between the southern boundary of Bush Forever Site 289 and Yanchep Beach Road **Type:** Desktop and Level 2 detailed flora and vegetation survey. A total of 17 quadrats were described throughout the survey area. **Timing:** One day in November 2010 and one day in October 2012	Investigation was undertaken in accordance with Guidance Statement No. 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004) as follows: • experience and appropriate qualification of staff in floristic surveys; • timing of the survey across all seasons over multiple years to enable observation of all species present; • survey sampling design and intensity was considered sufficient to infer vegetation type boundaries; and • consideration of results from database searches that provide available information for the survey area.
GHD (2018b) Yanchep Rail Extension Part 2 Biological Assessment	**Survey area:** Part 2 development envelope and additional survey area. The survey area comprised 147.8 ha. **Type:** Desktop and two season detailed flora and vegetation survey. A total of 29 quadrats and 5 relevés were described. Includes floristic community types determined through multivariate analysis. **Timing:** November 2016: detailed flora and vegetation and targeted survey of the development envelope (and YRE Part 1) May 2017: detailed flora and vegetation and targeted survey for the development envelope (and portion of YRE Part 1) July 2017: Reconnaissance flora and vegetation survey for a 10 m buffer on the development envelope through Bush Forever Site 289	• Desktop information was reviewed and updated at the time of the 2018 field survey to confirm adequacy of previous surveys. • Methodology was in accordance with Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b) and previous version of the guidance as follows: • multivariate comparative (cluster) analysis being performed on a species-by-site matrix (Bray-Curtis) based on group average. A dendrogram was also provided to illustrate the similarities between the vegetation units identified; • extensive experience and appropriate qualification of staff in floristic surveys; • timing of floristic surveys in spring over multiple seasons (2016–2018), which is considered the optimal season condition

Survey/Investigation	Survey area, type and timing	Study standard/guidance and limitations
	December 2017: detailed flora and vegetation targeted survey for additional tracks in the development envelope. November 2018: detailed flora and vegetation and targeted survey of a 100 m buffer on the development envelope through Bush Forever Site 289 (additional survey area).	• survey sampling design and intensity; and • consideration of results from previous investigations and use of available contextual data for the survey area. • GHD found that the survey was not subject to any major constraints affecting the thoroughness of the assessment or the conclusions formed (GHD 2018b).
GHD (2019) Yanchep Rail Extension Part 2, Biological Factors - Context and Impact Assessment	**Survey area:** Development envelope **Type:** Desktop assessment providing contextual information of the potential impacts at local and regional scales. **Timing:** January 2019	Describes and quantifies the potential impacts (direct and cumulative) associated with the Proposal on flora and vegetation at local and regional scales. Document prepared in accordance with *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b)
ELA (2018; Appendix O) Environmental (Bush Forever Site 289) Candidate Offset Site Investigation, Yanchep Railway Extension	**Survey area:** Approximately 440 ha of Bush Forever Site 289 within Lot 105 Marmion Avenue Yanchep including a portion of the Part 2 development envelope (representing approximately two thirds of the entire Bush Forever Site). **Type:** Desktop and reconnaissance field survey **Timing:** July 2018	No constraints or limitations to the survey affecting the conclusions of the investigation were identified.
Glevan Consulting (2011) *Northern Suburbs Railway, Alkimos to Yanchep,* *Phytophthora cinnamomic occurrence assessment*	**Survey area:** Original design for the YRE Project **Type:** Field and desktop assessment identifying the presence of *Phytophthora cinnamomi* **Timing:** 2011	Methodology in accordance with the following guidelines: • *Phytophthora cinnamomi* and disease caused by it, Volume I – Management Guidelines (DEC 2003). • *Phytophthora cinnamomi* and disease caused by it, Volume II – Interpreter Guidelines for Detection, Diagnosis and Mapping (DEC 2001). The survey was undertaken by a registered disease interpreter, consistent with the Phytophthora dieback guidelines.

Survey/Investigation	Survey area, type and timing	Study standard/guidance and limitations
Glevan Consulting (2017) *Yanchep Rail Extension, Phytophthora dieback Occurrence Assessment*	**Survey area:** Project corridor associated with the proposed Yanchep Rail Extension comprising 92 ha **Type:** Field and desktop assessment identifying the presence of *Phytophthora cinnamomi* **Timing:** August 2017	Methodology for the field assessment is in accordance with *FEM047 Phytophthora Dieback Interpreter's Manual for Lands Managed by the Department* (DPaW 2015). The dieback assessment adopted a comprehensive survey method defined in the Phytophthora dieback interpreter's manual (DPaW 2015) to provide high confidence disease distribution information and hygiene classification data, and was also undertaken by a registered disease interpreter, also consistent with the Phytophthora dieback interpreter's manual.

5.3.2 Vegetation types

Broad vegetation description

Vegetation occurring within the region was mapped at a broad scale (1:250,000) by Beard during the 1970s (Beard 1979). This dataset formed the basis of several regional mapping systems, including the biogeographical region dataset (Interim Biogeographic Regionalisation for Australia (IBRA) for Western Australia physiographic regions, and System 6 Vegetation Complex mapping undertaken by Heddle et al. (1980) and recently revised by Webb et al. (2016).

Two Beard (1979) vegetation associations (949 and 1007) intersect the development envelope. Table 5-2 provides context for the vegetation associations mapped as intersecting the development envelope.

Table 5-2: Occurrence of mapped vegetation associations within the development envelope

Association	Pre-European extent (ha)	Current extent (ha)	Extent in development envelope (ha)[1]
949: Low woodland; banksia			
NW subregion	38,330.32	17,173.49	0.79
1 km buffer	243.65	97.97	
1007: Mosaic: Shrublands; *Acacia lasiocarpa* and *Melaleuca acerosa* (now *M. systena*) heath / Shrublands; *Acacia rostellifera* and *Acacia cyclops* thicket			
NW subregion	10,801.16	5,048.24	48.38
1 km buffer	1,817.51	1,055.75	

Source: GHD 2019

[1] Vegetation mapped in Degraded or better condition

Regional vegetation has also been mapped as vegetation complexes based on major geomorphic units on the Swan Coastal Plain (SCP). The following two vegetation complexes (as described by Webb et al 2016) intersect the development envelope (GHD 2019) **(**Figure 5-1):

1. Quindalup complex: Restricted to the coastal dunes and can be subdivided mainly into two alliances. The strand and fore dune alliance contain *Angianthus cunninghamii*, *Trachyandra divaricatum*, *Arctotheca populifolia*, *Atriplex isatidea*, *Cakile maritima*, *Leucophyta brownii*, *Carpobrotus virescens*, *Pelargonium capitatum*, *Senecio lautus*, *Actites megalocarpus*, *Spinifex longifolius*, *Tetragonia implexicoma*, *T. decumbens*. The mobile and stable dune alliance contains *Acacia cyclops*, *Anthocercis littorea*, *Lepidosperma gladiatum*, *Myoporum insulare*, *Nitraria billardierei*, *Olearia axillaris*, *Scaevola crassifolia*, *S. nitida*, *Spyridium globulosum*, *Westringia rigida* and *Wilsonia backhousei*. The vegetation differs in its physiognomy and species composition from one place to another because of the variations in the dune environment caused by edaphic and topographical factors and the degree of shelter from salt-laden winds. The low closed-forest of *Melaleuca lanceolata*, *Callitris preissii* is restricted to small localised pockets. This formation was once more widespread along the coast. Other local variations include remnant occurrences of *E. foecunda*, *Pittosporum ligustrifolium*, *Santalum acuminatum*, *Exocarp sparteus* and *Acacia rostellifera*
2. Cottesloe complex – north: Predominantly low open forest and low woodland of *Banksia attenuata* (Slender Banksia) – *B. menziesii* (Firewood Banksia) – *Eucalyptus todtiana* (Pricklybark); closed heath on the limestone outcrops.

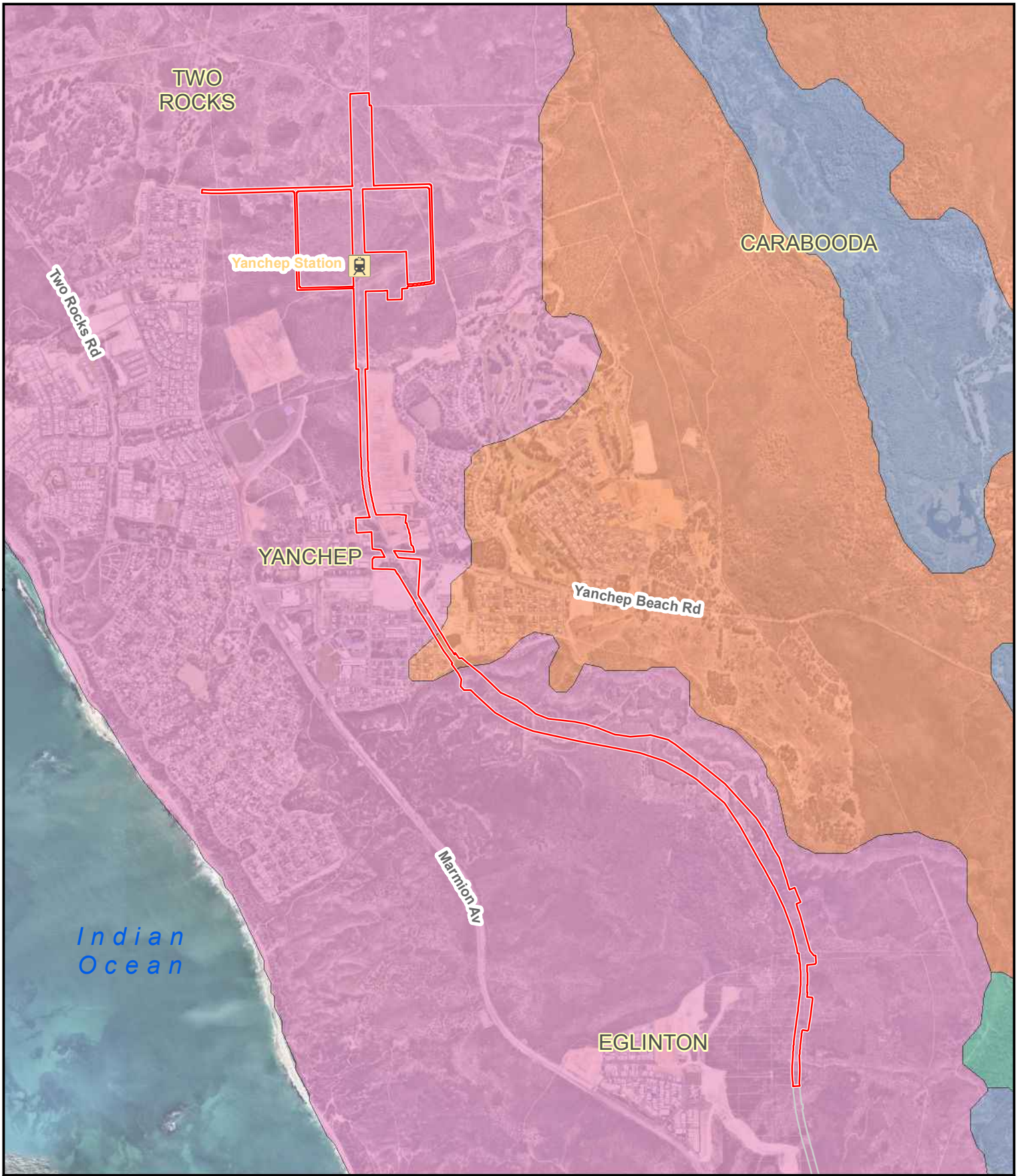
Table 5-3 provides context for the vegetation complexes mapped as intersecting the development envelope.

Table 5-3: Occurrence of mapped vegetation complexes within the development envelope

Complex	Pre-European extent (ha)	Current extent (ha)	Extent in development envelope (ha)[1]
Quindalup complex			
NW subregion	11,184.24	5,634.59	48.13
1 km buffer	1,734.76	1,028.55	
Cottesloe complex – north			
NW subregion	8,715.75	5,950.36	1.04
1 km buffer	326.55	125.33	

Source: GHD 2019

[1] Includes areas mapped in Degraded or better condition only coinciding with the Native Vegetation Extent (DPIRD-005) dataset



Yanchep Rail Extension (Part 2)
Figure 5-1 Vegetation Complexes

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Proposed Station

Vegetation Complexes

- Cottesloe Complex-Central and South
- Cottesloe Complex-North
- Herdsman Complex
- Quindalup Complex

Date Printed: 16/01/2019
Created By: David Fotheringham
Scale 1:30,000

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0 0.25 0.5 1 km

Document Path: Y:\ENVIRONMENTAL\Sam\06_Yanchep\02_MXDs\20181128_ERDReportFigures_Part2\Fig5_1_VegetationComplexes.mxd
Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Local vegetation description

The development envelope comprises a mixture of remnant native vegetation, planted vegetation, highly disturbed and cleared areas.

A total of 13 vegetation types comprising 62.30 ha were identified and described by GHD (2018b) for the development envelope. The remaining 10.56 ha of the development envelope is cleared.

Eleven of the vegetation types comprised remnant native vegetation, one vegetation type (VT12) was dominated by planted taxa and one vegetation type (VT13) comprised a mix of degraded native remnant vegetation and native regrowth (>10 years) (GHD 2019). Two thirds of the development envelope (49.17 ha) comprises remnant vegetation in Degraded or better condition (**Table 5-4**).

Eleven of the vegetation types identified by GHD (2018b) extend beyond the development envelope into the additional survey area. Two vegetation types (VT07 and VT08) were not recorded in this additional survey area and have a limited occurrence within the development envelope (Table 5-4).

The vegetation types and their extents within the development envelope and additional survey area are outlined in **Table 5-4** and presented in **Figure 5-2**.

Table 5-4: Vegetation types within the development envelope

ID	Vegetation type	Landform and substrate	Conservation significance	Extent in survey area[1]	Extent in development envelope (DE)		Extent in DE in Degraded or better condition	
				ha	ha	% DE	ha	% DE[2]
VT01	*Acacia saligna* and *Xanthorrhoea preissii* tall shrubland	Slopes of dunes with brown sandy soils		34.33	15.75	21.62	13.81	18.95
VT02	*Banksia sessilis* and *Melaleuca systena* mid-shrubland	Slopes of dunes with yellow sandy soils	Northern Spearwood shrublands and woodlands (PEC) (SCP24)	5.60	5.24	7.19	5.24	7.19
VT03	*Banksia sessilis* and *Spyridium globulosum* tall shrubland	Dune swales with brown sandy soils	Northern Spearwood shrublands and woodlands (PEC) (SCP24)	13.24	8.57	11.76	8.44	11.58
VT03a	*Spyridium globulosum* tall shrubland This vegetation type is very similar to VT03, but *Banksia sessilis* is either not present or occurs as isolated plants	Dune swales with brown sandy soils		5.17	2.80	3.84	2.80	3.84
VT04	*Banksia attenuata*, *B. menziesii* low woodland	Undulating plain with brown-yellow sandy soils	Banksia woodlands (TEC) / Banksia dominated woodlands (PEC)	6.88	4.75	6.52	4.75	6.52
VT05	*Lomandra* sp. herbland	Dunes ridges with white to brown sandy soils		15.34	5.31	7.29	5.31	7.29

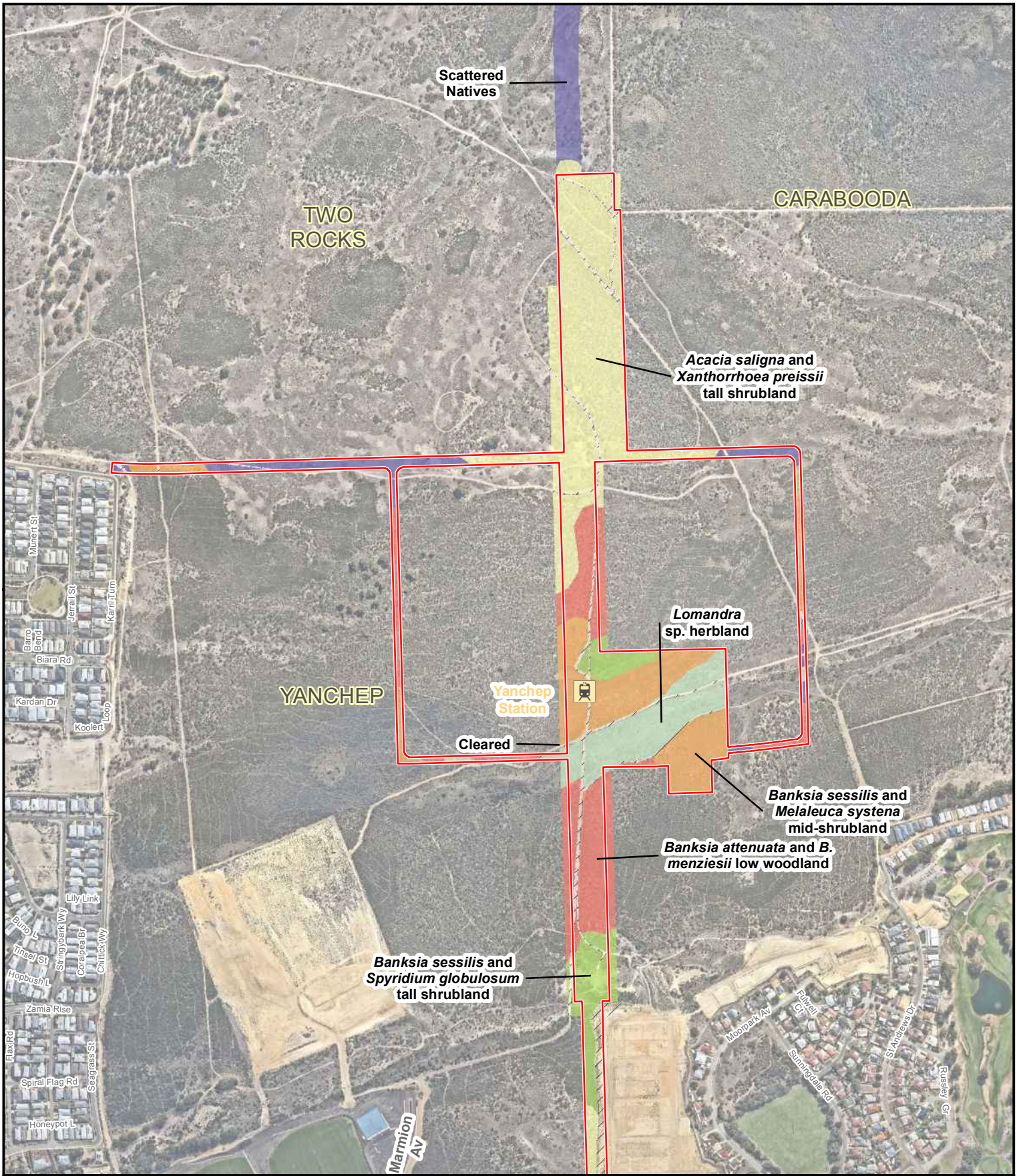
ID	Vegetation type	Landform and substrate	Conservation significance	Extent in survey area[1]	Extent in development envelope (DE)		Extent in DE in Degraded or better condition	
				ha	ha	% DE	ha	% DE[2]
VT06	*Eucalyptus gomphocephala* tall woodland The majority of Tuart trees present within this vegetation type are planted (>25 years ago). There is one patch of original Tuart woodland which contains large mature trees and a more complete native understorey.	Slopes of dunes with brown sandy soils	Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP (PEC)	8.56	2.13	2.92	2.13	2.92
VT07	*Eucalyptus sp.* and *Agonis flexuosa* woodland	Slopes of dunes with brown sandy soils		0.32	0.32	0.44	0.32	0.44
VT08	*Melaleuca huegelii* and *M. systena* shrubland	Upper slopes and ridge of dunes with brown to yellow sandy soils and numerous limestone out-cropping	*Melaleuca huegelii – M. systena* shrublands on limestone ridges (SCP 26a)	0.05	0.05	0.07	0.05	0.07
VT09	*Banksia attenuata* woodland	Undulating plain and dune swales with brown sandy soils	Banksia woodlands (TEC) / Banksia dominated woodlands (PEC)	12.99	4.01	5.50	4.01	5.50
VT10	*Xanthorrhoea preissii* shrubland	Slopes of dunes with brown sandy soils		1.63	1.46	2.00	1.46	2.00
VT13	Scattered Natives	Undulating plain and dunes slopes with sandy soils		9.79	3.04	4.17	0.84	1.15
VT12	Planted	Undulating plain and dunes slopes with sandy soils		22.08	8.87	12.17	-	-

ID	Vegetation type	Landform and substrate	Conservation significance	Extent in survey area[1]	Extent in development envelope (DE)		Extent in DE in Degraded or better condition	
				ha	ha	% DE	ha	% DE[2]
Subtotal (native vegetation types)					**62.30**	**85.49**	**49.17**	**85.17**
CL	Cleared	-		11.81	10.56	14.49	-	-
Total				147.80	**72.86**	**100**	**49.17**	**100**

[1] As per GHD 2018b – includes the development envelope and additional survey area

[2] Percentage of vegetation type in Degraded or better condition within the 72.86 ha development envelope

Source: Adapted from GHD 2018b and 2019



Yanchep Rail Extension (Part 2)
Figure 5-2 Vegetation Types

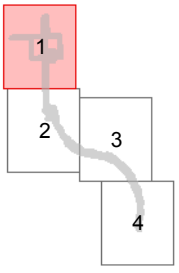
Public Transport Authority

Legend

- Development Envelope
- Proposed Station

Vegetation Community

- *Acacia saligna* and *Xanthorrhoea preissii* tall shrubland
- *Banksia attenuata* and *B. menziesii* low woodland
- *Banksia sessilis* and *Melaleuca systena* mid-shrubland
- *Banksia sessilis* and *Spyridium globulosum* tall shrubland
- Cleared
- *Lomandra sp.* herbland
- Scattered Natives



Development Envelope

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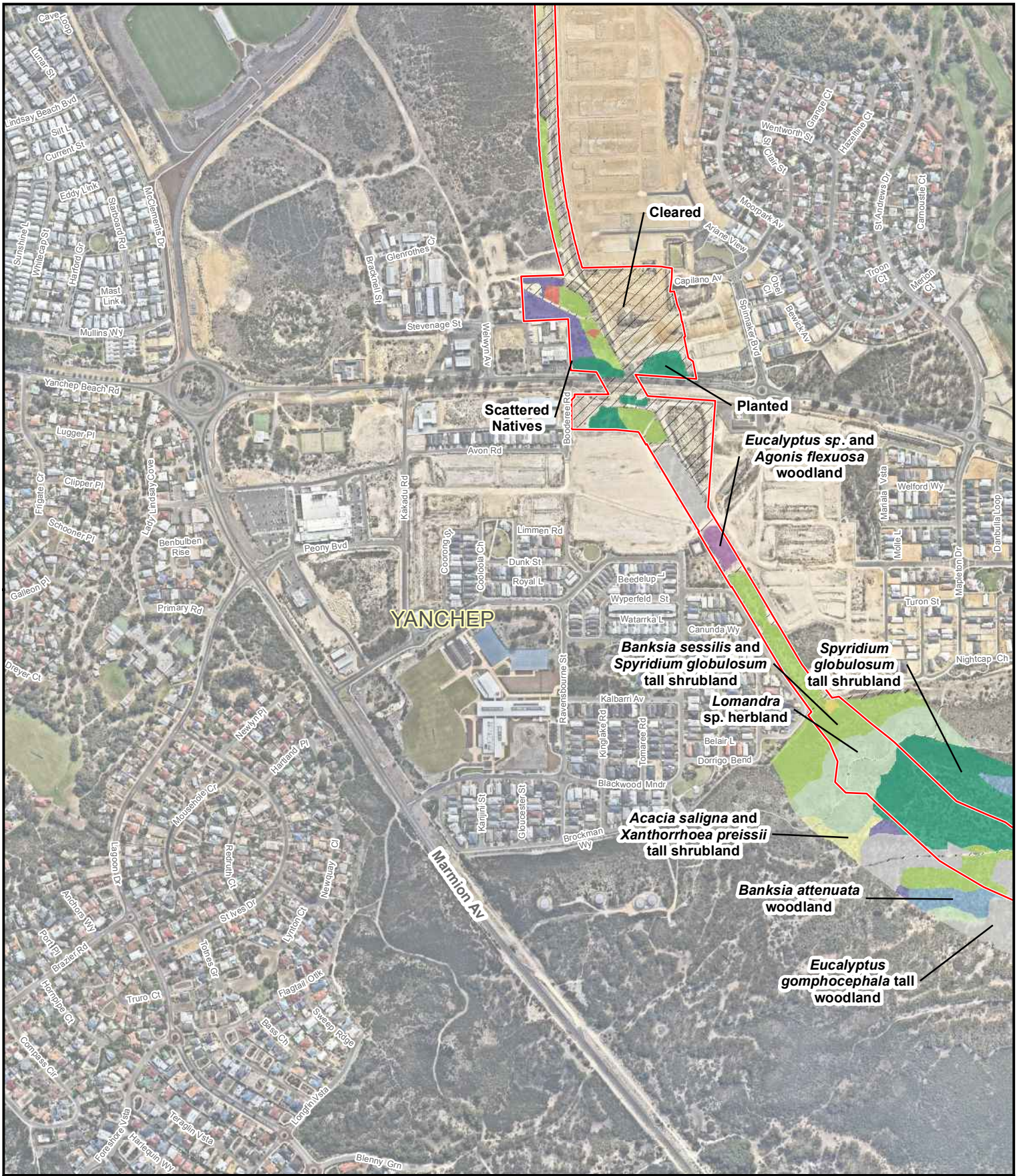


Yanchep Rail Extension (Part 2)
Figure 5-2 Vegetation Types

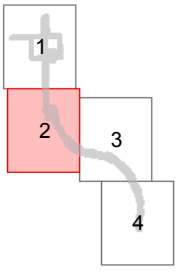
Public Transport Authority

Legend

- Development Envelope

Vegetation Community

- *Acacia saligna* and *Xanthorrhoea preissii* tall shrubland
- *Banksia attenuata* and *B. menziesii* low woodland
- *Banksia attenuata* woodland
- *Banksia sessilis* and *Spyridium globulosum* tall shrubland
- Cleared
- *Eucalyptus gomphocephala* tall woodland
- *Eucalyptus sp.* and *Agonis flexuosa* woodland
- *Lomandra sp.* herbland
- *Melaleuca huegelii* and *M. systena* shrubland
- Planted
- Scattered Natives
- *Spyridium globulosum* tall shrubland



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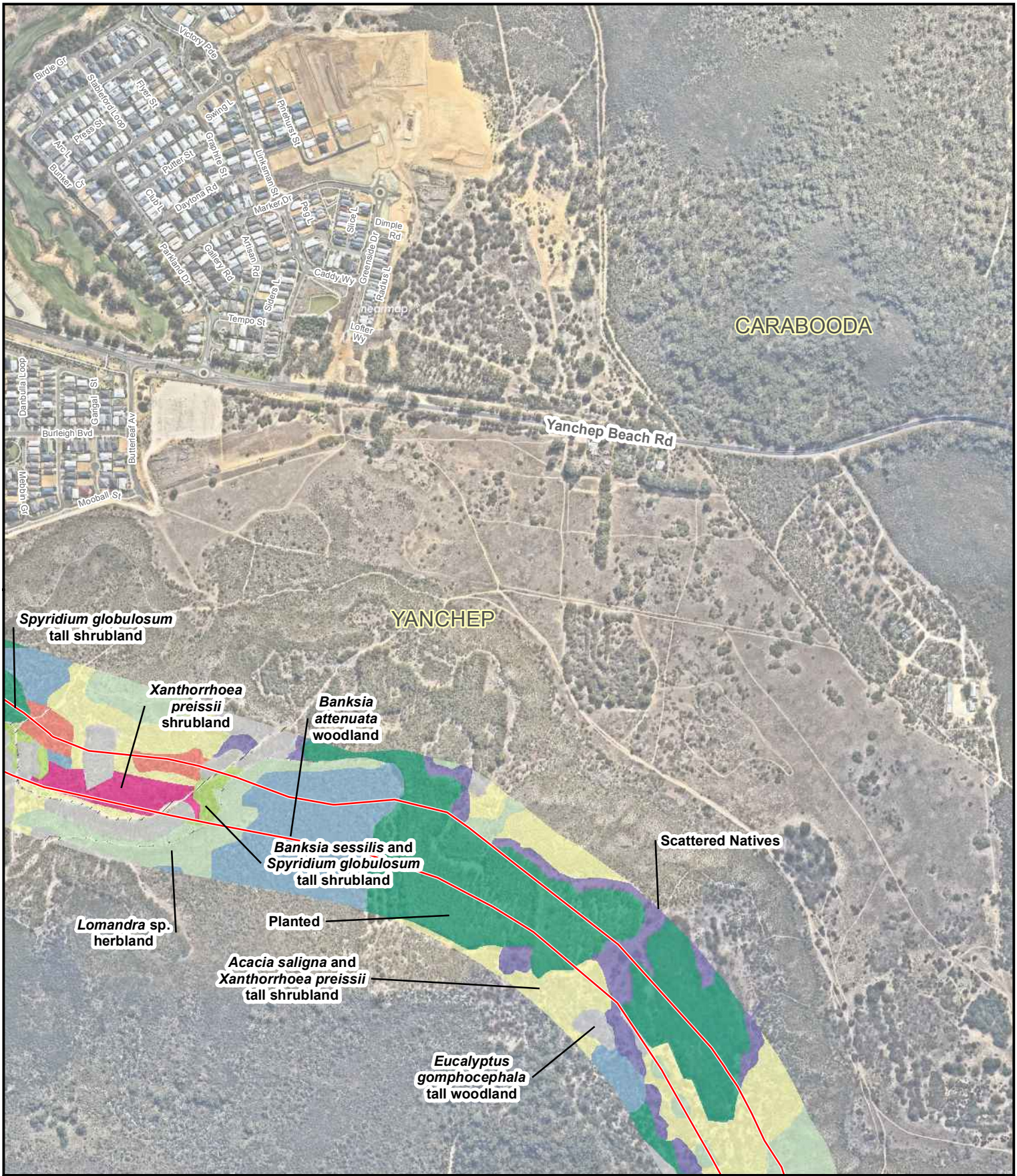


Yanchep Rail Extension (Part 2)
Figure 5-2 Vegetation Types

Public Transport Authority

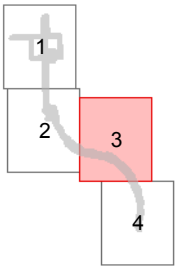
Development Envelope

Legend

- Development Envelope

Vegetation Community

- *Acacia saligna* and *Xanthorrhoea preissii* tall shrubland
- *Banksia attenuata* and *B. menziesii* low woodland
- *Banksia attenuata* woodland
- *Banksia sessilis* and *Spyridium globulosum* tall shrubland
- Cleared
- *Eucalyptus gomphocephala* tall woodland
- *Lomandra sp.* herbland
- Planted
- Scattered Natives
- *Spyridium globulosum* tall shrubland
- *Xanthorrhoea preissii* shrubland



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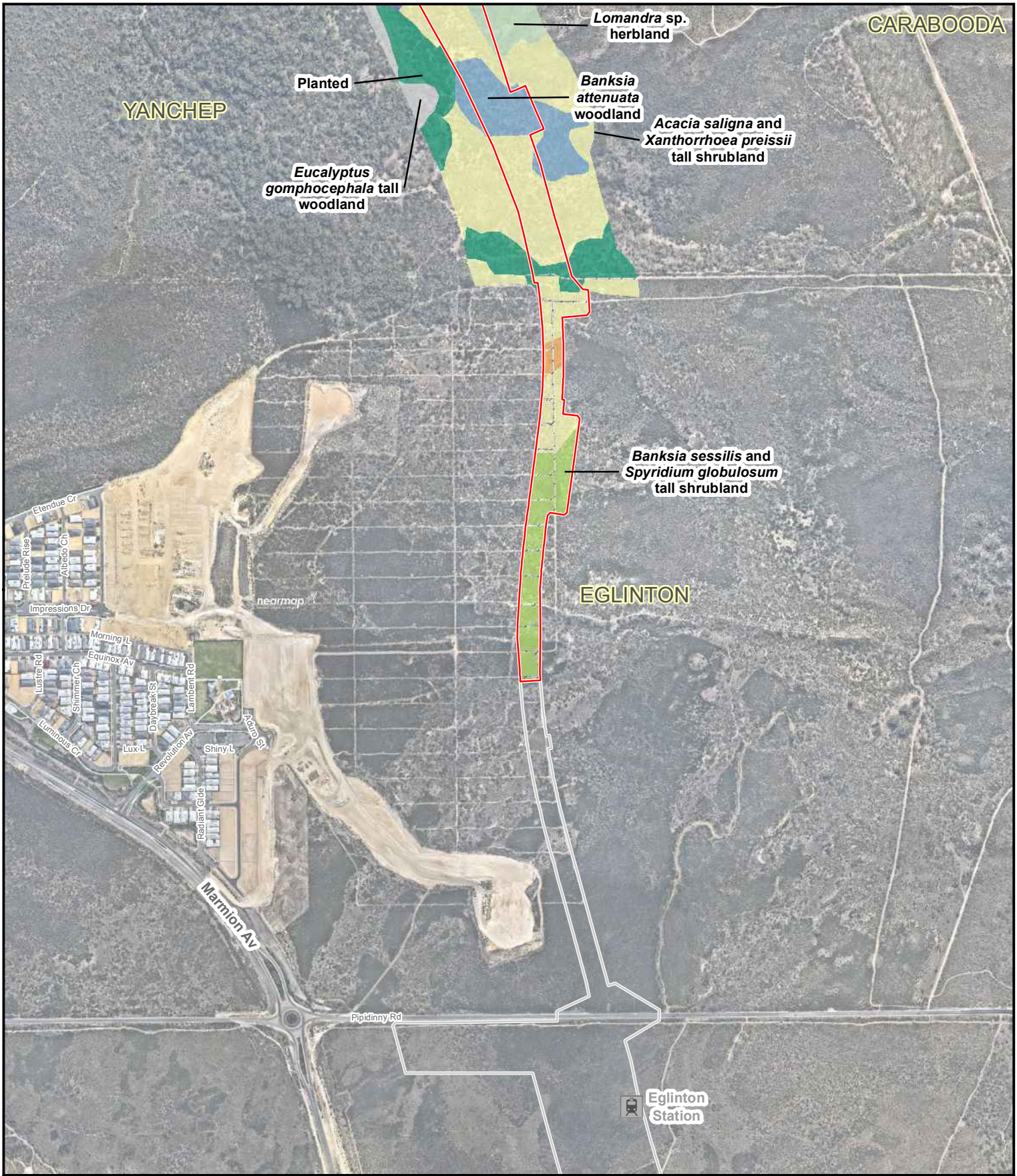


Yanchep Rail Extension (Part 2)
Figure 5-2 Vegetation Types

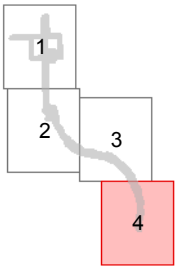
Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Proposed station (YRE Part 1)

Vegetation Community

- *Acacia saligna* and *Xanthorrhoea preissii* tall shrubland
- *Banksia attenuata* woodland
- *Banksia sessilis* and *Melaleuca systena* mid-shrubland
- *Banksia sessilis* and *Spyridium globulosum* tall shrubland
- Cleared
- *Eucalyptus gomphocephala* tall woodland
- *Lomandra sp.* herbland
- Planted
- Scattered Natives



Development Envelope

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Vegetation condition

Remnant native vegetation within the development envelope was rated from Excellent to Completely Degraded condition (Table 5-5), with just under half of the development envelope in Good or Very Good condition, 6.15% in Excellent condition, 13.52% in Degraded condition, with the remainder either in Completely Degraded condition or cleared.

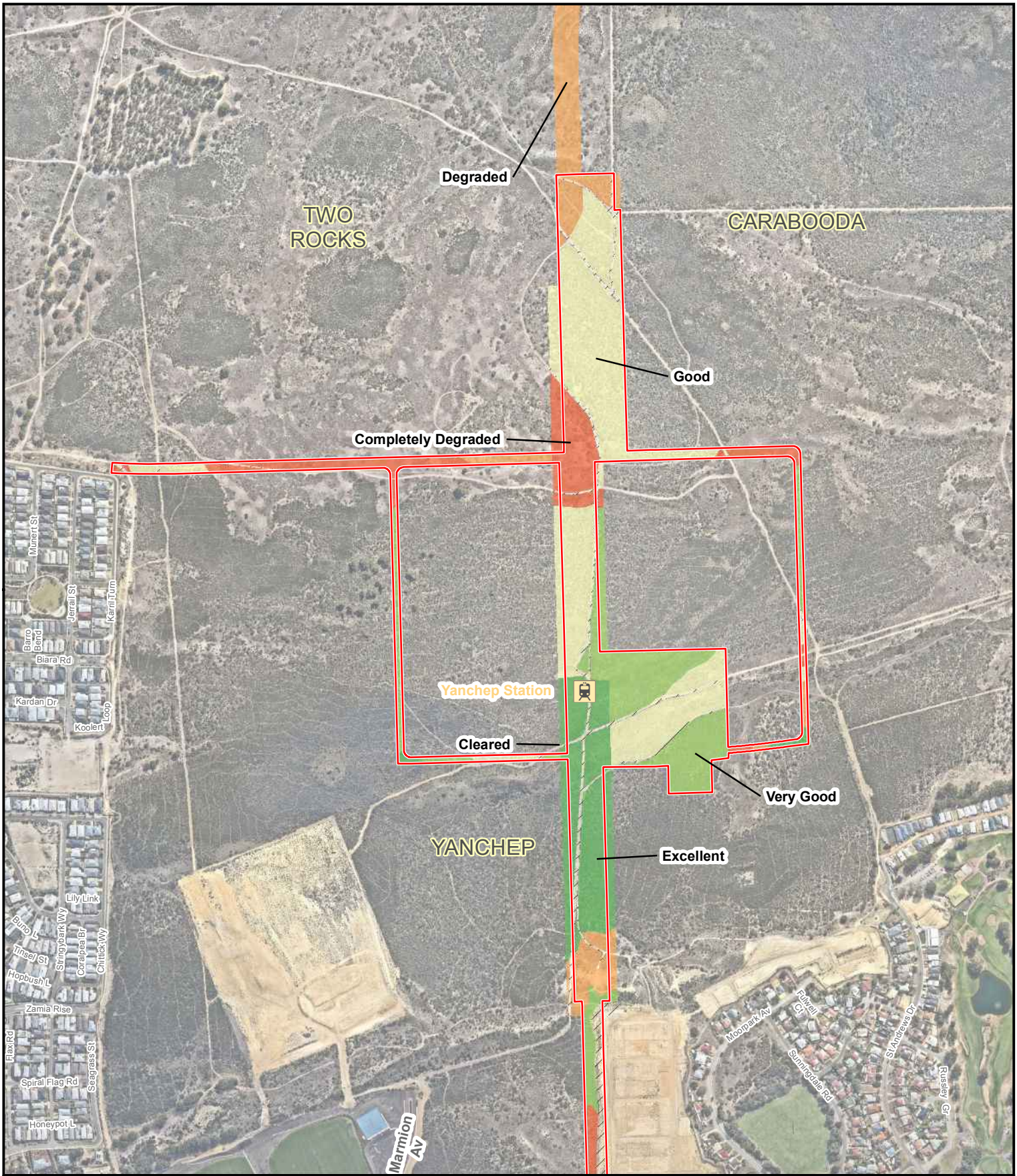
A total of 49.17 ha of native vegetation in Excellent to Degraded condition was mapped by GHD (2018b) within the development envelope. Vegetation rated as Completely Degraded has been excluded from the impact assessment as it is considered to no longer represent intact native vegetation (VT01, VT03, VT13 and VT12). This approach is consistent with the definition of native vegetation derived from the EP Act.

Figure 5-3 shows vegetation condition mapped within the GHD (2018b) survey area.

Table 5-5: Vegetation condition for remnant vegetation in the development envelope

Vegetation Condition	Extent in development envelope	
	ha	%
Excellent	4.48	6.15
Very Good	15.70	21.55
Very Good - Good	0.10	0.14
Good	18.85	25.87
Good - Degraded	0.18	0.25
Degraded	9.85	13.52
Remnant vegetation (Excellent to Degraded) total	**49.17**	**67.49**
Completely Degraded	13.13	18.02
Cleared	10.56	14.49
Total	**72.86**	**100**

Source: Calculated using raw datasets reported in GHD 2018b provided to PTA



Yanchep Rail Extension (Part 2)
Figure 5-3 Vegetation Condition

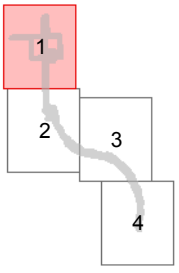
Public Transport Authority

Legend

- Development Envelope
- Proposed Station

Vegetation Community

- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded
- Cleared



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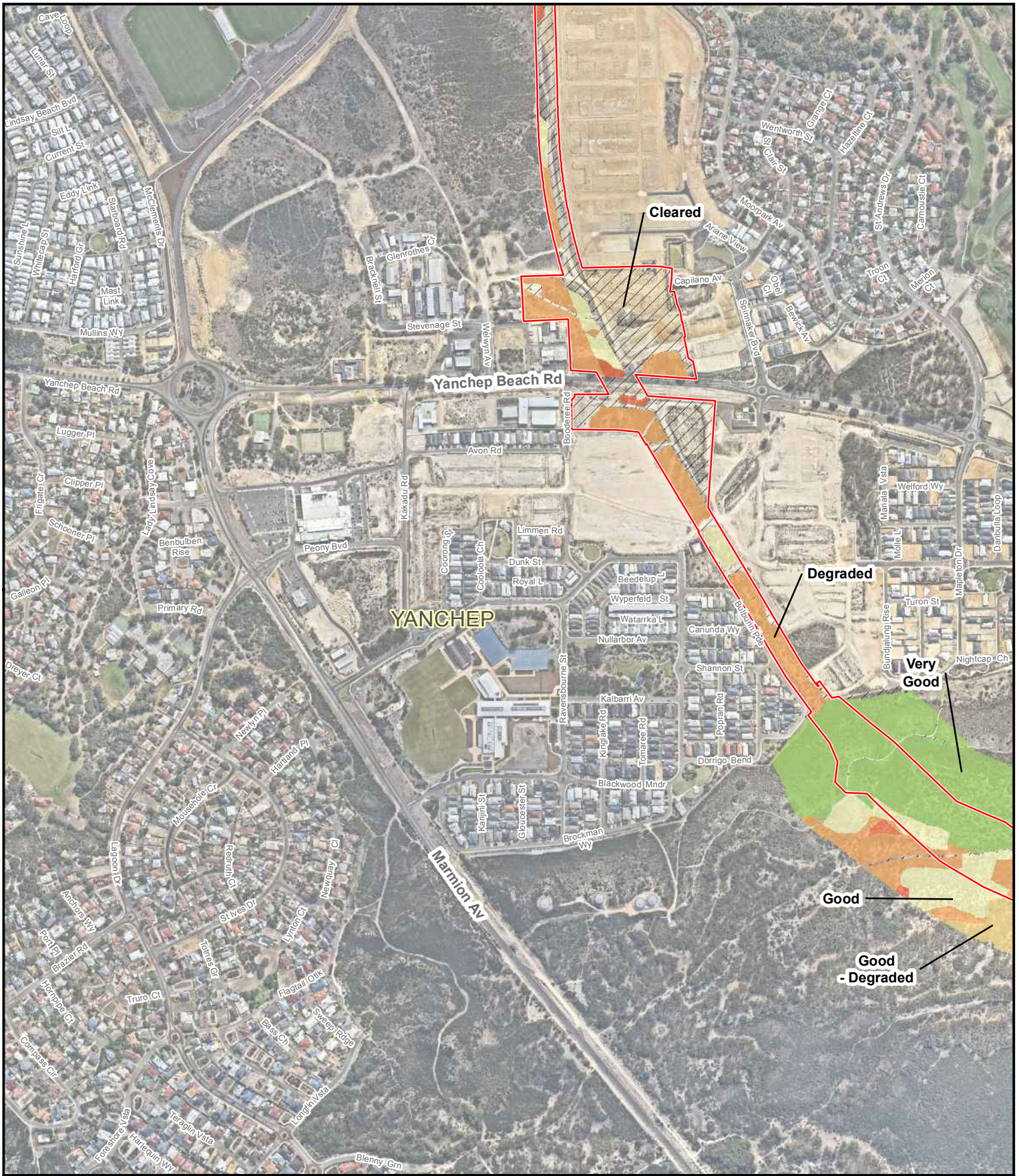
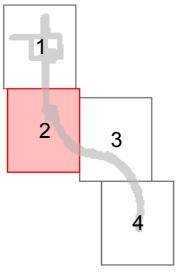


Yanchep Rail Extension (Part 2)
Figure 5-3 Vegetation Condition

Public Transport Authority

Legend

- Development Envelope
- **Vegetation Community**
  - Very Good
  - Good
  - Good - Degraded
  - Degraded
  - Completely Degraded
  - Cleared



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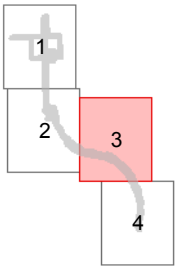
Yanchep Rail Extension (Part 2)
Figure 5-3 Vegetation Condition

Public Transport Authority

Legend

- Development Envelope
- **Vegetation Community**
  - Excellent
  - Very Good
  - Very Good - Good
  - Good
  - Good - Degraded
  - Degraded
  - Completely Degraded
  - Cleared



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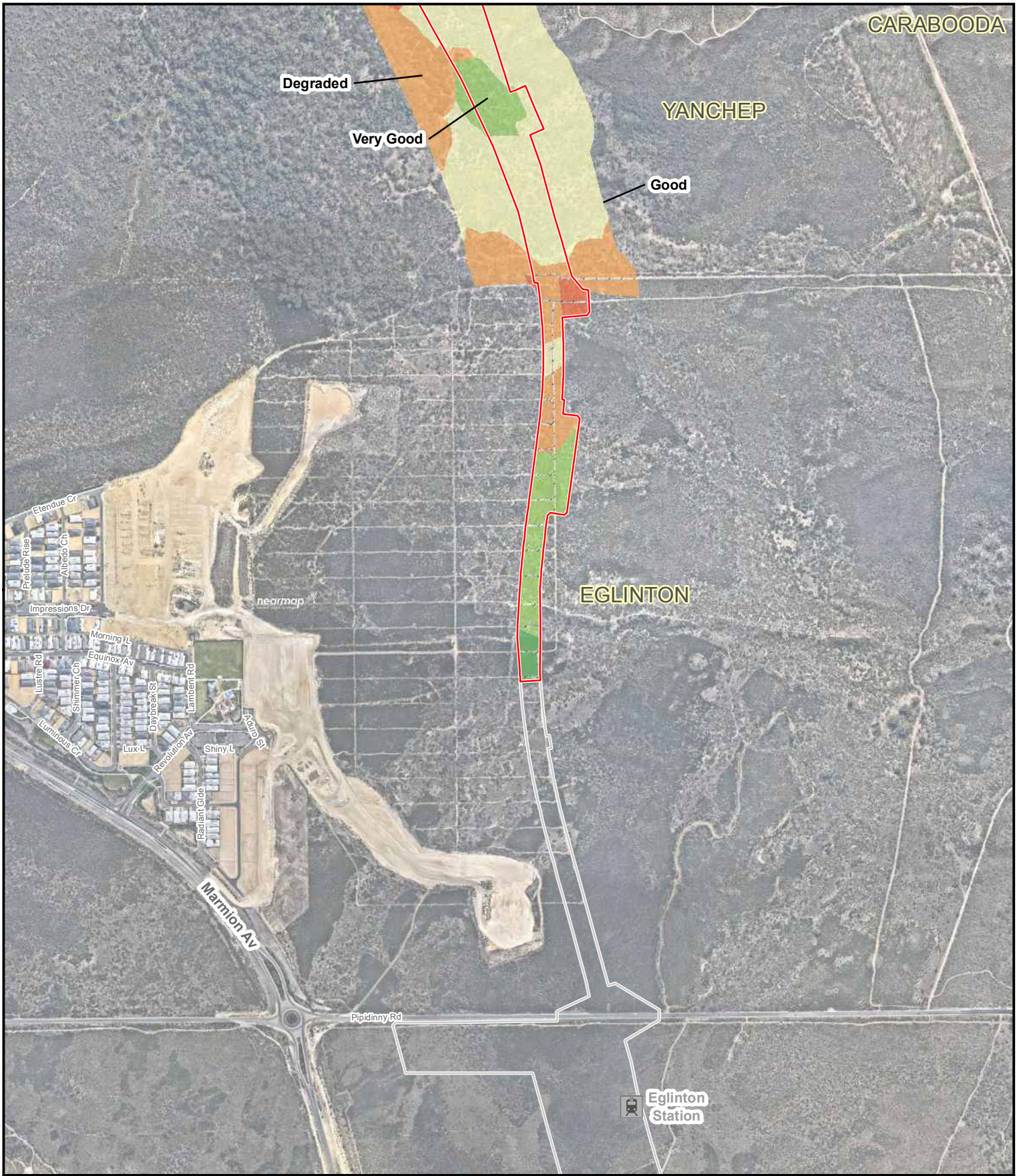


Yanchep Rail Extension (Part 2)
Figure 5-3 Vegetation Condition

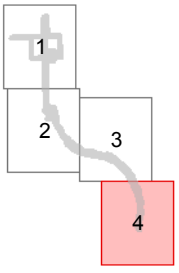
Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Proposed station (YRE Part 1)

Vegetation Community

- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded
- Cleared



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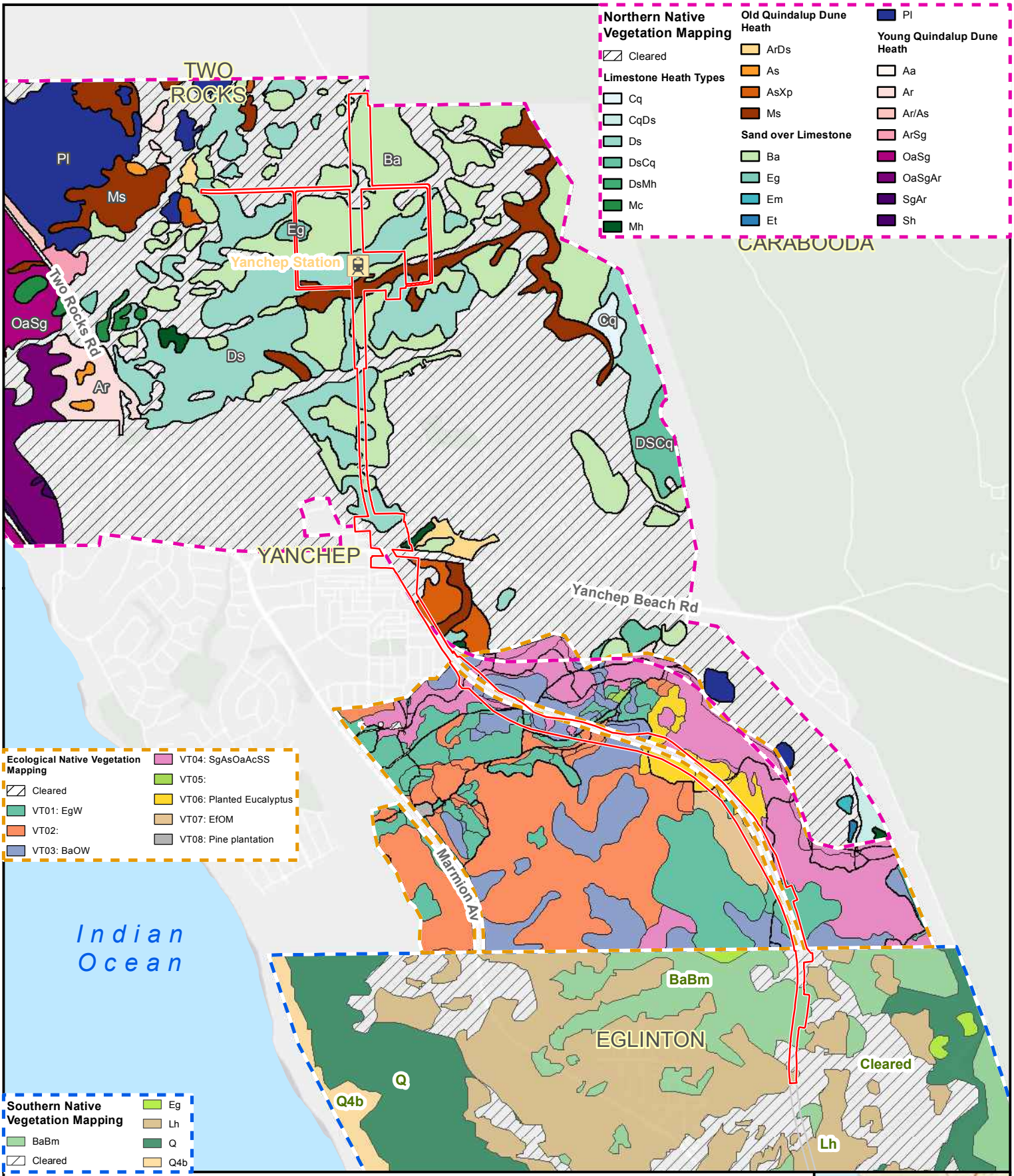
Local and regional extent of vegetation types

The vegetation types described by GHD (2018b) were mapped in the development envelope and additional survey area. To understand how these vegetation types are represented in a wider context outside of this study area, additional vegetation mapping available for the area has been reviewed.

The vegetation surrounding the development envelope was surveyed and mapped for the Environmental Review (ATA Environmental 2003) associated with MRS Amendment 1029/33 Alkimos-Eglinton and the Alkimos Eglinton District Structure Plan and St Andrews District Structure Plan Environmental Assessment (ATA Environmental 2007). In addition, ELA mapped the vegetation of the broader Bush Forever Site 289 (ELA 2018; Appendix O) to the extent that it occurs within Lot 105 Marmion Avenue, Yanchep. These three datasets provide a comprehensive indication of the broader extent of vegetation units at a local scale (Figure 5-4).

An analysis of the vegetation mapping units demonstrates that all vegetation units within the development envelope are well represented outside of the Proposal within the local area (Figure 5-4). This suggests that it is unlikely that vegetation units surveyed for the YRE Part 2 Proposal are restricted to the development envelope.



Yanchep Rail Extension (Part 2)
Figure 5-4 Surveyed Native Vegetation Adjacent to the Development Envelope

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Proposed Station

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Scale 1:30,000

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5.3.3 Threatened and Priority ecological communities

An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat. The complex range of interactions between the component species provides an important level of biological diversity in addition to genetics and species (DBCA 2018a).

Four TECs listed under the BC Act, and/or PECs listed by DBCA were identified within the development envelope:

- *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) SCP (previously *Melaleuca huegelii – M. acerosa* shrublands on limestone ridges);
- Banksia dominated woodlands of the SCP IBRA Region PEC;
- Northern Spearwood shrublands and woodlands ('community type 24') PEC; and
- Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC.

These TECs/PECs comprise 24.62 ha (approximately one third) of the development envelope.

In addition, Banksia dominated woodlands of the SCP TEC, listed under the EPBC Act, was also identified within the development envelope. Within the development envelope, this TEC comprises a subset of the Banksia dominated woodlands of the SCP IBRA Region PEC (GHD 2018b).

These TECs and PECs and their extents within the development envelope and additional survey area (as defined by GHD (2018b)) are outlined in Table 5-6 and presented in Figure 5-5. Delineation of vegetation within the additional survey area demonstrates that, with the exception of *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) SCP, some portion of all TECs and PECs recorded within the development envelope are present beyond the development envelope within the additional survey area (Table 5-6).

The condition of the TECs and PECs within the development envelope ranges from Completely Degraded to Excellent (Table 5-7).

Table 5-6: TECs and PECs within the development envelope

Ecological community	Conservation status	Associated vegetation type (GHD 2018b)	Extent in survey area[1] (ha)	Extent in development envelope (ha)
State listed				
Melaleuca huegelii – M. systena shrublands on limestone ridges (Gibson et al. 1994 type 26a) SCP	Endangered under Western Australia's BC Act	VT08	0.05	0.05
Banksia dominated woodlands of the SCP IBRA region PEC	Priority 3 (iii)[2]	VT04, VT09	19.88	8.76
Northern Spearwood shrublands and woodlands ('community type 24') PEC	Priority 3 (i)[3]	VT02, VT03	18.71	13.68
Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC	Priority 3 (iii)[3]	VT06	8.56	2.13
EPBC listed				
Banksia dominated woodlands of the SCP TEC	Endangered under Commonwealth EBPC Act	VT04, VT09	17.45	8.03

1. As per GHD (2018b) – includes development envelope and additional survey area

2. Priority 3 (iii) are communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change.

3. Priority 3 (i) are communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation.

Source: GHD (2018b; 2019)

Table 5-7: Condition rating of TECs and PECs within the development envelope and surrounds

Ecological community	Condition rating	Extent in survey area[1] (ha)	Extent in development envelope (ha)
Melaleuca huegelii – M. systena shrublands on limestone ridges (Gibson et al. 1994 type 26a) SCP	Very Good	0.05	0.05
	Total	**0.05**	**0.05**
Banksia dominated woodlands of the SCP TEC (EPBC listing)	Excellent	3.01	2.05
	Very Good	9.48	4.09
	Very Good - Good	1.52	0.10
	Good	3.44	1.79
	Total	**17.45**	**8.03**
Banksia dominated woodlands of the SCP IBRA region PEC	Excellent	3.01	2.05
	Very Good	10.08	4.45
	Very Good - Good	1.52	0.10
	Good	4.95	1.84
	Degraded	0.32	0.32
	Total	**19.88**	**8.76**
Northern Spearwood shrublands and woodlands ('community type 24') PEC	Excellent	1.49	1.29
	Very Good	9.36	7.46
	Very Good - Good	0.98	0
	Good	2.95	2.04
	Good - Degraded	0.66	0
	Degraded	3.22	2.89
	Total	**18.84**	**13.68**
Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC	Good	0.38	0
	Good - Degraded	2.23	0.05
	Degraded	5.95	2.08
	Total	**8.56**	**2.13**

[1] As per GHD(2018b) - includes development envelope and additional survey area

Source: GHD (2018b; 2019)

Each of the TECs and PECs present in the development envelope are discussed in further detail below.

Melaleuca huegelii - Melaleuca systena shrublands on limestone ridges (Gibson et al. 1994 type 26a) TEC

This Endangered TEC occurs on skeletal soils on ridge slopes and ridge tops with limestone outcropping (Luu and English 2005). The community is described as comprising of species rich thickets, heaths or scrubs dominated by *Melaleuca huegelii, M. systena* and *Banksia sessilis* over *Grevillea preissii, Acacia lasiocarpa* and *Spyridium globulosum* (community 26a as described by Gibson *et al*. 1994). The community is highly restricted and known from massive limestone ridges around Yanchep, as well as south of Perth, near Lake Clifton (Luu and English 2005).

Field observations inferred VT08 was likely to align with FCT 26a, however the multivariate analysis conducted by GHD (2018b) was inconclusive. The key characteristics of *Melaleuca huegelii - M. systena* shrublands of limestone ridges TEC met by VT08 were:

1. Occurring on hill crests, ridges and upper slopes with outcropping limestone
2. Vegetation structure of shrubland dominated by *Melaleuca huegelii, M. systena* and *Grevillea preissii*
3. Other typical and common species *Hardenbergia comptoniana, Gompholobium tomentosa, Leucopogon parviflorus, Banksia sessilis* and *Crassula colorata.*

For the purpose of this impact assessment, it has been assumed that VT08 is representative of the TEC. A total of 0.05 ha is present in the development envelope, which has been mapped in Very Good condition (GHD 2018b) (**Table 5-7**).

Banksia dominated woodlands of the SCP IBRA Region PEC

This Priority 3 PEC is described by DBCA (2017) as:

> *Canopy is most commonly dominated or co-dominated by Banksia attenuata and/or B. menziesii. Other Banksia species that can dominate in the community are B. prionotes or B. ilicifolia. It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands; it is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau and, in other less common scenarios.*

This PEC was confirmed to occur within the development envelope and is represented by vegetation types VT04 and VT09 (GHD 2018b).

A total of 8.76 ha of the Banksia dominated woodlands of the SCP IBRA region PEC is present within the development envelope, ranging from Excellent to Degraded in condition (**Table 5-7**). A further 1.69 ha of this PEC was identified beyond the boundary of the development envelope, within the additional survey area (GHD 2018b) (**Table 5-6**).

Northern Spearwood shrublands and woodlands ('community type 24') PEC

This Priority 3 PEC is described by DBCA (2017) as:

> *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 Dryandra (Banksia) sessilis, Calothamnus quadrifidus, and Schoenus grandiflorus.*

Other common healthland species forming part of this PEC include *Hardenbergia comptoniana, Melaleuca systena* and *Xanthorrhoea preissii*. *Banksias* found in this community include *Banksia attenuata* and *B. menziesii.*

There is 13.81 ha of the Northern Spearwood shrublands and woodlands PEC within the development envelope represented by vegetation types VT02 (5.24 ha) and VT03 (8.57 ha) (Table 5-7).

The key characteristics of Northern Spearwood shrublands and woodlands PEC met by VT02 and VT03 were:

- Occurs on the western SCP on the Cottesloe units of the Spearwood system
- Vegetation structure of mid to tall shrubland
- Typical and common species including *Banksia menziesii*, *B. sessilis, Melaleuca systena, Calothamnus quadrifidus, Xanthorrhoea preissii, Lepidosperma squamatum, Hardenbergia comptoniana, Phyllanthus calycinus, Conostylis aculeata, Dianella revoluta, Lomandra maritima, Schoenus grandiflorus, Desmocladus flexuosa* and *Austrostipa flavescens.*

This PEC is not restricted to the development envelope. A further 5.03 ha of this PEC, primarily in Very Good condition, was identified by GHD (2018b) beyond the development envelope within the additional survey area (**Table 5-6**).

*Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC*

This Priority 3 PEC is described by DBCA (2017) as:

> *Mostly confined to Quindalup Dunes and Spearwood Dunes from Jurien Bay to the Sabina River, with outliers along some rivers. Tuart is the key dominant canopy species however Tuart communities comprise a variety of flora and fauna assemblages. Flora commonly occurring with Tuart include Peppermint (Agonis flexuosa), Banksia attenuata, Banksia grandis, Allocasuarina fraseriana, Xylomelum occidentale, Macrozamia riedlei, Xanthorrhoea preissii, Spyridium globulosum, Templetonia retusa and Diplolaena dampieri.*

Vegetation type VT06 is representative of the Tuart woodlands of the SCP PEC (Table 5-7). This vegetation type occurs on Spearwood and Quindalup sands and is a woodland with *Eucalyptus gomphocephala* being the dominant canopy species. Whist the majority of Tuart trees present within VT06 are planted, they are established with a diameter at breast height (DBH) greater than 150 mm and aerial imagery indicates they are at least 25 years old.

There is 2.13 ha of the Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC present within the development envelope, ranging from Good - Degraded to Degraded in condition (Table 5-8). A further 6.43 ha was identified in the additional survey area (Table 5-7).

EPBC Act listed Banksia Woodlands of the SCP TEC

The Banksia Woodlands of the SCP TEC (Banksia Woodlands TEC) is restricted to the SCP IBRA bioregion and immediately adjacent areas, including the Dandaragan Plateau, from Jurien Bay in the north, to Dunsborough in the south, and northwest on the Whicher and Darling escarpments (GHD 2018b).

The ecological community typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands.

The TEC is listed as Endangered under the EPBC Act and is described by TSSC (2016) as:

> *A woodland associated with the SCP of southwest Western Australia. A key diagnostic feature is a prominent tree layer of Banksia, with scattered eucalypts 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.*

To meet the criteria for the TEC, an ecological community must meet key diagnostic characteristics and condition and minimum patch size thresholds (TSSC 2016). Two vegetation types (VT04 and VT09) were assessed by GHD (2018b) as meeting the key diagnostic characteristics for the Banksia Woodlands TEC, specifically:

1. The survey area occurs in the SCP IBRA bioregion
2. The survey area occurs on sandplain landform, notably Spearwood and Quindalup sands
3. The vegetation types have a low woodland structure and the upper sclerophyllous layer is dominated or co-dominated by *Banksia attenuata* and/or *B. menziesii*. The understorey consists of a mid-ground sclerophyllous shrub layer and/or a herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs that sometimes includes grasses.

While FCT 24 (VT02 and VT03) is listed in the EPBC conservation advice as a community with relationships to the TEC (TSSC 2016), in this case it was not found to meet the vegetation structure and composition key diagnostic criteria. VT02 and VT03 comprise mixed tall shrublands where *Banksia sessilis* was one of three species that were dominant. However, *Banksia sessilis* is not a diagnostic species for the TEC and the species does not form an upper layer of low trees (or large tall shrubs) distinctive to the other tall shrubs. As such, FCT 24 does not meet the criteria for Banksia Woodlands TEC within the development envelope.

To be considered a MNES (as defined under the EPBC Act), vegetation must meet minimum patch size and condition thresholds. Within the development envelope, this EPBC Act listed TEC represents a subset of the State listed Banksia dominated woodlands of the SCP IBRA Region PEC. Only vegetation in Good or better in condition was considered representative of the Banksia Woodlands TEC.

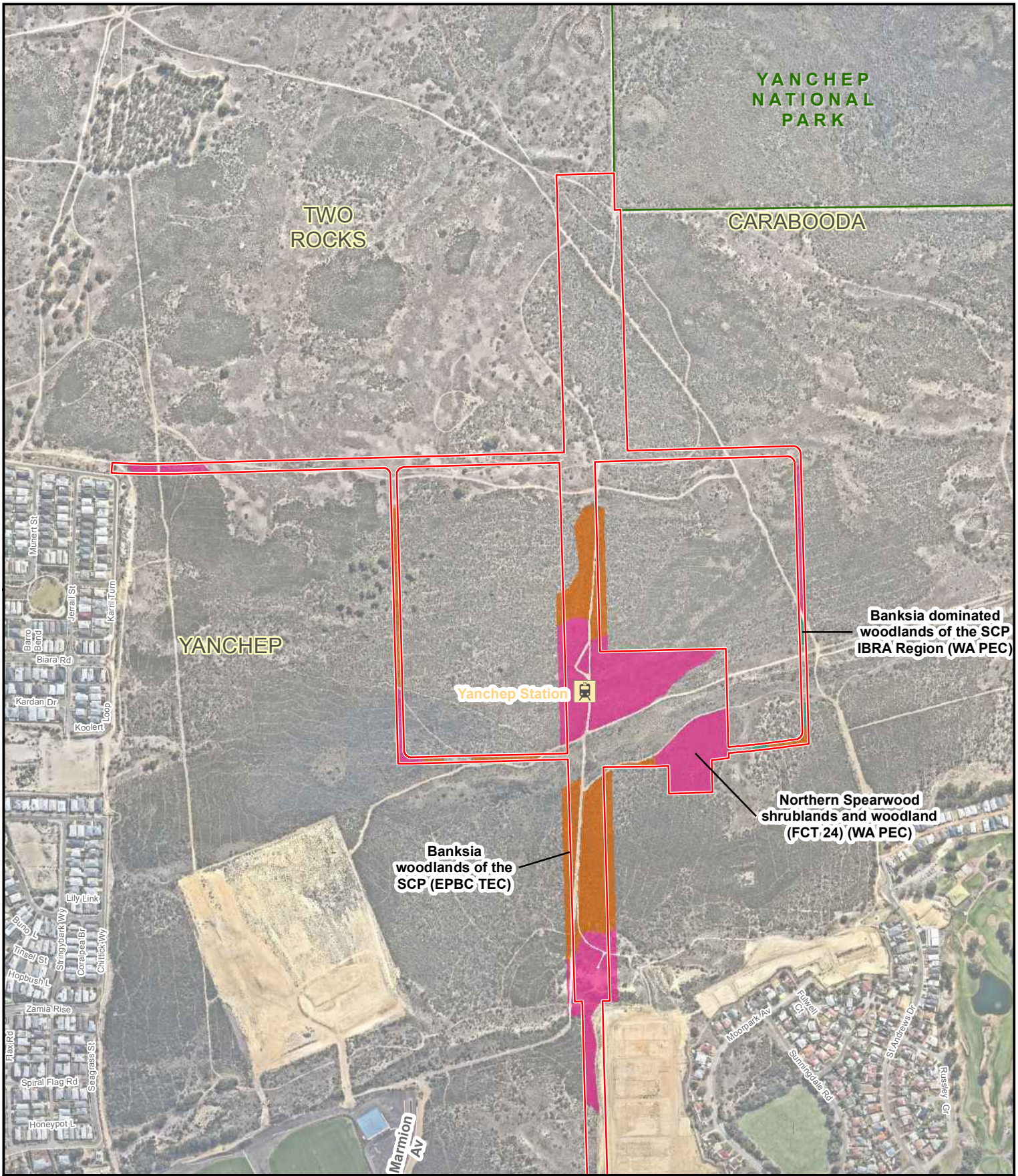
A total of 8.03 ha of this TEC is present in the development envelope, primarily in Very Good or Excellent condition (Table 5-8). A further 9.34 ha was identified beyond the boundary of the development envelope, within the additional survey area. Six patches of Banksia Woodlands meeting the key diagnostic characteristics and minimum criteria intersect the development envelope GHD (2018b). These six patches are presented in Figure 7 of GHD (2018b) and described in further detail in (Table 5-8).

Table 5-8: Extent of Banksia Woodlands TEC within the development envelope

Patch ID	Vegetation type	Vegetation condition and extent (ha)[1]	Comments
Patch 1	VT04	Very Good: 0.68 Good: 1.03 **Total area: 1.71**	Areas mapped as the TEC are part of a larger patch that extends east and west of the development envelope. Aerial imagery indicates this patch is approximately 20 ha. It is estimated that approximately 9% of the patch occurs within the development envelope[2].
Patch 2	VT04	Excellent: 0.13 **Total area: 0.13**	Areas mapped as the TEC are part of a larger, isolated patch that occurs directly adjacent to the survey area. Aerial imagery indicates this patch is approximately 1.64 ha, and it is estimated that approximately 8% of the patch occurs within the development envelope.[2]
Patch 3	VT04	Excellent: 1.92 Very Good: 0.08 **Total area: 2.00**	Areas mapped as the TEC are part of a larger patch that extends mostly west of the development envelope. This patch is separated from Patch 1 (which occurs to the north) by areas of VT03 and VT05. Aerial imagery indicates this patch is approximately 13 ha, and it is estimated that approximately 15% of the patch occurs within the development envelope.[2]
Patch 4	VT04 VT09	Good: 0.40 **Total area: 0.40**	Areas mapped as the TEC are part of a patch that extends both north and south of the development envelope. Vegetation mapping by GHD and Eco Logical Australia (ELA 2018; Appendix O) indicates the Banksia vegetation adjacent to the survey area is Good to Very Good in condition. Aerial imagery and the ELA mapping indicates this patch is approximately 2.17 ha. It is estimated that approximately 18% of the patch occurs within the development envelope.
Patch 5	VT09	Very Good: 2.13 Very Good to Good: 0.10 **Total area: 2.23**	Areas mapped as the TEC are part of a larger patch that extends south/south-west of the GHD survey area. Vegetation mapping by ELA (2018; Appendix O) indicates the Banksia vegetation adjacent to the survey area is Good to Very Good in condition. Aerial imagery and the ELA mapping indicates this patch is approximately 28 ha. It is estimated that approximately 8% of the patch occurs within the development envelope.
Patch 6	VT09	Very Good: 1.20 Good: 0.35 **Total area: 1.55**	Areas mapped as the TEC are part of a patch that extends east of the development envelope. GHD mapping indicates this patch is approximately 2.93 ha in Good or Very Good condition. It is estimated that 53% of the patch occurs within the development envelope.

[1] Calculated using raw data reported in GHD 2018b

[2] For Patches 1, 2 and 3, where condition mapping does not exist outside the development envelope, it has been assumed that the condition of the patch outside the development envelope would reflect that within it.

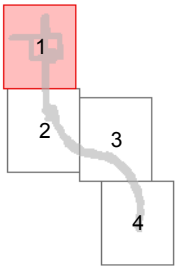


Yanchep Rail Extension (Part 2)
Figure 5-5 Threatened and Priority Ecological Communities

Public Transport Authority

Legend

- Development Envelope
- National Park
- Proposed Station
- Banksia Dominated Woodlands - PEC
- Banksia Woodlands - TEC
- Northern Spearwood



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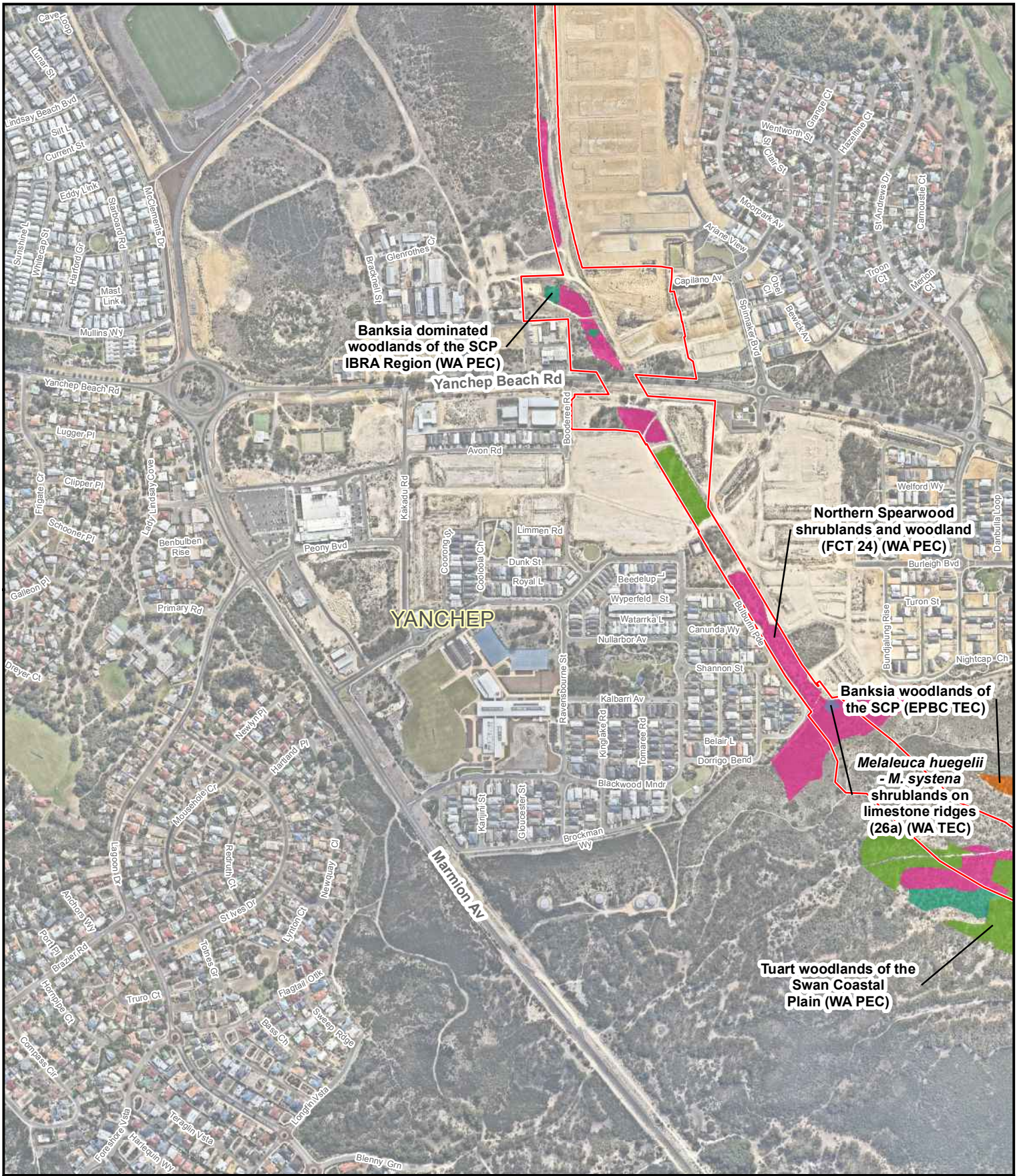
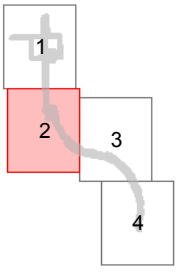


Yanchep Rail Extension (Part 2)
Figure 5-5 Threatened and Priority Ecological Communities

Public Transport Authority

Legend

- Development Envelope
- Banksia Dominated Woodlands - PEC
- Banksia Woodlands - TEC
- *Melaleuca huegelii* - TEC
- Northern Spearwood
- Tuart Woodlands of SCP - PEC



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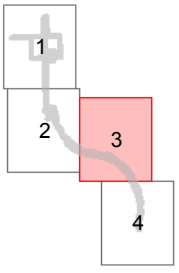
Yanchep Rail Extension (Part 2)
Figure 5-5 Threatened and Priority Ecological Communities

Page 3 of 4

Public Transport Authority

Legend

- Development Envelope
- National Park
- Banksia Dominated Woodlands - PEC
- Banksia Woodlands - TEC
- Northern Spearwood
- Tuart Woodlands of SCP - PEC



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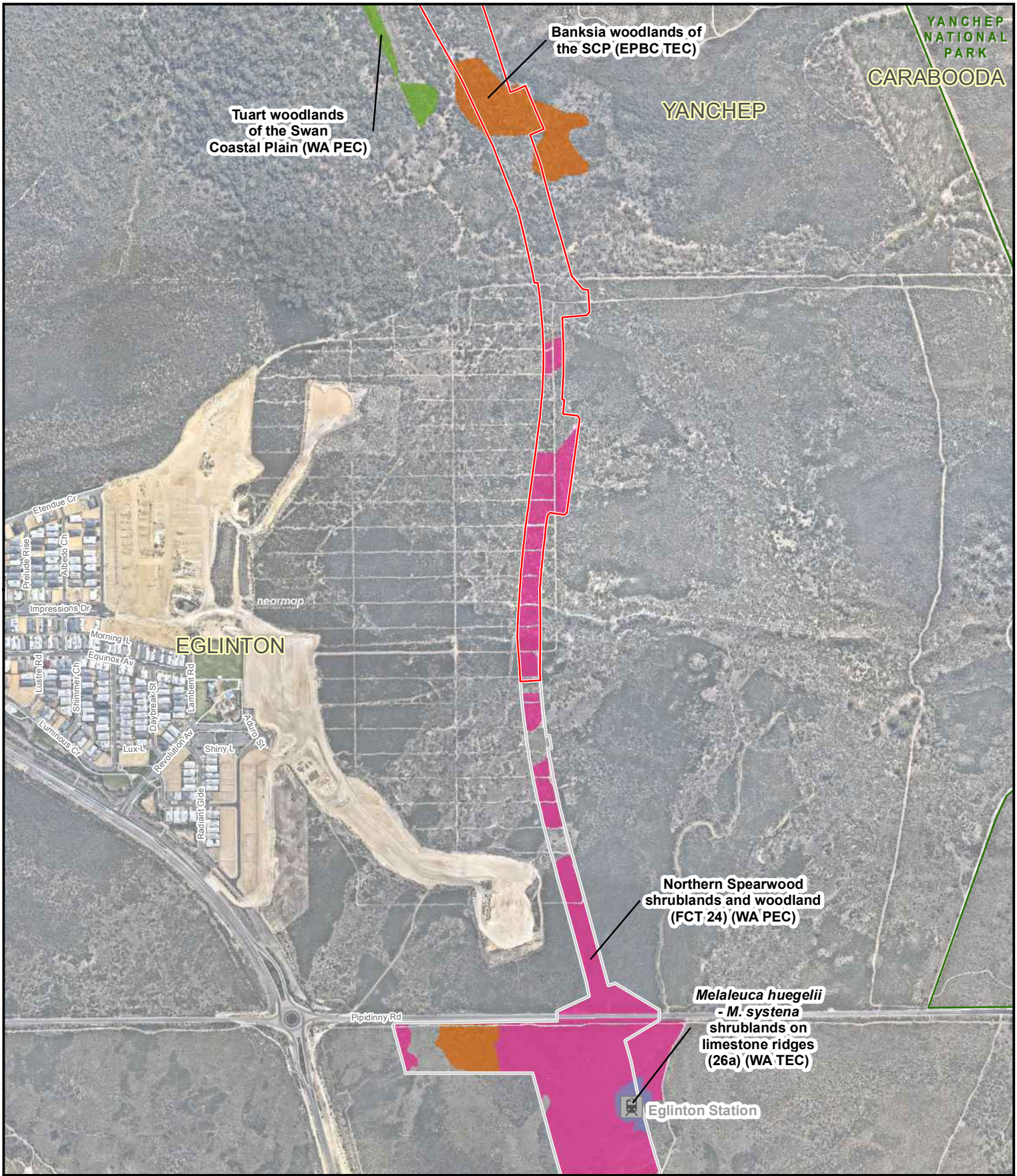
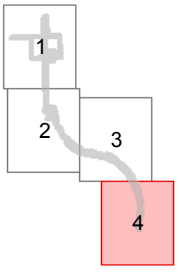


Yanchep Rail Extension (Part 2)
Figure 5-5 Threatened and Priority Ecological Communities

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Proposed station (YRE Part 1)
- Banksia Woodlands - TEC
- *Melaleuca huegelii* - TEC
- Northern Spearwood
- Tuart Woodlands of SCP - PEC



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5.3.4 Flora

Flora and vegetation surveys recorded 150 native taxa and 62 introduced flora taxa within the YRE survey area. Dominant families were Poaceae (21 taxa), Fabaceae (21 taxa) and Proteaceae (21 taxa) (GHD 2018b). Historically, surveys of the Quindalup Dune System have recorded 9 to 35 species per 100 m^2, while species diversity in the Spearwood Dune System is higher at 37 to 55 species per 100 m^2 (GHD 2018b). Species diversity ranged from 12 to 49 (average 32) taxa per 100 m^2 during the GHD surveys, with the highest floristic diversity recorded in *Banksia attenuata*, *B. menziesii* low woodland (VT04). The development envelope is considered to be representative of the floristic diversity in the area (GHD 2018b).

Introduced flora

Sixty-two introduced flora taxa were recorded in the development envelope (GHD 2018b). Of the 62 introduced flora species, six are Declared Pests as defined by the *Biosecurity and Management Act 2007* (BAM Act) and/or Weeds of National Significance (WoNS).

- **Gomphocarpus fruticosus* (narrowleaf cottonbush) – Declared Pest
- **Moraea flaccida* (One-leaf Cape Tulip) – Declared Pest
- *Solanum linnaeanum* (apple of Sodom) – Declared Pest
- **Zantedeschia aethiopica* (Arum Lily) – Declared Pest
- *Lantana camara* (common lantana) – Declared Pest and WoNS
- *Asparagus asparagoides* (bridal creeper) – Declared Pest and WoNS.

The remaining introduced taxa are considered environmental weeds and have been previously recorded on the SCP (GHD 2018b).

Conservation listed flora

No threatened flora species listed under the EPBC Act or BC Act were recorded in the development envelope or the additional survey area (GHD 2018b). One DBCA Priority-listed flora species, *Hibbertia spicata* subsp. *leptotheca* (P3), was recorded in the development envelope during the 2016-2018 surveys (GHD 2018b). An additional three DBCA Priority-listed flora species - *Conostylis pauciflora* subsp. *euryrhipis* (P4), *Conostylis pauciflora* subsp. *pauciflora* (P4), and *Beyeria cinerea* subsp. *cinerea* (P3) - were recorded during the 2012 flora and vegetation survey (GHD 2012). These records were not relocated during the 2016-2018 field surveys.

5.3.5 Bush Forever

The Bush Forever policy aims to protect regionally significant bushland of the SCP portion of the Perth Metropolitan Region (Government of Western Australia 2010). It seeks to protect at least 10% of the original extent of each of the 26 vegetation complexes in the region as defined by Gibson et al. (1994).

One Bush Forever Site intersects the development envelope (Bush Forever Site No. 289; Ningana Bushland) and four Bush Forever Sites are located adjacent to, or within 3 km, of the Proposal (Table 5-9, Figure 5-6).

Table 5-9: Bush Forever Sites within or in close proximity to the development envelope

Bush Forever Site No.	Name	Total area (ha)	Distance and direction relative to development envelope
289	Ningana Bushland, Yanchep/Eglington	640.83	Intersects
288	Yanchep National Park and Adjacent Bushland	2,899.5	Immediately adjacent to the northeast corner and running parallel to the alignment 1 to 2 km to the east
130	Link between Yanchep and Neerabup National Parks	92.0	3 km southeast
397	Coastal strip from Wilbinga to Mindarie	552.5	2 km west
129	Bernard Road Bushland	102.8	3 km southeast

Bush Forever Site No. 289 (Ningana Bushland) consists of a large area of remnant vegetation that provides a valuable ecological corridor from the coast (Bush Forever Site No. 397) to Yanchep National Park (Bush Forever Site No. 288). Ningana Bushland is characterised by coastal dune, parabolic dune and blowout landscape features and supports woodland, heath, shrubland and grassland communities (Government of Western Australia 2000). The upland woodland and heath communities include potential foraging and breeding habitats for Carnaby's Cockatoo *(Calyptorhynchus latirostris)* (ELA 2018; Appendix O). The bushland is currently intersected by Marmion Avenue.

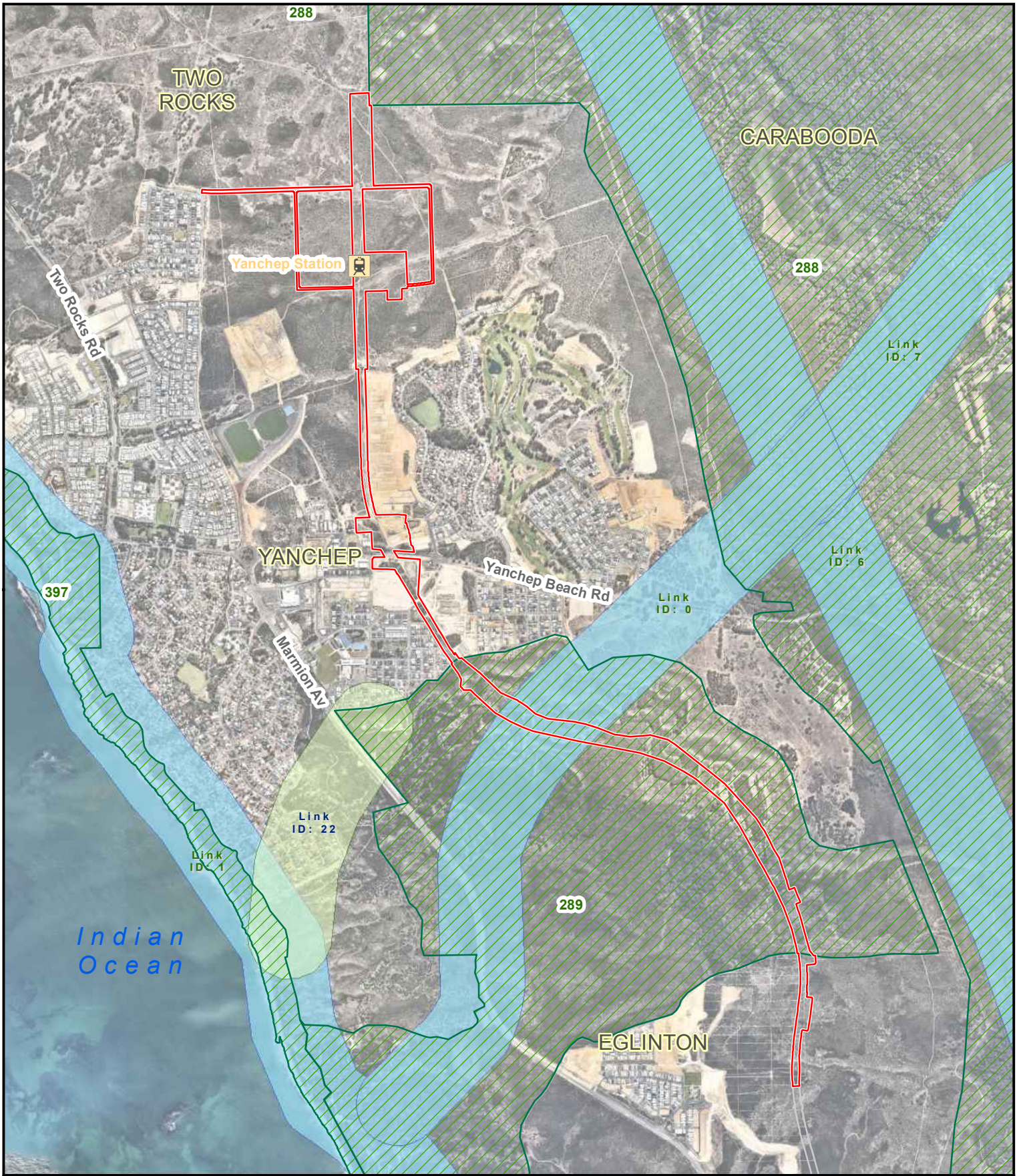
Flora and vegetation values within the Ningana Bushland include the potential occurrence of the following TEC/PECs (ELA 2018; Appendix O):

- *Banksia* woodlands TEC
- *Banksia* dominated woodlands of the SCP IBRA region PEC
- Northern Spearwood shrublands and woodlands (‘community type 24’) PEC
- Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC

Within the portion of Ningana Bushland mapped by ELA (2018; Appendix O), approximately 80% of has been mapped in Good or Very Good condition. An additional 18% is in Degraded condition, with the remainder of the site mapped as Completely Degraded or cleared (ELA 2018; Appendix O).

5.3.6 Conservation and recreation areas

No DBCA-managed conservation areas are located within the development envelope **(**Figure 2-4). The closest DBCA managed area is Yanchep National Park (R 9868, Class A nature reserve), located immediately east of the development envelope.



Yanchep Rail Extension (Part 2)
Figure 5-6 Ecological Linkages in the Vicinity of the Development Envelope

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Bush Forever (Site Number Labelled)
- Local Ecological Linkage
- Regional Ecological Linkage
- Proposed Station

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Created By: David Fotheringham
Scale 1:30,000

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Reference: City of Wanneroo Local Biodiversity Plan 2018/19-2023/24 (360 Environmental, 2018)

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Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

5.3.7 Ecological linkages

Regional and local ecological linkages act as corridors for flora and fauna to move between regionally and locally significant areas (Western Australian Local Government Association (WALGA) 2004). One east-west regional ecological linkage, Link No. 0, intersects the development envelope (Figure 5-6). Link No. 0 (an extension of Link No. 7) is identified within the City of Wanneroo Local Biodiversity Strategy 2018–2024 (City of Wanneroo 2018) links Bush Forever Sites No. 288, 289 and 397. The link is currently intersected by Marmion Avenue. Another regional ecological link- proposed Greenway linkage 37 is identified in Alan Tingay and Associates (1998). Link 0 and 37 are in close proximity to each other. They provide a link through Ningana Bushland to two major north-south linkages in the region, the coastal bushland strip and the inland wetlands chains. Proposed Greenway linkage 37 is not discussed further with Link 0 representing both linkages.

Three regional ecological linkages occur within 2 km of the development envelope (Figure 5-6):

- Link No. 1 occurs west of the development envelope, running parallel and links Bush Forever Sites No. 406 and 397, maintaining connectivity along the Coast for the Quindalup Complex.
- Link No. 6 occurs east of the development envelope, running parallel and links Bush Forever Sites No. 284, 288, 129, 130, 383, 299, 202.
- Link No. 7 occurs east of the development envelope, running perpendicular and links Bush Forever Sites No. 288, 381, 380.

All links have been impacted by previous vegetation clearing and urban development (GHD 2019).

One local ecological linkage (Link No. 22) occurs to the west of the development envelope (Figure 5-6). This is an east-west linkage mapped within the City of Wanneroo Local Biodiversity Strategy 2018–2024 (City of Wanneroo 2018). Link No. 22 connects the north-west portion of Bush Forever Site No. 289 with the coast and Bush Forever Site No. 397.

5.4 Potential impacts

The Proposal has the potential to directly and indirectly impact on flora and vegetation during construction and operation phases.

Potential direct impacts of the Proposal due to vegetation clearing within the development envelope are:

- Permanent loss of
    - 49.17 ha of native vegetation in Excellent to Degraded condition;
    - 0.05 ha *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) TEC;
    - 8.76 ha of Banksia dominated woodlands of the SCP IBRA Region PEC, of which 8.03 ha is also representative of the Banksia dominated woodlands of the SCP TEC;
    - 13.68 ha of Northern Spearwood shrublands and woodlands (‘community type 24’) PEC;
    - 2.13 ha of Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC;
    - Up to 33 individuals of conservation significant flora within the development envelope. This includes individuals of two Priority 3 (poorly known taxa) taxa and two Priority 4 (Rare, Near Threatened and other taxa in need of monitoring) taxa.
- Permanent loss of 28.82 ha of Bush Forever Site No. 289 (Ningana Bushland); and
- Fragmentation of regional ecological linkage extension (Link No. 0).

Potential indirect impacts of the Proposal are:

- Introduction and/or spread of Declared Pests and other weed species within the development envelope and/or into vegetation adjacent to the development envelope due to increased vehicle and personnel access during construction and operation;
- Introduction and spread of Phytophthora dieback into vegetation adjacent to the development envelope due to increased vehicle and personnel access during construction and operation; and
- Degradation of adjacent remnant vegetation through potential:
    - Contamination of surface water and groundwater during construction and operation;
    - Alteration of surface hydrology, rainfall infiltration and/or increased sedimentation during construction and operation;
    - Dust emissions during construction; and
    - Fragmentation of vegetation, including Bush Forever Site 289 and TECs/PEC

The potential for indirect impacts on remnant vegetation from dust will be managed in accordance with standard construction and operating procedures. As mitigation is well established and successful, it is not considered further in this assessment.

5.5 Assessment of impacts

Vegetation rated as Completely Degraded has been excluded from the impact assessment presented in Sections 5.5.1 to 5.5.7, as it is considered to no longer represent intact native vegetation. This approach is consistent with the definitions of native vegetation contained within the EP Act.

Yanchep Rail Extension Part 1 and ULDO data have been used to present potential cumulative impacts. See Section 4.3.5 for further detail on how these have been used.

5.5.1 Permanent loss of native vegetation

Impacts to regional vegetation mapping units

A total of 49.17 ha of native remnant vegetation in Degraded or better condition was mapped within development envelope and will be cleared as a result of the Proposal (GHD 2019).

The National Objectives and Targets for Biodiversity Conservation (Commonwealth of Australia 2001) target to avoid clearance of ecological communities with a pre-European extent of below 30%.

Vegetation to be cleared within the development envelope comprises two vegetation associations (949 and 1007). After implementation of the Proposal, more than 44% of the Pre-European extent of these vegetation associations will remain at both a regional and local level.

Vegetation to be cleared within the development envelope comprises two vegetation complexes - Quindalup complex and Cottesloe complex - north. Within the Perth IBRA sub-region, these complexes have 62% and 58% of the pre-European extent remaining, respectively. After implementation of the Proposal these percentage will remain unchanged at this scale (Table 5-10).

Clearing the development envelope will remove up to 4.04% of the remaining extent of the Quindalup Complex at a local scale; however, at a regional and bioregional scale this impact is 0.74% and 0.13%, respectively (Table 5-10). The current extents remaining of the Quindalup Complex remains greater than 62% at a regional scale and 56% at a local scale after development of the Part 2 Proposal (GHD 2019).

In addition, greater than 21% of the remaining pre-European extents occur in conservation areas (GHD 2018b) (Table 5-10). For vegetation complexes, the remaining extent within conservation areas ranges from 42.05% to 50.12% at a local scale and from 29.08% to 92.94% at a regional scale (GHD 2019).

Based on the remaining extent of vegetation associations and vegetation complexes impacted by the Proposal and their representation in areas managed for conservation, there are no expected significant residual impacts to vegetation at this regional mapping scale.

Table 5-10: Remaining extent of vegetation complexes at local, subregional and regional scales

Vegetation complex (Webb et al. 2016)	Scale	Pre-European extent (ha)	Current extent (% remaining)	Current extent in conservation areas (DBCA Legislated Lands and Waters, and Bush Forever Sites)		Extent in development envelope (ha) (Vegetation in Degraded or better condition)	Extent after Proposal implementation (ha) (% pre-European extent)
				Area (ha)	% of current extent		
Cottesloe complex-north	Perth IBRA subregion	43,474.30	25,162.35 (57.88%)	18,789.29	74.67	1.04 (<0.01%)	25,161.96 (57.88%)
	NW subregion	8,715.75	5,950.36 (68.27%)	5,530.25	92.94	1.04 (0.01%)	5,949.97 (68.27%)
	1 km buffer	326.55	125.33 (38.38%)	62.82	50.12	1.04 (0.31%)	124.95 (38.26%)
Quindalup complex	Perth IBRA subregion	53,007.07	32,954.86 (62.17%)	10,734.03	32.57	48.13 (0.13%)	32,913.30 (62.09%)
	NW subregion	11,184.24	5,634.59 (50.38%)	1,638.47	29.08	48.13 (0.74%)	5,593.03 (50.01%)
	1 km buffer	1734.76	1,028.55 (59.29%)	432.53	42.05	48.13 (4.04%)	986.99 (56.90%)

Source: Adapted from GHD (2019).

Impacts to locally mapped vegetation units

Clearing for the Proposal will result in the permanent loss of 49.17 ha of native vegetation in Excellent to Degraded condition (Table 5-3, Figure 5-1**).** This vegetation comprises twelve mapped vegetation units (remnant vegetation and planted taxa). These units are generally well represented outside of the development envelope with more than 30% of the mapped extent for eight of the twelve vegetation units occurring within the additional survey area.

This is supported by a visual assessment of vegetation mapping available for the area surrounding the development envelope (Figure 5-4) which suggest that vegetation units impacted by the Proposal are also well represented in the locality and region.

Four of the mapped vegetation units had 10% or less occurring outside of the development envelope in the additional survey area. These were:

- VT02: *Banksia sessilis* and *Melaleuca systena* mid-shrubland.
- VT07: *Eucalyptus* sp. and *Agonis flexuosa* woodland.
- VT08: *Melaleuca huegelii* and *M. systena* shrubland.
- VT10: *Xanthorrhoea preissii* shrubland.

Of these units, VT02 and VT08 were identified as components of the Northern Spearwood shrublands and woodlands PEC and *Melaleuca huegelii – M. systena* shrublands on limestone ridges TEC, and as such are discussed separately in Section 5.5.2. The remaining units, VT07 and VT10 were represented by only small areas within the development envelope (0.32 and 1.63 ha respectively) and do not align with any known high conservation values (e.g. TECs/PECs).

Cumulative impacts

Table 5-11 demonstrates the cumulative impacts on the vegetation complexes mapped within the development envelope at local and regional scales.

Table 5-11: Cumulative impacts of vegetation clearing (Webb et al. [2016] vegetation complexes) due to YRE Parts 1 and 2 and predicted future developments (from the Perth and Peel ULDO) at a local and subregional scale

Vegetation complex (Webb et al. 2016)	Scale	Current extent (ha)	YRE Part 2 proposed clearing (ha)	YRE Part 1 proposed clearing (ha)	Potential future clearing within ULDO areas[1](ha)	Cumulative clearing (ha)
Cottesloe complex- north	NW subregion	5,950.36	1.04 (0.01%)	0.00 (0%)	163.96 (2.76%)	164.35 (2.76%)
	1 km buffer	125.33	1.04 (0.31%)	0.00 (0%)	39.81 (31.76%)	40.20 (32.07%)
Quindalup complex	NW subregion	5,634.59	41.13 (0.74%)	26.81 (0.46%)	3,561.78 (63.21%)	3,629.24 (64.41%)
	1 km buffer	1,028.55	41.13 (4.04%)	11.37 (1.07%)	507.55 (49.35%)	560.16 (54.46%)

Source: Adapted from GHD (2019).

[1] Excludes overlaps with the YRE Part 1 and Part 2 development envelopes

The assessment shows there will be substantial pressure on the remaining vegetation of the Cottesloe complex – north and Quindalup complex at a local and regional scale, primarily due to future residential, commercial and industrial development (GHD 2019). However, even with total clearing assumed within ULDO areas, after combined cumulative impacts are considered more than 30% of the Pre-European extent of both vegetation complexes would remain at a local and regional scale.

5.5.2 Permanent loss of State listed TECs and PECs

The Proposal will result in the loss of 24.62 ha of the mapped extents of one State listed TEC and three PECs present within the development envelope, which together comprise approximately one third (of the development envelope. Table 5-12 provides contextual information for this loss at a local and regional scale. Table 5-12 also provides an indication of the proportion of the mapped extents of these ecological communities occurring within conservation areas.

Apart from a small area (0.3 ha) of Banksia dominated woodlands of the SCP PEC, current DBCA mapping does not include any areas of PECs or TECs within the development envelope. Therefore, all occurrences mapped by GHD in the development envelope (apart from the 0.3 ha) are in addition to the current mapped extent as shown in Table 5-12**.**

Clearing for the Proposal will also result in loss of approximately 8.03 ha of EPBC Act listed Banksia Woodlands TEC, forming a subset of the areas mapped as Banksia dominated woodlands of the SCP IBRA Region PEC.

Table 5-13 provides an indication of cumulative impacts to the TECs and PECs as a result of the combined YRE project (Part 1 and Part 2).

Table 5-12: Mapped extent of TECs and PECs at local and regional scales and representation within conservation areas

Ecological community	Scale	Current extent remaining[1] (ha)	Current extent in conservation areas (DBCA Legislated Lands and Waters, and Bush Forever Sites) [1]		Current extent using GHD data for the survey area[2] (ha)	Extent in development envelope[3] (ha)	Extent after Proposal implementation	
			Area (ha)	% of current extent			ha	% of current extent
Melaleuca huegelii – M. systena shrublands (TEC) (SCP 26a)	NW subregion	100.84	81.21	80.54	100.89	0.05	100.79	99.95
	1 km buffer	0	-	-	0.05	0.05	0	0
Banksia dominated woodlands of the SCP IBRA Region PEC[4]	NW subregion	16,836.81	15,532.33	92.25	16,839.24	8.76	16,828.05	99.95
	1 km buffer	125.45	62.90	50.14	127.88	8.76	116.69	93.02
Northern Spearwood shrublands and woodlands (SCP24) PEC	NW subregion	332.59	329.22	98.99	351.43	13.68	318.91	95.89
	1 km buffer	0	-	-	18.84	13.68	0	0
Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC	NW subregion	3,643.73	2,047.84	56.20	3,652.29	2.13	3,641.60	99.94
	1 km buffer	18.76	18.40	98.06	27.32	2.13	16.63	88.65

Source: Adapted from GHD (2019) using numbers extracted from DBCA datasets (unseen) provided by PTA

[1] Numbers based on DBCA dataset only

[2] Numbers provided by PTA extracted using GHD mapping for the survey area and DBCA mapping outside of this

[3] As per GHD mapping (2018b)

[4] Banksia woodlands (TEC) is a subset of the Banksia dominated woodlands of the SCP IBRA Region PEC

Melaleuca huegelii - Melaleuca systena shrublands on limestone ridges (Gibson et al. 1994 type 26a) TEC

The Proposal will result in the permanent loss of 0.05 ha of the *Melaleuca huegelii - M. systena* shrublands on limestone ridges TEC in Very Good condition.

Approximately 101 ha of this TEC was identified in the DBCA (2018b) TEC/PEC dataset at a regional scale. The Proposal will impact less than 0.1% of the known extent of this TEC at this scale (Table 5-12). Although mapping would appear to indicate a complete loss of the TEC at a local scale, it should be noted that the occurrence of 0.05 ha of the TEC within the development envelope was not previously identified in the DBCA (2018b) TEC/PEC dataset or the Interim Recovery Plan (Luu and English 2005). The perceived impact to the *Melaleuca huegelii-Melaleuca systena* shrublands TEC at the local scale is likely a reflection of its restricted and isolated occurrences and the limited extent of this TEC within a 1 km buffer of the development envelope (GHD 2019).

Of the mapped extent of the *Melaleuca huegelii-Melaleuca systena* shrublands on limestone ridges TEC, approximately 80.5% occurs within conservation areas (GHD 2019) at the regional scale, suggesting a high degree of long-term protection of its known extent.

The TEC is classified as Endangered and is endorsed by the WA Minister for Environment. Despite the high degree of representation of this TEC in conservation areas, it is still highly restricted with a small area of occupancy and is under threat from clearing due to mining and urban housing and infrastructure (Luu and English 2005). The residual impact of clearing 0.05 ha of the TEC is therefore considered significant.

Banksia dominated woodlands of the SCP IBRA Region PEC

The Proposal will result in the loss of 8.76 ha of the *Banksia* dominated woodlands PEC, which ranges in condition from Excellent to Degraded. The clearing loss associated with the Proposal is estimated to contribute a less than 7% reduction in the PEC at a local scale 0.05% reduction in the PEC at a regional scale (Table 5-12) (GHD 2019).

Of the mapped extent of the Banksia dominated woodlands of the SCP PEC, more than 50% at a local scale, and more than 90% occurs within conservation areas at the regional scale, suggesting a high degree of long-term protection of its known extent.

The PEC is not an ecological community protected by statute (i.e. not formally recognised as being threatened). No rare or endangered plants have been recorded in the mapped occurrences of the PEC within the development envelope, and the occurrences of the PEC impacted by the Proposal are not within the formal conservation reserve system. The impact from the Proposal is considered small and incremental and is not considered to cause the PEC or flora or fauna taxa to become rare or endangered. Therefore, in accordance with the considerations of significance set out in the *WA Environmental Offsets Guidelines* (Government of Western Australia 2014), the residual impact to the PEC from the Proposal is not significant.

Northern Spearwood shrublands and woodlands ('community type 24') PEC

The Proposal will result in the loss of 13.68 ha of the Northern Spearwood shrublands and woodlands (SCP24) PEC, the majority of which is in Very Good or Excellent condition. The Proposal's impact to the PEC will result in 4.11% of the PEC's extent cleared at a regional level (GHD 2019).

Although mapping indicates 100% loss of the surveyed extent of this PEC at a local scale, it should be noted that the occurrence of the PEC within the development envelope was not previously identified in

DBCA's TEC/PEC dataset. The 5.16 ha recorded in the additional survey area by GHD (2018b) outside of the development envelope therefore increases the known extent of this PEC remaining after implementation of the Proposal. Given the identification of this PEC across the area surveyed by GHD both within and outside of the development envelope where it is not recorded in the DBCA dataset, it appears likely that additional areas of this PEC would also be found within the balance of Bush Forever Site No. 289, further reducing the significance of loss at a local scale.

This PEC is listed as Priority 3(i) by DBCA (2017) and is classified as a poorly known community that is known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation. In the absence of threats to many of these occurrences, it is unlikely the Proposal will cause an increase in conservation status in the PEC or associated flora or fauna species.

Of the mapped extent of the Northern Spearwood shrublands and woodlands PEC, approximately 99% occurs within conservation areas at the regional scale, suggesting a very high degree of long-term protection of its known extent.

The PEC is not an ecological community protected by statute (i.e. not formally recognised as being threatened), and no rare or endangered plants have been recorded in the mapped occurrences of the PEC within the development envelope. The occurrences of the PEC impacted by the Proposal are outside the formal conservation reserve system. Therefore, in accordance with the considerations of significance set out in the WA Environmental Offsets Guidelines (Government of Western Australia 2014), the residual impact to the PEC from the Proposal is not significant.

Tuart (Eucalyptus gomphocephala) woodlands of the SCP PEC

The Proposal will result in the loss of 2.13 ha of the Tuart (*Eucalyptus gomphocephala*) woodlands PEC, primarily in degraded condition, representing a loss of less than 0.1% of the remaining extent at a regional scale and approximately 11% at a local scale.

Mapping undertaken by ELA for Lot 105 in Bush Forever Site No. 289, adjacent to the development envelope (2018; Appendix O), includes a *Eucalyptus gomphocephala* community as part of the mapped vegetation structural units. This community was mapped across 91.38 ha, or 21%, of the survey area (440 ha). The inclusion of this community as a mapped structural unit may suggest its occurrence more broadly at a local scale than current DBCA mapping indicates (approximately 19 ha within this same area), further reducing the significance of loss at a local scale.

This PEC is well represented in conservation areas, with approximately 98% of the mapped current extent at a local scale and approximately 56% of the current extent conserved at the regional scale in conservation areas.

The PEC is not an ecological community protected by statute (i.e. not formally recognised as being threatened). The impact from the Proposal is considered small and incremental, and the occurrence of the PEC is in largely Degraded condition. No rare or endangered plants have been recorded in the mapped occurrences of the PEC within the development envelope, and the Proposal is not considered to cause the PEC or flora or fauna taxa to become rare or endangered. Therefore, in accordance with the considerations of significance set out in the WA Environmental Offsets Guidelines (Government of Western Australia 2014), the residual impact to the PEC from the Proposal is not significant.

Cumulative impacts to State listed PEC/TECs

Cumulative impacts to the State listed PEC/TECs present within the development envelope are presented in **Table 5-13.**

Table 5-13: Cumulative impacts to TECs and PECs

Ecological community	Scale	Current extent[1]	Current extent within Part 2 development envelope (ha)	Current extent within Part 1 development envelope (ha)	Current extent within ULDO areas (ha)[1]	Cumulative extent (ha)	Proportion of current extent (%)[2]
SCP 26a	NW subregion	100.84	0.05	0.53	0	0.58	0.58
	1 km buffer	0.05	0.05	0.40	0	0.45	100[3]
Banksia PEC[4]	NW subregion	16,836.43	8.76	14.17	203.01	225.94	1.34
	1 km buffer	125.06	8.76	1.01	39.84	49.61	39.66
SCP24 PEC	NW subregion	332.59	13.68	16.05	0	29.73	8.94
	1 km buffer	0	13.68	9.25	0	22.93	100[3]
Tuart PEC	NW subregion	3,643.46	2.13	0.32	156.97	159.10	4.37
	1 km buffer	124.97	2.13	0	13.12	15.25	12.20

[1] Excludes overlaps with the YRE Part 1 and Part 2 development envelopes.

[2] Includes GHD mapping for the survey area.

[3] Cumulative extents are greater that current extent due to discrepancy between GHD mapping in the Part 1 development envelope and the DBCA dataset.

[4] Banksia Woodlands TEC is a subset of Banksia PEC.

Source: GHD (2019)

Implementation of YRE Part 1 will result in clearing of additional areas of each of the four TEC/PECs (Table 5-13). Potential cumulative losses to the Banksia and Tuart PECs predominantly relate to future urban residential and commercial development (Table 5-13). It should be noted that ULDO data does not necessarily account for avoidance of key values that may be incorporated in detailed design. No additional losses to the SCP 26a or SCP 24 PEC are expected at local or regional scales as a result of urban residential or commercial developments based on ULDO mapping (Table 5-13).

5.5.3 Permanent loss of EPBC listed Banksia dominated woodlands of the SCP TEC

The Proposal will result in the loss of 8.03 ha of Banksia dominated woodlands of the SCP TEC. Within the development envelope this vegetation comprises a subset of the Banksia dominated woodlands of the SCP IBRA Region PEC.

Given the reliance on key diagnostic characteristics and minimum criteria to define the occurrence of the EPBC listed ecological community, there is no definitive dataset to define the extent of this TEC. However, an assessment of impacts can be undertaken using correlated Beard (1979) vegetation systems to provide context to impacts relating to the Proposal.

At a regional scale (NW subregion), two associations (949 and 1001) are listed as likely to comprise a major component of the Banksia Woodlands ecological community (TSSC 2016). One of these (949) is

present at a local scale. Just under half of vegetation association 949 occurs within conservation areas at a local scale (Table 5-2).

Table 5-14 provides further context on the status of these associations. It should be noted that these areas do not include vegetation associations that partially correspond or comprise of minor component of the Banksia Woodlands ecological community (identified in TSSC 2016). They also do not account for minimum criteria.

Table 5-14: Estimated extent of EPBC listed Banksia Woodlands TEC

Scale	Pre-European extent[1] (ha)	Current extent[1] (ha)	Extent within the development envelope[2] (ha)	Proportion of current extent (%)
NW subregion	39011.90	17,363.15	8.03	0.05

[1]Calculated using vegetation associations comprising a major component of the Banksia Woodlands ecological community as listed in the Conservation Advice (TSSC 2016)

[2]As mapped by GHD (2018b)

It was not considered appropriate to use extent of vegetation association 949 at a local scale to provide context to impacts to the Banksia Woodlands TEC. This is due to the scale of mapping of the vegetation association dataset.

Impacts to the Banksia dominated woodlands of the SCP IBRA Region TEC are discussed in Section 13 in relation to the *Commonwealth's Significant Impact Guidelines 1.1 for MNES* (DoE 2013). Consistent with these guidelines, the Proposal has potential to significantly impact the TEC through:

- A reduction in the extent of the ecological community by 8.03 ha.
- An increase in fragmentation of the ecological community.

Cumulative impacts

By the nature of its listing as a TEC under the EPBC Act, the Banksia woodlands ecological community is recognised as facing a high risk of extinction in the near future. Whilst it is not possible to provide quantitative assessment of the likely cumulative impacts to the TEC in the absence of definitive mapping of the community, clearing and fragmentation as a result of urban development are recognised as major future threats to the community (TSSC 2016).

5.5.4 Permanent loss of conservation significant flora through clearing

The Proposal will result in the loss of up to 33 individuals of conservation significant flora within the development envelope (GHD 2019). This includes individuals of two Priority 3 (poorly known taxa) taxa and two Priority 4 (Rare, Near Threatened and other taxa in need of monitoring) taxa.

The loss associated with the Proposal represents a complete loss at a local scale of known occurrences of two taxa – one individual of *Hibbertia spicata* subsp. *leptotheca* and two individuals of *Beyeria cinerea* subsp. *cinerea*.

At a regional scale, losses represent approximately 10% of records for each of three of the taxa, and approximately two thirds reduction in the case of *Beyeria cinerea* subsp. *cinerea* (**Table 5-15**). The perceived impacts to conservation significant flora at the local and regional scales are a reflection of limited targeted survey effort and available count (frequency) data (GHD 2019). GHD found that population estimates are underrepresented, with the actual number of individuals expected to be much higher and that therefore, the impact calculations are considered very conservative (GHD 2019).

Regional spatial data (with sufficient information) was not available to inform a cumulative assessment for conservation significant flora at a local or regional scale. No conservation significant flora were recorded from the YRE Part 1 project.

At the regional scale, *Hibbertia spicata* subsp. *leptotheca* and *Conostylis pauciflora* subsp. *euryrhipis* are well represented in conservation areas and *Conostylis pauciflora* subsp. *pauciflora* is poorly represented (**Table 5-15**). There are no records of *Beyeria cinerea* subsp. *cinerea* in conservation areas at a regional scale (**Table 5-15**).

Of the current records, there are up to 81.82% of conservation significant flora records within conservation areas at a regional scale. At a local scale there are no conservation significant flora records within conservation areas (GHD 2019).

The Priority flora are not protected by statute (i.e. not formally recognised as being threatened) and the Proposal is not considered to cause the flora to become threatened. Therefore, in accordance with the considerations of significance set out in the WA Environmental Offsets Guidelines (Government of Western Australia 2014), the residual impact to flora from the Proposal is not likely to be significant.

Table 5-15: Conservation significant flora within the development envelope

Scale	Current records (individuals in brackets)	Current records in conservation areas	Known records in conservation areas	Number of records in development envelope (individuals in brackets)	% current records within development envelope	Current records after Proposal is implemented (individuals in brackets)
***Hibbertia spicata* subsp. *leptotheca* (Priority 3)**						
State-wide	63 (250+)	unknown	unknown	1 (1)	1.61 (0.4)	62 (249+)
NW subregion	11 (110+)	9	81.82%	1 (1)	9.09 (0.91)	10 (109+)
1 km buffer	1 (1)	–	–	1 (1)	100 (100)	–
***Conostylis pauciflora* subsp. *euryrhipis* (Priority 4)**						
State-wide	56 (1,270+)	unknown	unknown	2 (22)	3.57 (1.73)	54 (1,248+)
NW subregion	18 (156)	13	72.22%	2 (22)	11.11 (14.10)	16 (134)
1 km buffer	2 (22)	–	–	1 (20)	50 (90.91)	1 (2)
***Conostylis pauciflora* subsp. *pauciflora* (Priority 4)**						
State-wide	26 (65)	unknown	unknown	1 (10)	3.85 (15.38)	25 (55)
NW subregion	9 (56)	2	22.22%	1 (10)	11.11 (17.86)	8 (46)
1 km buffer	4 (51)	–	–	1 (10)	25 (19.61)	3 (41)
***Beyeria cinerea* subsp. *cinerea* (Priority 3)**						
State-wide	63 (134)	unknown	unknown	2 (2)	3.17 (1.49)	61 (132)
NW subregion	3 (3)	–	–	2 (2)	66.67 (66.67)	1 (1)
1 km buffer	2 (2)	–	–	2 (2)	100 (100)	–

Source: GHD (2019)

5.5.5 Direct impacts to Bush Forever Site No. 289

The Proposal directly impacts 28.82 ha of the site. Of this, 27.71 ha comprises native vegetation in Degraded or better condition (Table 5-16). The balance of Bush Forever Site No. 289 comprises completely degraded areas, planted species and cleared areas (GHD 2019). This is classified as regionally significant bushland as per Bush Forever policy (Government of Western Australia 2010). (Table 5-16).

Directly impacted areas are representative of the broader Bush Forever Site, including areas of the following ecological communities:

- Banksia Woodlands TEC
- *Banksia* dominated woodlands of the SCP IBRA region
- Northern Spearwood shrublands and woodlands ('community type 24')
- Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP.

Table 5-16: Extent and condition of Bush Forever Site No. 289 within the development envelope

Vegetation condition	Area of Bush Forever Site No. 289 within the development envelope (ha)
Excellent	0.44
Very Good	8.29
Very Good - Good	0.10
Good	7.73
Good - Degraded	0.18
Degraded	10.97
Sub-total Degraded or better	**27.71**
Completely Degraded	0.81
Cleared	0.28
Total	**28.82**

The Proposal will reduce the size of Bush Forever Site No. 289 by removing approximately 4.50% of this site, with no other foreseeable future development contributing to cumulative direct impacts (GHD 2019). The remaining extent of Bush Forever Site No. 289 after the implementation of the Proposal is 612.01 ha (GHD 2019).

Given the status of Bush Forever Sites, and their intention to be managed for conservation, the direct impact to Bush Forever Site No. 289, resulting in the loss of 27.71 ha of regionally significant bushland is considered significant.

5.5.6 Fragmentation of Bush Forever Site No. 289 and an ecological linkage (Link No. 0)

The Proposal will directly impact Bush Forever Site No. 289 by clearing a 2.9 km long and approximately 100 m wide corridor through the site. The proposed rail alignment is positioned in a central portion of the Bush Forever Site No. 289, travelling in a north-south direction and will split Bush Forever Site No. 289 into two separate portions of land, leaving approximately 300 ha to the west and 130 ha to the east. Reducing the size of contiguous portions of the site could contribute to reduced ecological function of the site as a whole. The long-term viability of Bush Forever Sites rely on them being within natural areas to

provide buffering and linkages to prevent loss of biodiversity (WALGA 2004). Over the long-term, without adequate management, fragmentation has the potential to reduce the ecological values associated with the currently contiguous portion of Bush Forever Site No. 289, by increasing boundary to area ratios and increasing the potential for edge effects (WALGA 2004).

From a cumulative perspective, further urbanisation in areas surrounding the Bush Forever Site is also likely to contribute to increased pressure on vegetation within the site, and potential degradation of vegetation condition.

The clearing through the Bush Forever Site No. 289 also fragments east-west regional ecological linkage (Link No. 0), identified within the City of Wanneroo Local Biodiversity Strategy 2018–2024 (City of Wanneroo 2018). Link No. 0 links Bush Forever Sites 288, 289 and 397. The linkage is currently intersected by Marmion Avenue to the west of the development envelope. The function of this linkage relates to fauna values and as such, impacts to the linkage are considered further in Section 6.

5.5.7 Indirect impacts to adjacent vegetation

The Proposal could cause degradation of the adjacent native vegetation outside of the development envelope, prior to the future development of urban areas anticipated immediately adjacent to the Proposal and within Bush Forever Site No. 289.

The primary threatening processes that have the potential to indirectly impact surrounding native vegetation are the introduction and/or spread of weed species and *Phytophthora* dieback during construction activities and by maintenance vehicles during operations. There is also the potential for contamination of groundwater or surface water runoff during construction and operational activities, with potential sources including uncontained spills, refuelling and plant and vehicle fluid leaks, as well as impacts on adjacent vegetation from sedimentation and the alteration of surface hydrological regimes. There is also the potential for indirect impacts to vegetation arising from indirect impacts of the Proposal to landforms.

These potential indirect impacts of the Proposal are discussed further below.

Weeds

The Proposal has the potential to introduce new weed species to the development envelope and adjacent vegetation or cause the spread of existing weed species. Weeds cause the degradation of native vegetation by competing with native flora for resources such as space, sunlight, water and nutrients. In high numbers, certain species can also disrupt the natural ecological processes of an area of bushland. Six Declared Pests have been recorded within the development envelope (GHD 2018b).

Without management in place and given enough time in the right environmental conditions, weeds could become widespread and/or new weed species could become established in and around the development envelope. This could result in impacts that, while not significant, would be detrimental to the condition of remnant vegetation.

Phytophthora dieback

Phytophthora dieback is caused by the plant pathogen, *Phytophthora cinnamomi*, which kills susceptible plants by attacking their root systems. More than 40% of native plant species in south-west Western Australia are known to be susceptible, particularly plants belonging to the Proteaceae, Ericaceae and Xanthorrhoeaceae families. Two Phytophthora dieback assessments have been undertaken by Glevan Consulting (2011) and Glevan Consulting (2017) for the YRE Project. No *Phytophthora* dieback infestations have been recorded, however more than half of the development envelope was uninterpretable due to a lack of sufficient indicator species (Glevan Consulting 2017). The presence of

calcareous soils and limestone throughout most of the YRE Project area reduces the likelihood of *Phytophthora* dieback being present, as the pH of such soils is hostile to the pathogen (Glevan Consulting 2017).

Without adequate management in place, it is possible that *Phythophthora* dieback could lead to the death of susceptible species in affected areas. However, given the very low likelihood of the disease being present in the majority of the YRE Project area due to the soil composition (Glevan Consulting 2017), it is not anticipated the Proposal will have a significant residual impact on the surrounding native vegetation due to *Phytophthora* dieback.

Altered hydrological regimes and quality

Potential impacts to inland waters are detailed in Section 9. The predicted residual impacts of the Proposal on inland waters relevant to adjacent vegetation are:

- No change to groundwater levels is predicted, as dewatering and abstraction are not proposed for this Proposal.
- No change to surface water features (all located outside the development envelope) and minor change to rainfall runoff and recharge patterns within the development envelope.
- Minor contamination risk that can be appropriately managed, with no significant residual impact to inland water quality.

Based on the conclusions above, impacts to flora and vegetation as a result of changes to hydrological regimes are not expected to result in any significant residual impacts to flora and vegetation. Without management in place, contamination risks associated with the construction and on-going operation of the Proposal could result in impacts that, while not significant, would be detrimental to the condition of remnant vegetation.

Potential blowouts to adjacent Quindalup dune system supporting Banksia Woodlands TEC

The potential for the Proposal to have indirect impacts (such as erosion and blowouts) on the Quindalup dune system has been identified in Section 8.4. There is the potential for consequential indirect impacts to Banksia Woodlands TEC on affected Quindalup dunes outside of the development envelope. If indirect impacts were to occur, exposed and/or unstabilised interfaces between the development envelope and Quindalup dunes/Banksia Woodlands TEC immediately adjacent to cuttings would be the most vulnerable.

Locations of potential indirect impacts from blowouts to Banksia Woodlands TEC have been identified by comparing where the railway is in a cutting through Quindalup dunes supporting Banksia Woodlands TEC. Two such locations have been identified in the northern part of Ningana Bushland, which are limited in extent i.e. less than 250 m.

The discussion in Section 8.5.2 concludes that indirect impacts to the Quindalup dune system from erosion and blowouts are unlikely to occur. Additionally, only the railway will be within the cutting, with batters, access tracks and the PSP to be at-grade outside of the cutting but within the development envelope, reducing the length of interface between cuttings and adjacent Banksia Woodlands TEC. Accordingly, consequential indirect impacts to the Banksia Woodlands TEC on Quindalup dunes are also unlikely to occur.

5.6 Mitigation

Table 5-17 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied during Proposal design and in the development of appropriate mitigation and management strategies to address the key potential impacts to flora and vegetation.

The Proposal's construction and access areas were 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 intentionally avoid direct impacts to vegetation which may have otherwise been able to be retained within future public open space reservations.

Where impacts cannot be avoided during the Proposal design phase, they will be minimised and/or rehabilitated where practicable. The PTA has an established history of managing potential direct and indirect impacts to flora and vegetation values with similar railway projects constructed in the region, such as the South West Metropolitan Railway (SWMR) and the Butler Rail Extension. The SWMR, which runs between Perth and Mandurah, is a recent and relevant example of a large-scale PTA rail project planned and constructed in a similar urban coastal environment to the Proposal that successfully managed the environmental impacts associated with construction and operations. The PTA prepared and implemented all the identified environmental management plans for SWMR. Successes included the rehabilitation of land in Wellard Road, Leda and land adjacent to Stakehill Swamp, and undertaking weed control in a preservation area that was effective in reducing and maintaining a low abundance of weed species. The learnings from past PTA projects have informed the proposed management measures for this Proposal.

Table 5-17: Application of mitigation hierarchy for flora and vegetation

Potential Impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Loss and fragmentation of vegetation, including ecological linkages, Bush Forever and TEC/PECs	• Development envelope was modified during the design phase to avoid the direct impacts to Bush Forever Site No. 130 and Bush Forever Site No. 288 • 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 intentionally avoid direct impacts to vegetation which may have otherwise been able to be retained within future POS reservations.	Measures to minimise the impacts to vegetation will be detailed in a CEMP (ELA 2019; Appendix Q), which will include: • The development envelope will be demarcated to prevent clearing outside approved areas. • Measure to manage indirect impacts to surrounding vegetation. • Minimise clearing to as low as reasonably practicable. • Should batters be of a suitable gradient and material and not required for operational infrastructure purposes, they will be stabilised with planting of locally endemic species where possible and/or bioengineering controls. • Measures to prevent the distribution of declared Pests and other weed species offsite and prevent introduction of *Phytophthora* dieback to the surrounding vegetation as detailed below.	Not applicable.	• Permanent loss of 49.17 ha of remnant native vegetation in Excellent to Degraded condition • Permanent loss of 0.05 ha of *Melaleuca huegelii – M. systena* shrublands on limestone ridges TEC in Very Good condition. • Permanent loss of 8.76 ha of Banksia dominated woodlands of the SCP IBRA Region PEC in Excellent to Degraded condition. • Permanent loss of 13.81 ha of Northern Spearwood shrublands and woodlands PEC in Excellent to Degraded condition. • Permanent loss of 2.13 ha of Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC in Degraded condition.

Potential Impact	Avoidance	Minimisation	Rehabilitation	Residual impact
				• Permanent loss of 8.03 ha of Banksia dominated woodlands of the SCP TEC • Permanent loss of 28.82 ha of Bush Forever Site No. 289 • Fragmentation of Bush Forever Site 289 and severing of an associated ecological linkage.
Introduction of weeds to adjacent vegetation	The risk to adjacent vegetation from weeds cannot be entirely eliminated	Measures to minimise the impacts to vegetation will be detailed in a CEMP (ELA 2019; Appendix Q), which will include: • Inspection of all vehicles and machinery at exit and entry locations to be free of weeds and soil prior to entering the development envelope. • Manage any newly identified declared weeds within the development envelope in accordance with the BAM Act and subsidiary regulations. • Require all personnel to complete a site induction that will include hygiene training with regards to weed management requirements • Site inspections to identify the presence of weeds and implementation of weed control as necessary.	Not applicable.	Potential residual impacts are as low as reasonably practicable.

Potential Impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Introduction of dieback to adjacent vegetation	It is not feasible to entirely eliminate the risk to adjacent vegetation from dieback.	The CEMP (ELA 2019; Appendix Q) will be implemented during construction and includes requirements such as: • Inspection of all vehicles and machinery at exit and entry locations to be free of weeds and soil prior to entering the development envelope. • If practicable, conduct ground disturbance activities in dry months to reduce the risk of spreading disease. • Avoid topsoil movement from uninterpretable areas to uninfested areas. • Require that any materials brought into the development envelope are dieback free. • Install a temporary fence or appropriate buffer to prevent access to surrounding vegetation. • Site inspections to identify the presence of weeds and implementation of weed control as necessary. • Require all personnel to complete a site induction that will include hygiene training with regards to dieback hygiene management requirements, the environmental implications of the introduction and spread of dieback and obligations to follow this CEMP.	Not applicable.	Potential residual impacts are as low as reasonably practicable.

Potential Impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Altered hydrology affecting water availability for vegetation	No surface water features or drainage lines are located within the development envelope. No groundwater dewatering or abstraction is proposed for this Proposal.	Best practice WSUD will be incorporated in the design to protect existing hydrological regimes, as detailed in Section 11.	Not applicable	No residual impact to flora or vegetation based on changes to the hydrological regime.
Contamination of groundwater impacting on vegetation	Avoidance of storage of fuels and chemicals during construction and operation is not a feasible option	Implementation of the CEMP to minimise the risk of contamination, including: • Installation of drainage diversion around chemical storage areas. • Implementation of drainage controls to prevent offsite discharge of runoff. • Spill response procedures and training. • Storage of fuels or chemicals in bunds capable of storing 110% of the capacity of the largest storage tank. • Secondary spill containment around tanks (with a perimeter bund) with sufficient freeboard capacity to contain all captured rainwater from a 20-year average return interval, 72-hour storm. • Spill kits located in storage and refuelling areas. Implementation of the PTA's standard spill response framework for operational rail corridors. Stormwater and surface water management measures and controls will be designed with	Not applicable	Potential residual impacts are as low as reasonably practicable. Contamination risk is managed with no significant residual impact flora or vegetation.

Potential Impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		consideration of best practice WSUD principles, maximising infiltration at source.		

5.7 Predicted outcome

The key flora and vegetation values identified in the development envelope include:

- Native vegetation in Excellent to Degraded condition
- Two Threatened and three Priority ecological communities
- Four Priority flora species
- Bush Forever Site 289, which forms part of an east-west ecological linkage.

The predicted outcomes of the Proposal in relation to flora and vegetation include:

- Permanent loss of:
  - 49.17 ha of native vegetation in Excellent to Degraded condition.
  - Threatened and Priority ecological communities, including:
    - 0.05 ha of *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) TEC;
    - 8.76 ha of Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC, including 8.03 ha of Banksia dominated woodlands of the SCP TEC;
    - 13.68 ha of Northern Spearwood shrublands and woodlands ('community type 24') PEC; and
    - A total of 2.13 ha of Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC.
  - 28.82 ha of Bush Forever Site 289.
- Fragmentation of Bush Forever Site 289 and severing of an associated regional ecological linkage (Link No. 0).
- Indirect impacts relating to the risk of introduction and/or spread of weeds or *Phytophthora* dieback into vegetation adjacent to the development envelope and risk to vegetation as a result of accidental contamination will be successfully mitigated using established management practices.

Through the implementation of the EPA's mitigation hierarchy (Section 5.6 and Table 5-17), the residual impacts of the Proposal to flora and vegetation are as low as reasonably practicable. With the exception of impacts to two TECs and regionally significant bushland within Bush Forever, the impacts of the Proposal are not considered significant. Offsets are proposed to counterbalance the following significant residual impacts:

- Permanent loss of:
  - 0.05 ha of *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) TEC.
  - 8.03 ha of EPBC Act listed Banksia dominated woodlands of the SCP TEC.
  - 28.82 ha of regionally significant bushland within Bush Forever Site No. 289.

The appropriateness of offsets to achieve the objective of counterbalancing the significant residual impacts is discussed in Section 12.

The PTA has undertaken comprehensive baseline studies, taken steps to reduce the development envelope to avoid potential impacts and is proposing the implementation of a CEMP to further mitigate and manage potential impacts as well as an Offsets Strategy to offset significant residual impacts. Given these commitments and the PTA's past performance in implementing appropriate mitigations as part of the construction and operation of railway projects, the PTA considers that the Proposal can be managed to meet the EPA's objective for flora and vegetation.

6 Terrestrial fauna

6.1 EPA objective

The EPA's objective for terrestrial fauna is to protect terrestrial fauna so that biological diversity and ecological integrity are maintained (EPA 2018e).

6.2 Policy and guidance

The following policies and guidance are relevant to the Terrestrial Fauna factor:

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

6.3 Receiving environment

6.3.1 Previous studies

Three terrestrial fauna surveys have been undertaken within the development envelope. The survey results, along with six desktop assessments, are described in the reports outlined in **Table 6-1**.

The terrestrial fauna information in this chapter is primarily derived from the GHD (2018b, c) survey reports, along with the further assessment of this data presented as a dedicated impact assessment in GHD (2018a, d; 2019), and a short range endemic (SRE) desktop assessment undertaken by Invertebrate Solutions (2018a). Other reports (Bamford 2019a, ELA 2018; Appendix O) are used for additional context and information where relevant.

GHD (2018b; 2019) reported on vegetation confined to the development envelope and immediately adjacent land only. This adjacent land was confined to a 100 m buffer of the development envelope through Bush Forever Site No. 289 (Ningana Bushland). The area mapped by GHD (2019) within the buffer but outside of the development envelope is referred to in this chapter as the 'additional survey area'.

Table 6-1: Summary of previous investigations

Consultant Survey/investigation	Study area, type and timing	Objective, study standard/guidance and limitations
GHD (2011) *Report for Northern Suburbs Railway Alignment from Romeo Road (Alkimos) to Yanchep, Graceful Sun-moth Survey*	**Survey area:** Romeo Road (Alkimos) to Yanchep **Type:** Desktop and targeted field assessment **Timing:** A six-day survey targeting Graceful Sun-moth in a portion of the YRE Project in March 2011	Targeted survey for the Graceful Sun-moth.

Consultant Survey/investigation	Study area, type and timing	Objective, study standard/guidance and limitations
GHD (2012) *Northern Suburbs Railway Alignment Butler to Yanchep Environmental Investigation*	**Survey area:** A portion of Part 2 development envelope comprising 22.42 ha between the southern boundary of Bush Forever Site 289 and Yanchep Beach Road **Type:** Desktop and Level 1 fauna field assessment **Timing:** One day in November 2010 and one day in October 2012	The fauna assessment was a reconnaissance survey aimed at identifying habitat types and terrestrial vertebrate fauna using the survey area. No sampling for aquatic species occurred. Investigation was undertaken in accordance with EPA's *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia Guidance Statement No. 56* as follows: • Experience and appropriate qualification of staff in fauna habitat surveys. • Timing of the survey across all seasons over multiple years to enable observation of all species present. • Consideration of results from database searches that provide available information for the survey area.

Consultant Survey/investigation	Study area, type and timing	Objective, study standard/guidance and limitations
GHD (2018b) *Yanchep Rail Extension Part 2 Biological Assessment*	A biological assessment for the YRE Project that delineates key flora, vegetation and fauna values within and surrounding the development envelope. **Survey area:** Part 2 development envelope and additional survey area. The survey area comprised 147.8 ha and extended from the northern boundary of YRE Part 1 (north of Pipidinny Road) to north of the proposed Yanchep Railway Station **Type:** Desktop and field assessment. Level 1 terrestrial vertebrate fauna and targeted Black Cockatoo assessment **Timing:** Undertaken as part of five field trips conducted in 2016 – 2018 (14 days)	Desktop information was reviewed and updated at the time of the 2018 field survey to confirm adequacy of previous surveys. Methodology was in accordance with *Technical Guidance – Terrestrial Fauna Surveys* (EPA 2016e) and previous version of the guidance. The guidelines were met in terms of: • Experience of staff in fauna habitat surveys. • Timing of the survey. • Consideration of results from database searches that provide available information for the survey area. GHD found that the survey was not subject to any constraints affecting the thoroughness of the assessment or the conclusions formed (GHD 2018b).
GHD (2019) *Yanchep Rail Extension Part 2 Biological Factors - Context and Impact Assessment*	**Survey area:** Development envelope "additional survey area" **Type:** Desktop assessment **Timing:** January 2019	Describes and quantifies the potential impacts (direct and cumulative) associated with the Proposal on flora and vegetation, and fauna at local and regional scales.
Bamford Consulting Ecologists (2019a) *Yanchep Rail Extension Part 2 Fauna Desktop Study*	**Survey area:** Development envelope **Type:** Desktop assessment, Reconnaissance fauna survey and targeted conservation significant species search **Timing:** 10 January 2019	This desktop study provides a revised list of vertebrate fauna expected to be representative of the fauna assemblage expected within the development envelope based on unpublished and published data.

Consultant Survey/investigation	Study area, type and timing	Objective, study standard/guidance and limitations
Bamford Consulting Ecologists (2019b) *Fauna Underpass Assessment Statement*	**Study area:** Development envelope **Type:** Desktop assessment **Timing:** 11 January 2019	This desktop study provides a review of: • Likely efficacy of the proposed fauna underpasses for the Proposal with emphasis on location and design. • Alternatives for fauna crossings through Ningana Bushland. • Potential for fauna to temporarily use the constructed road bridges prior to use by road traffic.
Bamford Consulting Ecologists (2019c) Proposal for fauna crossings; response to the outcomes of workshop held on 7th March 2019	**Study area:** Development envelope **Type:** Desktop assessment **Timing:** 26 April 2019	Memorandum providing advice on the suitability of the proposed PTA fauna crossing criteria, as discussed in the workshop on 7 March 2019.
Invertebrate Solutions (2018a) *Desktop Review and Risk Assessment of Short Range Endemic Invertebrates for the Yanchep Rail Extension, Western Australia*	**Study area:** Part 1 and 2 Development Envelope comprising 143.11 ha. Assessment was also undertaken for the local area defined by a rectangle bounded by the northwest corner (31°21'00"S 115°30'00"E,) and the southeast corner (31°54'00"S 116°10'15"E). Study area is similar in size to the spatial extent of the North-west Sub-region **Type:** Desktop assessment **Timing:** May 2018	This report reviews previous SRE invertebrate fauna assessments for the YRE Project and provides further information about the suitable habitats for SRE invertebrates within the YRE Project and in the local area. Limitations were restricted to the scope of the works and the information provided in assessment reports.

Consultant Survey/investigation	Study area, type and timing	Objective, study standard/guidance and limitations
ELA (2018; Appendix O) *Environmental (Bush Forever site 289) Candidate Offset Site Investigation, Yanchep Railway Extension*	**Survey area:** Approximately 440 ha of Bush Forever Site 289 within Lot 105 Marmion Avenue Yanchep including a portion of the Part 2 development envelope (representing approximately two thirds of the entire Bush Forever Site). **Type:** Desktop and reconnaissance field survey **Timing:** July 2018	No constraints or limitations to the survey affecting the conclusions of the investigation were identified.

6.3.2 Regional context

Ecoregions in Australia are geographically distinct plant and animal communities defined by the World Wildlife Fund (WWF) based on a number of variables including geology, soils, climate, and predominant vegetation. The Proposal is located within the Southwestern coast of Australia Ecoregion which is spatially defined by the extent of the Swan Coastal Plain (SCP) (WWF 2018). The SCP is characterised by a Mediterranean climate with hot and dry summers, and cool, moist winters and relatively high rainfall. This ecoregion contains a diverse range of vegetation, from coastal dunes and sandplains to Banksia and eucalypt woodlands leading to a diverse range of fauna species including small mammals and black cockatoos (WWF 2018). The Proposal occurs in northern SCP and supports high biodiversity values (Bamford 2019a).

Despite the biologically diversity in the SCP, this region is heavily developed with approximately 80% of the SCP already cleared. While there are several large conservation areas in the region, continued development, habitat fragmentation, dieback disease, and inappropriate fire regimes pose large threats to existing biodiversity values.

Conservation areas

There are a large number of conservation areas in the northwest (NW) subregion. These conservation areas include the following regional and national parks:

- Yellagonga Regional Park
- Gnangara-Moore River State Forest
- Jandabup Nature Reserve
- Lake Joondalup Nature Reserve
- Neerabup National Park
- Neerabup Nature Reserve
- Woodvale Nature Reserve
- Yanchep National Park
- Yeal Nature Reserve.

There are 89 Bush Forever Sites located within the NW subregion. The development envelope intersects one Bush Forever Site No. 289 (Ningana Bushland) and there are four Bush Forever Sites located adjacent to, or within 3 km, of the Proposal. Approximately a third of the length of the Proposal passes through Ningana Bushland, which comprises stabilized Quindalup dunes and supports a diverse range of vegetation in Good or better condition (Bamford 2019b). Ningana Bushland comprises 640.83 ha and

extends from near Bush Forever Site No. 288 (Yanchep National Park) in the east to Bush Forever Site No. 397 (Coastal strip from Wilbinga to Mindarie) in the west (Figure 5-3).

6.3.3 Fauna habitat and significance

The local context for the Proposal is defined as an area within 1 km of the Proposal.

Seven fauna habitat types comprising 61.68 ha were distinguished and mapped by GHD (2019) within the development envelope. Of the fauna habitat mapped within the development envelope, approximately 65% was considered high value, with approximately 20% considered medium value habitat (GHD 2019). The balance of the development envelope comprised highly disturbed areas (cleared) that provided limited foraging and shelter values. Of the Highly disturbed areas comprised 15% of the development envelope and were considered by GHD (2019) as low value fauna habitat.

The seven habitat types within the development envelope are:

- *Banksia sessilis* over low mixed shrubland
- *Eucalyptus* woodland
- Limestone ridge lines
- *Lomandra* herb lands on secondary dunes
- Mixed *Banksia* woodland
- Mixed tall shrubland
- Planted *Eucalyptus* woodland.

The extent of general fauna habitat and highly disturbed areas in the development envelope differs from the areas mapped as vegetation types and cleared areas in Section 5 due to differences in classification criteria; for example, exotic plant species may provide some habitat value for fauna.

The Proposal does not intersect any creeklines or riparian areas.

A summary of fauna habitat within the development envelope, associated value and corresponding vegetation types is presented in **Table 6-2**. All habitat types are present outside the development envelope and expand into Ningana Bushland (ELA 2018; Appendix O). Limestone ridgelands were not identified by GHD (2019) to occur in the additional survey area; however, this habitat type was identified by ELA (2018; Appendix O) to occur broadly in the eastern portion of Ningana Bushland.

Fauna habitat within the development envelope is presented in **Figure 6-1**.

Table 6-2: Fauna habitat within the development envelope

ID	Habitat type description	Habitat value	Related vegetation types	Mapped extent[1] (ha)	Extent within development envelope[2]	
					Area (ha)	%
1	*Banksia sessilis* over low mixed shrubland	High	VT02, VT03	18.84	13.81	18.95
2	*Eucalyptus* woodland	High	VT06	8.56	2.13	2.92
3	Limestone ridgelands	Moderate	VT08	0.05	0.05	0.07
4	*Lomandra* herbland on secondary dunes	Moderate	VT05	15.34	5.31	7.29
5	Mixed *Banksia* woodland	High	VT04, VT09, VT15	19.87	8.76	12.02
6	Mixed tall shrubland	High	VT01, VT07, VT10, VT11, VT13	46.71	22.75	31.23
7	Planted *Eucalyptus* woodland	Moderate	VT12	22.08	8.87	12.17
Subtotal				**131.45**	**61.68**	**84.65**
8	Highly disturbed	Low	'Cleared'	16.34	11.18	15.34
Total				**147.79**	**72.86**	**100.0**

Source: Vegetation types consistent with those in GHD (2018b);

[1] Based on findings presented in GHD (2018b) within the development envelope and additional survey area.

[2] Based on findings presented in GHD (2019) within the development envelope.

All fauna habitats are not restricted to the development envelope and occur in the local area and adjacent conservation areas. This includes Ningana Bushland (as described above) and in broad scale vegetation mapping from other environmental approvals (ATA Environmental 2003). Relationships between GHD's vegetation types and broad scale vegetation units identified by ATA Environmental (2003) is presented in Section 5.3.2 and in Figure 5-3. Spatial extents of vegetation provided by other environmental approvals, and vegetation present in adjacent conservation areas demonstrates the local extent of vegetation and; therefore, fauna habitat outside the development envelope.

Conservation areas provide long term protection of fauna habitats. Of the current extent remaining, there is approximately 43% within conservation areas (including DBCA managed lands and Bush Forever Sites) at a local scale and approximately 75% and 45% within conservation areas at regional and bioregional scales (GHD 2019) (**Table 6-3**).

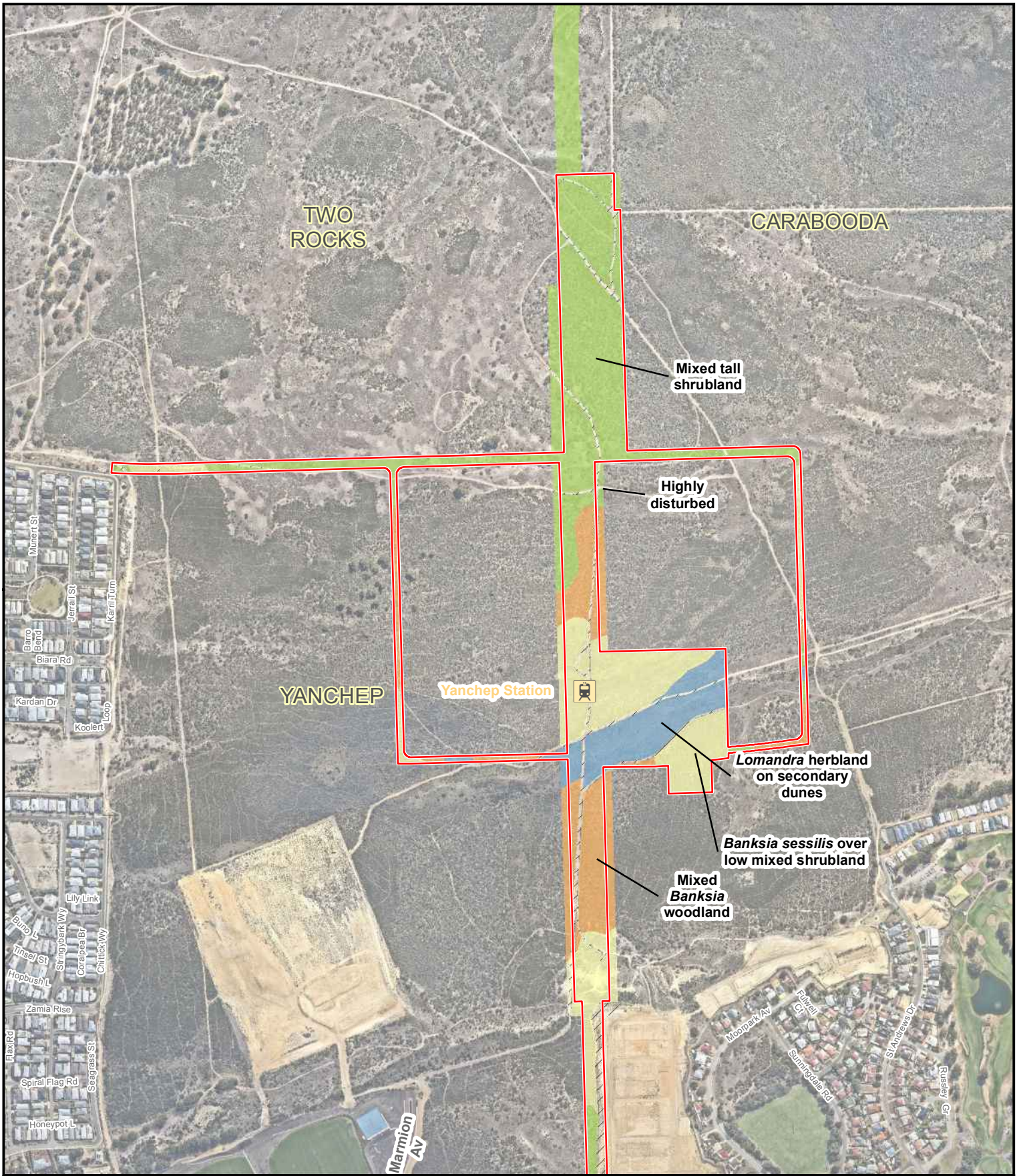
Fauna habitats also align to two Beard (1979) vegetation associations and two regional vegetation complexes (Webb et al. 2016). These vegetation associations and regional vegetation complexes are represented at a subregional and regional scale, with their distribution not limited to the development envelope. This further confirms that the fauna habitats found in the development envelope are not limited to the development envelope.

Table 6-3: Current extent of native vegetation (fauna habitat) in conservation areas

Scale	Current extent in WA (ha)	Current extent remaining %	Current extent in conservation areas (ha)			
			DBCA	Bush Forever Sites	Total	% of current extent
Perth IBRA subregion	465,369.28	41.65	186,970.02	21,553.29	208,523.32	44.81
NW subregion	42,581.90	55.22	16,363.90	6,606.02	22,969.92	53.94
1 km buffer	1,155.34	56.01	122.21	374.34	496.55	42.98

Source: GHD (2019)

Note: DBCA extent: calculated using DBCA – Legislated Lands and Waters (DBCA-011) and DBCA – Lands of Interest (DBCA-012); Bush Forever Site extent: calculated using Bush Forever Areas 2000 (DOP-071) that lies outside of calculated DBCA extent.



Yanchep Rail Extension (Part 2)
Figure 6-1 Terrestrial Fauna Habitats

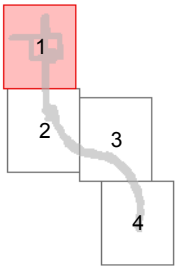
Public Transport Authority

Legend

- Development Envelope
- Proposed Station

Fauna Habitats

- *Banksia sessilis* over low mixed shrubland
- *Lomandra* herbland on secondary dunes
- Mixed *Banksia* woodland
- Mixed tall shrubland
- Highly Disturbed



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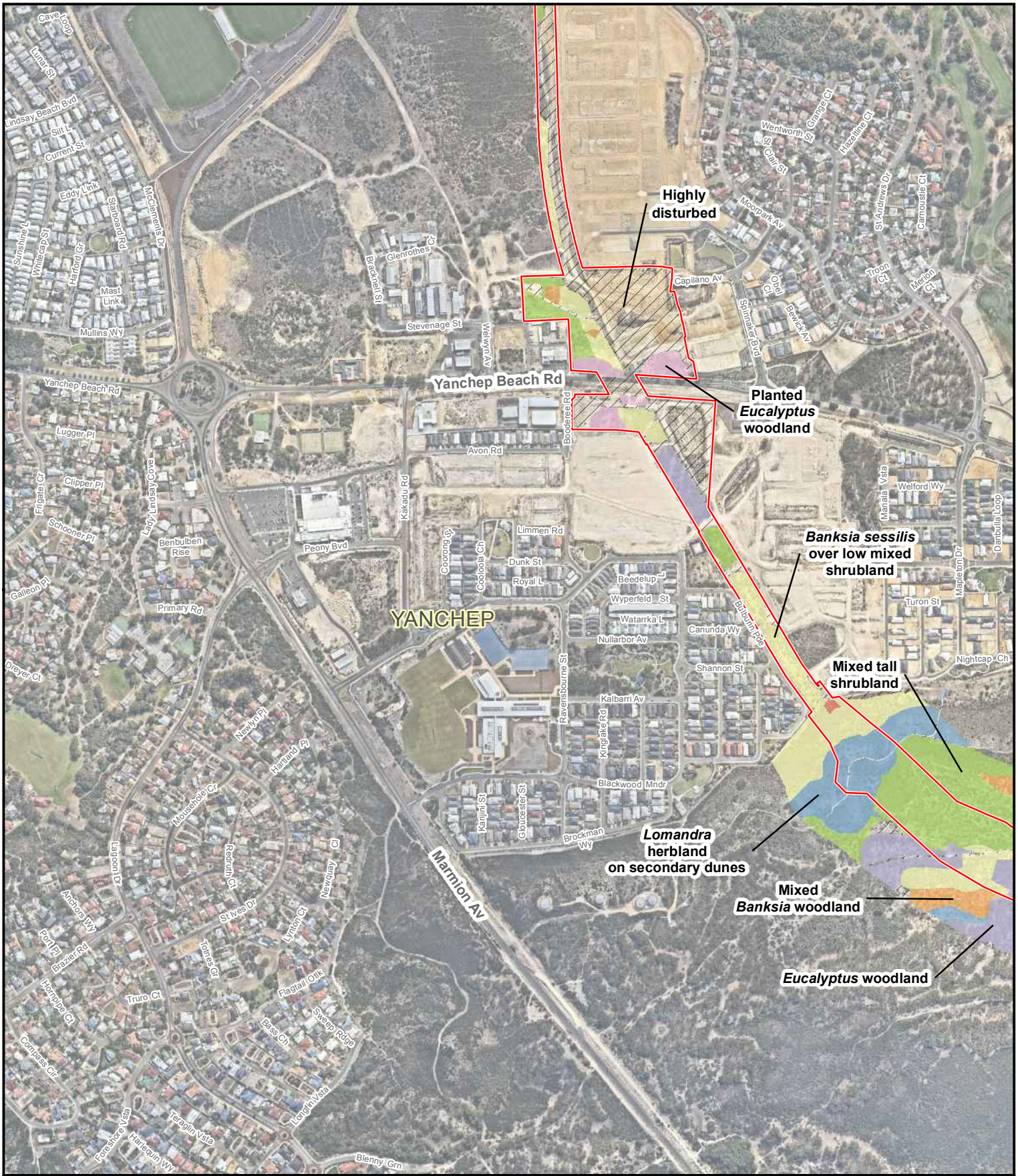

Yanchep Rail Extension (Part 2)
Figure 6-1 Terrestrial Fauna Habitats

Public Transport Authority

Legend

- Development Envelope

Fauna Habitats

- *Banksia sessilis* over low mixed shrubland
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- *Lomandra* herbland on secondary dunes
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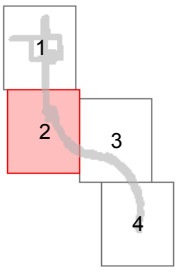
- Mixed tall shrubland
- Planted *Eucalyptus* woodland
- Highly Disturbed



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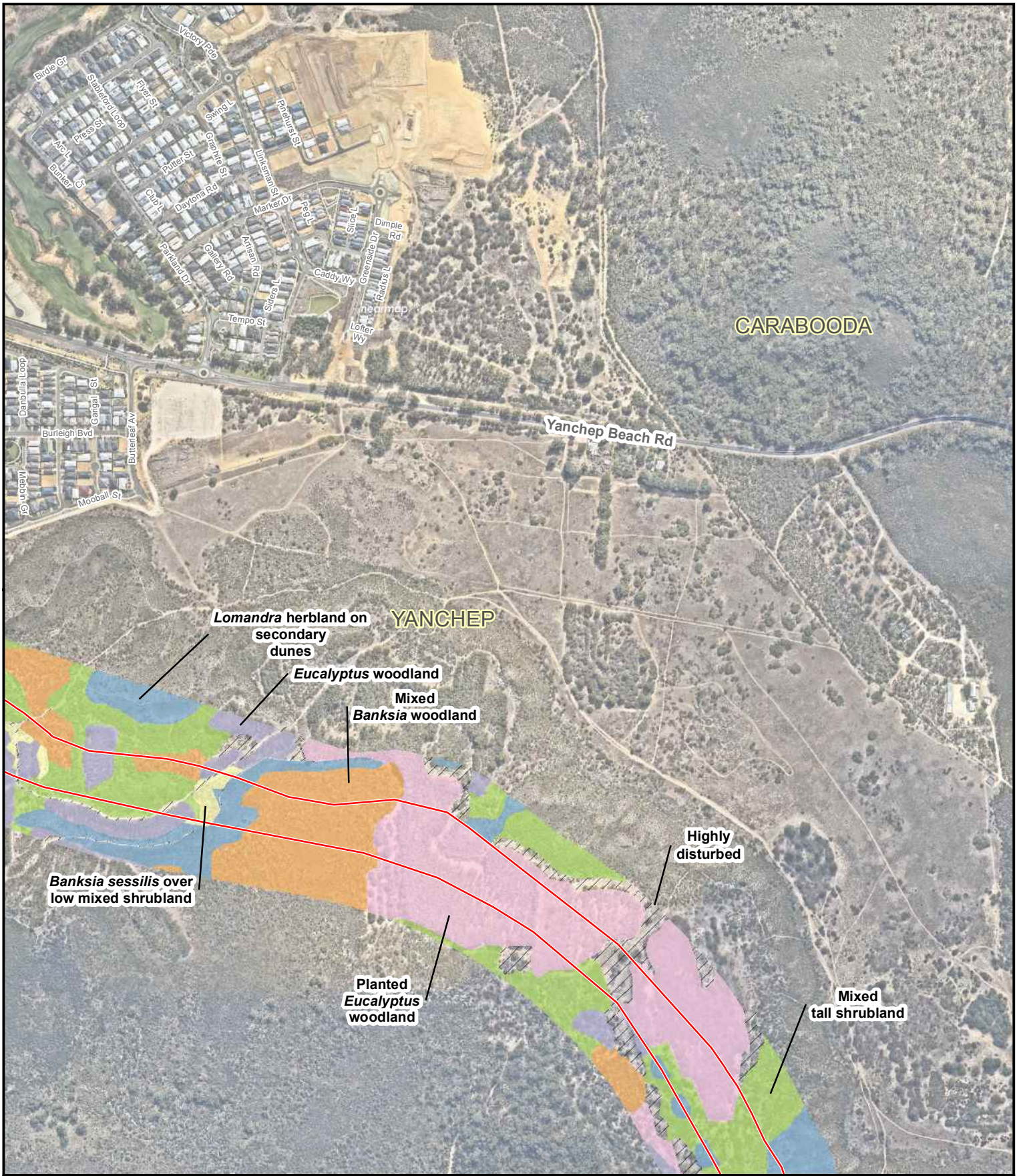

Yanchep Rail Extension (Part 2)
Figure 6-1 Terrestrial Fauna Habitats

Public Transport Authority

Legend

- Development Envelope
- **Fauna Habitats**
  - *Banksia sessilis* over low mixed shrubland
  - *Eucalyptus* woodland
  - *Lomandra* herbland on secondary dunes
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  - Mixed tall shrubland
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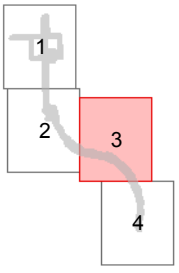
  - Highly Disturbed



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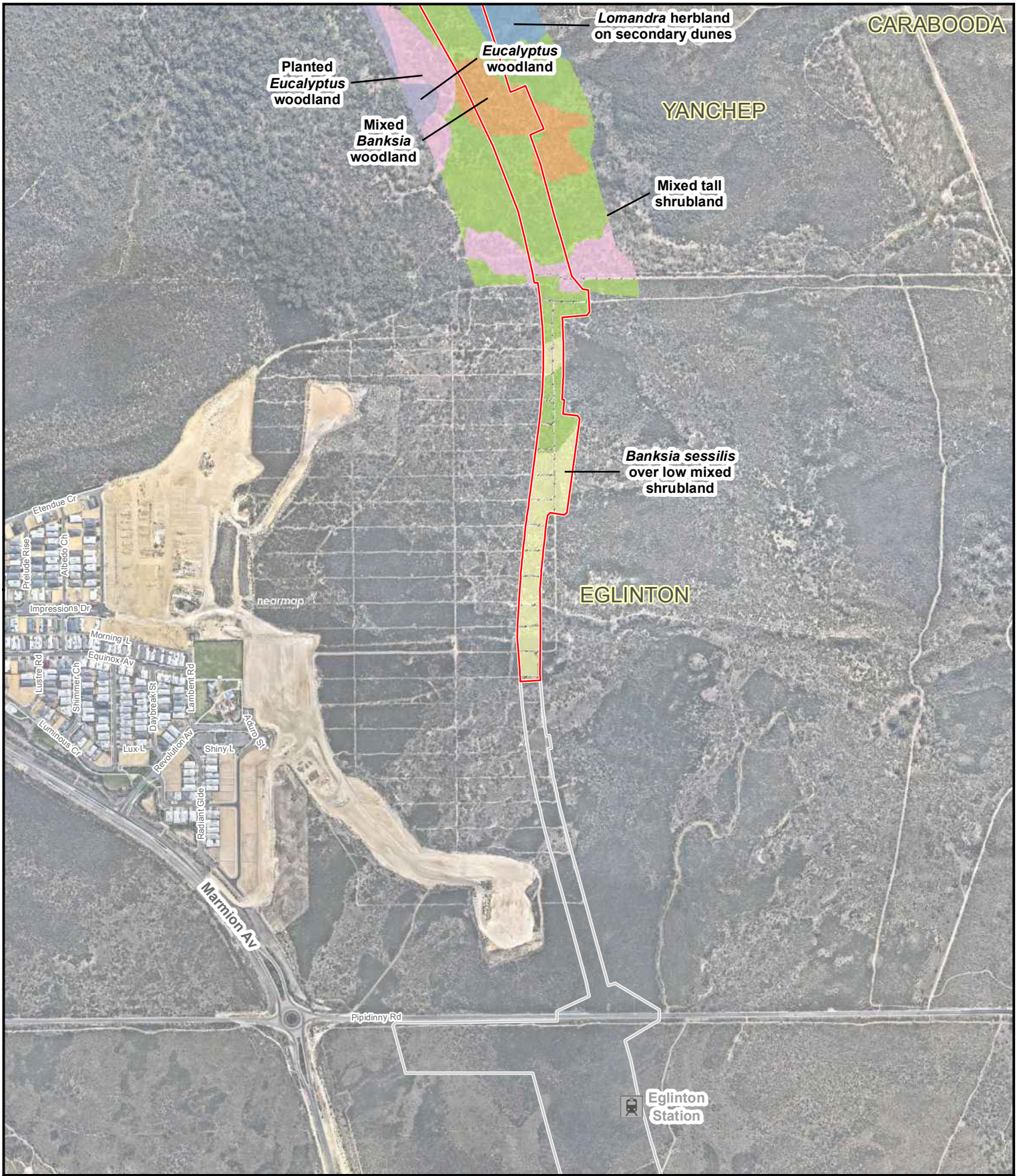


Yanchep Rail Extension (Part 2)
Figure 6-1 Terrestrial Fauna Habitats

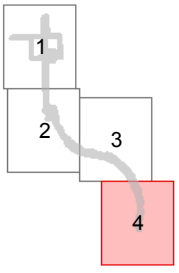
Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Proposed station (YRE Part 1)

Fauna Habitats

- *Banksia sessilis* over low mixed shrubland
- *Eucalyptus* woodland
- *Lomandra* herbland on secondary dunes
- Mixed *Banksia* woodland
- Mixed tall shrubland
- Planted *Eucalyptus* woodland
- Highly Disturbed



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Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

6.3.4 Habitat connectivity

The objective of ecological linkages is to facilitate the movement of wildlife and connect significant vegetation, habitat and landscape features with continuous corridors of native vegetation (City of Wanneroo 2018; WALGA 2004). These linkages have been identified as having conservation, recreation, heritage and education values (Alan Tingay and Associates 1998). The need to manage and conserve locally significant ecological linkages between remnant urban bushland areas has been documented in several polices and initiatives (Alan Tingay & Associates 1998). Ecological connections for terrestrial fauna on the SCP are typically expressed as contiguous patches of vegetation of sufficient condition to enable the movement of fauna across the landscape. Barriers to fauna movement (such as areas of degraded habitat or where linear infrastructure such as fences and roads are present) may limit habitat connectivity values associated with the ecological linkage. These characteristics may affect some species more than others, e.g. a highway may be a barrier for small reptiles but not for some birds.

The development envelope is a mosaic of intact remnant and previously disturbed areas (GHD 2018b). Much of the region is designated for residential development and many areas in the region show evidence of clearing since the commencement of biological surveys for the Proposal in 2012. Significant urban development has occurred in and around Yanchep between the coast and Yanchep National Park. New developments have commenced in Eglinton at the southern end of the development envelope.

Despite the increasing urban development around the Yanchep area, there are still large remnant tracts of relatively intact native vegetation maintaining connectivity across the landscape. Urban development in this area has not yet progressed to the degree where large tracts of vegetation are isolated and disconnected from other large tracts of vegetation other than by roads. Various bushland connections exist between significant landscape features and the habitats they provide. An example of this is the inland chain of coastal wetlands within Yanchep National Park (Bush Forever site 288) and coastal vegetation within Bush Forever site 397 (Coastal strip from Wilbinga to Mindarie) to the west.

Ningana Bushland (Bush Forever site 289) extends between the coast and Yanchep National Park to the south of Yanchep and is aligned with an ecological linkage (Link No. 0) as shown on Figure 5-6. It is largely intact, intersected at present only by Marmion Avenue. The portion east of Marmion Avenue could be considered as a functional extension of Yanchep National Park, which currently adjoins Ningana Bushland immediately to the east.

Recent surveys within Ningana Bushland did not identify any well-defined fauna movement corridors across the development envelope within Ningana Bushland (Bamford 2019b). Movements of smaller reptiles and birds in dense shrublands (such as the White-breasted Robin) are likely to be linked to habitats and features in the landscape such as thickets in valleys (Bamford 2019b). Movement of small fauna species with limited dispersal abilities (such as fossorial reptiles and some invertebrates) are likely to be at a highly localised scale linked to their preferred habitat features (Bamford 2019b). Larger fauna species such as kangaroos have larger home ranges and are therefore more reliant on habitat connectivity across the landscape. This is particularly a factor when other pressures such as encroachment from development constrain or increasingly isolate remnant habitat patches. Given the similarity in vegetation and fauna habitats in other bushland areas surrounding the development envelope to those within Ningana Bushland, it is likely that fauna movement in remnant vegetation surrounding the Proposal is similarly linked to species' preferred habitat features and does not follow any well defined movement corridors. In summary, fauna movement is expected to occur throughout continuous patches of remnant bushland aligned with habitat preferences.

Over time, current and proposed urban developments in Yanchep and Eglinton are likely to result in the removal of significant extents of vegetation in the vicinity of the development envelope. This process will

have the overall effect of reducing habitat connectivity in the region. Ningana Bushland is therefore likely to carry more importance for habitat connectivity in the future than it does at present.

There is also similar habitat connectivity between the coast and Yanchep National Park at the northern end of the development envelope. However, the northern end of the development envelope, in close proximity to the proposed site of Yanchep Station is already becoming increasingly constrained due to the urban expansion of Yanchep for urban development. It is expected that habitat connectivity in this area – particularly the connection between the coast and Yanchep National Park – is already being limited by urban development, with remnant areas located further north offering better connectivity as a result.

6.3.5 Species diversity

Previous investigations have identified 602 fauna species historically recorded within 10 km of the Proposal (GHD 2018c). A total of 185 vertebrate fauna species was identified by Bamford (2019a) as potentially occurring in the development envelope. This assemblage included seven frogs, 47 species reptiles, 107 birds, 19 native mammals (of which five species may be locally extinct) and five introduced mammals (**Table 6-5**) (Bamford 2019a).

A total of 74 vertebrate fauna species have been recorded in previous surveys in proximity of the development envelope (Bamford 2019a). This includes 54 birds, 14 reptiles and six mammals. Two invertebrates were also recorded in the development envelope by GHD in the 2011–2012 surveys (GHD 2011; 2012):

- Ground cricket (*Pachysaga munggai/strobila*); and
- Graceful Sun-moth (*Synemon gratiosa*).

However, neither of these two invertebrate species were recorded in the subsequent 2016–2018 biological assessments.

The following introduced species were recorded within the development envelope and surrounding area by GHD (2018b) and Bamford (2019a):

- Red Fox (*Vulpes vulpes*);
- Feral Cat (*Felis catus*);
- European Rabbit (*Mus musculus*);
- House Mouse (*Mus musculus*);
- Laughing Kookaburra (*Dacelo novaeguineae*);
- Dog (*Canis lupus familiaris*);
- Feral Pig (*Sus scrofa*); and
- Laughing Dove (*Spilopelia senegalensis*).

Table 6-4: Composition of vertebrate fauna assemblage potentially occurring within the development envelope

Taxon	Number of species potentially occurring within the development envelope	Number of species				
		Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Frogs	7	1	3	3	-	-
Reptiles	47	44	-	1	1	1

Taxon	Number of species potentially occurring within the development envelope	Number of species				
		Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Birds	107 (8 introduced)	38	32	27	10	?
Native Mammals	19 (including locally extinct)	10	2	1	1	5
Introduced Mammals	5	5	-	-	-	-
Total	**185**	**98**	**37**	**32**	**12**	**6**

Source: Bamford (2019a), which incorporates records from GHD (2018b)

The fauna assemblage of the development envelope is already modified due to habitat loss and urbanisation, with substantial species loss and further species loss likely due to the juxtaposition of urban areas with associated feral species, disturbance and decline in vegetation condition (Bamford 2019a).

Key features of the fauna assemblage in the development envelope are (Bamford 2019a):

- **Uniqueness:** The assemblage is typical of Banksia woodlands and coastal heaths of the Perth SCP and will vary across the site with differences in landform, vegetation type and condition. The fauna assemblage may be the closest intact in relation to Perth based on the size and condition of the Ningana Bushland, and the extensive bushland to the east. A distinctive feature of the assemblage is the presence of a few coastal heath species that do not occur further south on the SCP, such as the White-breasted Robin and Moodit (Bush-Rat).
- **Completeness:** The assemblage is intact in terms of frogs, reptiles and potentially birds due to the extent and quality of some areas of the environment, and to the area being part of a larger area of bushland that lies to the east (Yanchep and Neerabup National Parks). However, the assemblage has lost some mammal species. This is likely to be due to a range of factors including predation by feral species.
- **Richness:** The assemblage is moderately rich in the local context due to the large extent and high quality of environments. The vegetation and soils are also moderately uniform so species richness that can result from having a range of terrestrial ecosystems is absent.

6.3.6 Conservation significant fauna

Based on the likely fauna assemblage identified in Bamford (2019a), a total of 75 species of conservation significance may occur in the development envelope. Locations of DBCA conservation significant fauna records plotted by GHD (2018b) show fauna records were predominantly concentrated in Yanchep National Park and the future South Yanchep urban development area between the coast and Marmion Avenue. Very few records were located within or immediately adjacent to the development envelope such as Ningana Bushland.

A summary of the key conservation significant species recorded or with the potential to occur within the development envelope is presented in **Table 6-5.**

Two fauna species of conservation significance were recorded within the development envelope during the 2016–2018 surveys, Carnaby's Cockatoo (*Calyptorhynchus latirostris*) and Western Brush Wallaby (*Macropus irma*) (GHD 2018b). The Graceful Sun-Moth was recorded in 2011 (GHD 2011) and the

ground cricket (*Pachysaga munggai* or *strobila)* was recorded in 2012 (GHD (2012). Neither of these species were recorded during the 2016-2018 surveys GHD (2018b).

A summary of the known and likely occurrence of conservation significant fauna species within the Proposal based on GHD (2018b) is outlined in **Table 6-5**.

Table 6-5: Assessment of known and likely occurrence and habitat of conservation significant fauna

Species	BC Act*	Presence in proximity of development envelope
Mammals		
Western Brush Wallaby (*Macropus irma*)	Priority 4	**Present.** One individual was observed during the field assessment in November 2016 (GHD 2018b). This species may opportunistically use all habitats presented in the development envelope. Mixed tall shrubland, Banksia woodlands and Eucalyptus woodlands are of highest value to this species for seeking shelter and foraging. Habitat connectivity with substantial bushland around Yanchep and further east allows this species to range widely within the northern SCP and utilise the development envelope on an occasional to frequent basis (GHD 2018b).
Southern Brown Bandicoot / Quenda (*Isoodon obesulus* subsp. *Fusciventer*)	Priority 4	**Likely.** This species may opportunistically use all habitats presented in the development envelope for foraging and shelter (GHD 2018b). There are historical records of this species present within the development envelope, within 4 km of the development envelope and known records of this species in *Banksia sessilis* habitat north of Alkimos (GHD 2018b). As such, this species is likely to occur within the development envelope.
Birds		
Carnaby's Cockatoo (*Calyptorhynchus latirostris*)	Endangered (BC Act and EPBC Act)	**Present.** The Proposal is located within the modelled feeding and breeding distribution (Yanchep National Park) for Carnaby's Cockatoo. One small flock was observed foraging in shrubs and others were observed flying overhead during the field assessment (GHD 2018c). Carnaby's Cockatoo was observed foraging, heard calling and evidence of recent activity (e.g. foraging residue such as chewed *Banksia sessilis* flowers and *B. attenuata* cones) was recorded within the development envelope. There are numerous historical records of this species occurring within and 10 km of the Proposal. This species is expected to be a regular visitor, most likely in the autumn when large flocks roost in the Gnangara pine plantation and disperse over the coastal plain woodlands and shrublands to feed each day. The development envelope does not provide nesting habitat for this species (Bamford 2019a).

Species	BC Act*	Presence in proximity of development envelope
		The Banksia woodlands, Mixed tall shrubland and Eucalyptus woodland within the development envelope provides high value foraging habitat for Carnaby's Cockatoo.
Peregrine Falcon (*Falco peregrinus*)	Other specially protected fauna	**Likely.** This species may opportunistically use all habitats presented in the development envelope for foraging and the closest record is within 10 km of the Proposal (GHD 2018c). This may be a more regular visitor and the development envelope may lie within the foraging range of a pair, however, does not provide nesting habitat (large trees or cliff faces) (Bamford 2019a). As such, this species is likely to occur within the development envelope.
Reptiles		
Jewelled South West Ctenotus (*Ctenotus gemmula*)	Priority 3	**Likely.** The habitat within the development envelope is suitable for this species (GHD 2018b). There are no records from the development envelope with the nearest record approximately 20 km from the development envelope. However, this is likely due to a lack of current data for this species and; therefore, records are unlikely to indicate its true distribution. This species is expected to be a resident within the development envelope (Bamford 2019a). As such, this species is likely to occur within the development envelope.
Black Striped Snake (*Neelaps calonotos*)	Priority 3	**Likely.** The habitat within the development envelope is suitable for this species. There are multiple records within 5 km of the development envelope including Pipidinny Road, approximately 1 km to the south (GHD 2018b). This species is expected to be a resident within the development envelope (Bamford 2019a). This species is likely to occur within the development envelope based on the ecology of the species, suitable habitat within the development envelope and records of this species in the general region (Bamford 2019a).
Invertebrates		
Ground cricket (*Pachysaga* sp.)	Priority 1 and confirmed SRE (*Pachysaga strobila* only)	**Present.** One single ground cricket *Pachysaga* spp. was recorded in *Banksia sessilis* over low mixed shrubland habitat in 2012 by GHD and is likely a resident (GHD 2018b). This species was not confirmed to be *Pachysaga strobila* and is considered by (Invertebrate Solutions 2018a), likely to be *Pachysaga munggai* (not listed as a Threatened or Priority species), based on its larger distribution and due to *P. strobila* being only known from its type locality (specimen recorded in Vasse).

Species	BC Act*	Presence in proximity of development envelope
		This species has subsequently been reviewed by DBCA and is no longer conservation significant within the SCP bioregion (GHD 2018b). *P. strobila* is a poorly known, understudied species, and the record of this individual would extend its distribution by over 250 km. Therefore, it is not expected that additional populations of this species would exist within this distribution. This species may reside in mixed banksia woodland within the development envelope (GHD 2018b). This species may be present within the development envelope.
Graceful Sun-Moth (*Synemon gratiosa*)	Priority 4	**Likely.** This species occurs in coastal and near coastal dunes that support *Lomandra maritima*, the primary host plant of the Graceful Sun Moth (GHD 2018b). Graceful Sun-Moth (GSM) was recorded by GHD (2011). The GSM was not recorded during subsequent surveys however the habitat within the development envelope (Lomandra herblands on secondary dunes) is still considered by GHD (2018b) to be suitable breeding habitat for the species. There are also government database records of this species within 1 km of the development envelope.
Tree cricket (*Austrosaga spinifer*)	Priority 2 and potential SRE	**Potential.** Habitat is potentially suitable and there are records within 7 km (GHD 2018c)
Woolybush bee (*Hylaeus globuliferus*)	Priority 3	**Potential.** Some suitable habitat is present and the closest record is 10 km away (GHD 2018c)

* Conservation status in Western Australia, whether listed under BC Act or listed by DBCA.

A further 15 conservation listed species were considered unlikely to occur in the development envelope (GHD 2018b), including Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp. *naso*). These two threatened cockatoo species were considered unlikely to occur as the development envelope is outside of their current mapped distribution (GHD 2018b) and the vegetation present within the development envelope is not considered by GHD (2018b) or Bamford (2019a) to be preferred habitat. These species are not discussed further.

Western Quoll (Dasyurus geoffroii)

The Western Quoll (*Dasyurus geoffroii*; listed as Vulnerable under the EPBC Act and BC Act), was previously assessed as likely to occur in the development envelope (GHD 2018b). This species is the largest carnivorous marsupial (family Dasyuridae) occurring in WA; at maturity, it is approximately the size of a small domestic cat. It is found in Jarrah forests and woodlands in the southwest corner of WA, and along the south coast and to the east near Ravensthorpe in woodlands, mallee shrublands and heaths (DEC 2012a). This species has the potential to occur within the development as a vagrant (Bamford 2019a). This species was not detected during field surveys of the development envelope, and further assessment of the literature has determined that the Western Quoll are considered locally extinct in the coastal northern SCP (DEC 2012a; DBCA 2007-2018; Bamford 2019a) and would not occur in the development envelope. Records in the vicinity of the development envelope are historic and primarily relate to skeletons and fossils. The closest recent (less than 30 years old) published live sighting of this

species is from Lexia, east of Wangara, 27 km from the nearest boundary of the development envelope (DBCA 2007-2018). It was also recorded in Ellenbrook in 2004 (Bamford 2019a). As the Western Quoll is expected only as a vagrant and the development envelope does not provide a unique ecological function for the species, the development envelope is not expected to be significant habitat for the species (Bamford 2019a). Therefore, this species is considered unlikely to occur in the development envelope (GHD 2018b, Bamford 2019a) and is not discussed further in this ERD.

The conservation listed species that have been recorded in the development envelope, or are considered likely to occur, are discussed in detail below.

Carnaby's Cockatoo (*Calyptorhynchus latirostris*)

Carnaby's Cockatoo is endemic to southwest WA with populations extending from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin (DoEE 2018a). The species is a post-breeding nomad, tending to move west to coastal areas with its young after breeding (late spring to mid-winter), particularly to the SCP. A small number of birds remain resident on the SCP all year and have been recorded breeding in several areas including Gingin, Yanchep, Mandurah, and Bunbury. Like most cockatoo species, Carnaby's Cockatoo is gregarious and is usually seen in small groups and will occasionally congregate in large flocks comprised of hundreds or, exceptionally, thousands of birds. During the breeding season, adults nest as solitary pairs.

Carnaby's Cockatoo foraging habitat includes native shrubland, kwongan heathland and woodland dominated by proteaceous plant species including *Banksia*, *Hakea* and *Grevillea*. This species is known to forage in pine plantations, eucalypt woodland, forest that contains foraging species and individual trees and small stands of these species (DoEE 2017). Carnaby's Cockatoo nest in hollows of smooth-barked eucalypts, especially Salmon Gum (*Eucalyptus salmonophloia*) and Wandoo (*Eucalyptus wandoo*), but nests have also been found in other eucalypts, including York Gum (*Eucalyptus loxophleba*), Flooded Gum (*Eucalyptus rudis*), Tuart (*Eucalyptus gomphocephala*) and the rough-barked Marri (*Corymbia calophylla*). On the SCP, most nests are in Tuart trees (Johnstone & Storr 1998). Breeding birds forage no more than approximately 20 km from their nesting hollows during the breeding season, and therefore having sufficient foraging and water resources close to breeding areas is critical to their breeding success (Saunders 1980).

Carnaby's Cockatoo communally roost in a suitable tree or group of tall trees, usually close to a water source, and within an area of quality foraging habitat. Suitable roosting trees include *Eucalyptus* and *Corymbia* species and introduced pines. The cockatoos fly to feeding areas each day before returning to the night roost (DSEWPAC 2012a). However, use of a particular night roost site may vary from daily to weekly. There are no important water sources for Carnaby's Cockatoo within or immediately adjacent to the development envelope. The nearest important water source includes quality foraging habitat, riparian/permanent surface water features and known roost locations is represented by Loch McNess. Loch McNess is approximately 1.9 km northeast of the development envelope (see Figure 2-2).

Foraging habitat

Carnaby's Cockatoo foraging habitat value was determined by reviewing the described/mapped fauna habitat types present within the development envelope (GHD 2018b) and, based on vegetation structure, species (and food items) present and vegetation condition, were assigned a value of either high, moderate or low (Table 6-6).

There is a total of 56.31 ha of potential high and medium value foraging and breeding habitat for Carnaby's Cockatoos within the development envelope (GHD 2019) (Table 6-6). Carnaby's Cockatoo habitat is not restricted to the development envelope and extends into Ningana Bushland (Table 6-6).

Approximately 77% of the development envelope provides suitable foraging habitat for Carnaby's Cockatoo (Table 6-6 and Table 6-7) (GHD 2019). The remaining areas are highly disturbed or comprise fauna habitat types not considered suitable for Carnaby's Cockatoo breeding or foraging (GHD 2019).

Table 6-6: Carnaby's Cockatoo value within the development envelope and additional survey area

Fauna habitat types	Carnaby's Cockatoo value		Extent of Carnaby's Cockatoo habitat in development envelope		Extent of Carnaby's Cockatoo habitat in mapped extent[1]
	Foraging	Breeding	Area (ha)	%	Area (ha)
Banksia sessilis over low mixed shrubland	High	–	13.81	18.95	18.84
Eucalyptus woodland	Moderate	Moderate	2.13	2.92	8.56
Mixed *Banksia* woodland	High	–	8.76	12.02	19.87
Mixed tall shrubland	Moderate	–	22.76	31.23	46.71
Planted *Eucalyptus* woodland	Moderate	–	8.87	12.17	22.08
Total foraging area			**56.31**	**77.3**	**116.06**

Source: Adapted from GHD (2018b)
[1] Based on findings presented in GHD (2018b) within the development envelope and additional survey area.

Table 6-7: Extent of Carnaby's Cockatoo habitat types and value recorded in the development envelope

Habitat type	Habitat value	Extent within development envelope	
		Area (ha)	%
Foraging (breeding)	High	22.56	30.97
	Moderate	33.75 (2.13)	46.32
Total		**56.31 (2.13)**	**77.29**

Adapted from GHD (2019)

Of the current extent remaining, there is 42.31% of potential foraging habitat within conservation areas at a local scale (GHD 2019). At a regional scale there is 80.13% of potential foraging habitat within conservation areas (**Table 6-8**).

Table 6-8: Current extent of Carnaby's Cockatoo habitat in conservation areas

Scale	Current extent (ha)	Remaining %	Current extent in conservation areas (ha)			
			DBCA	Bush Forever Sites	Total	% of current extent
Foraging						
NW subregion	25,808.75	-	15,088.44	5,593.07	20,681.51	80.13
1 km buffer	766.99	-	64.18	260.36	324.54	42.31

Source: GHD (2019)
Note: DBCA extent: calculated using DBCA – Legislated Lands and Waters (DBCA-011) and DBCA – Lands of Interest (DBCA-012); Bush Forever Site extent: calculated using Bush Forever Areas 2000 (DOP-071) that lies outside of calculated DBCA extent.

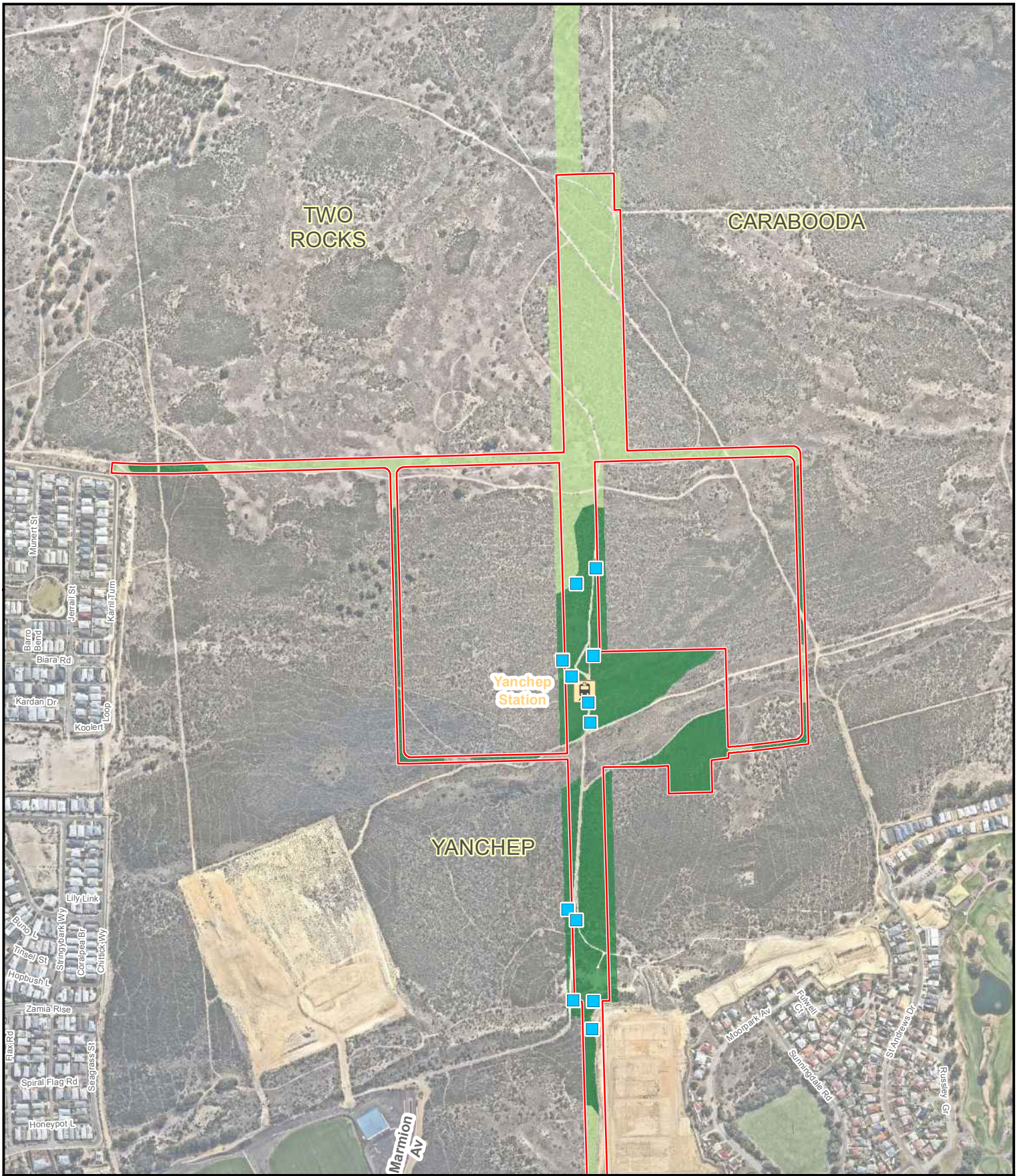
Breeding and roosting habitat

The development envelope is located within the buffer of a confirmed breeding area (GHD 2018b). A known breeding record is located approximately 3 km east of the development envelope (GHD 2019). There are two confirmed roosting areas approximately 2 km east of the Proposal; and one unconfirmed roosting area approximately 1.1 km east of the Proposal (GHD 2019). All records are from Yanchep National Park, excluding the unconfirmed roosting area (GHD 2019). No breeding events of any species of black cockatoo were recorded within the development envelope or immediate adjacent areas (GHD 2019).

A total of 70 potential breeding habitat trees with a DBH greater than 500 mm (including 66 Tuarts and four introduced eucalypts) were identified by GHD (2019) within the development envelope and additional survey area. None of these trees contained hollows. There are 45 potential breeding trees within the development envelope (GHD 2019).

Carnaby's Cockatoo roost areas datasets were sourced from DBCA to review roost locations in relation to the DE to provide context. These datasets provided locations of confirmed, unconfirmed and buffered roost areas based on observations (as outlined by Glossop et al. (2011)). Planted Eucalyptus woodlands generally lack the emergent height above surrounding habitat to be deemed as potential roosts (GHD 2019). The closest known Carnaby's Cockatoo roosts (as documented by roost count data from Birdlife Australia) are three sites located in the Yanchep area approximately 1.5 km north to the northeast of the development envelope (GHD 2019).

Whilst suitable roosting habitat was identified within the development envelope, no roosting sites were recorded as being used by Carnaby's Cockatoos within the development envelope and therefore will not be further assessed as roosting habitat in this report. Furthermore, the extent of the suitable roosting habitat has been captured within breeding and foraging extents. There is approximately 2.13 ha of suitable breeding habitat within the development envelope comprising Eucalyptus woodland. Eucalyptus woodland is considered by GHD (2019) to be moderate habitat value for Carnaby's Cockatoos (**Table 6-6**).

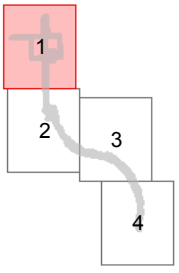


Yanchep Rail Extension (Part 2)
Figure 6-2 Black Cockatoo Habitat

Public Transport Authority

Legend

- Development Envelope
- Black Cockatoo Foraging Evidence
- Proposed Station
- **Black Cockatoo Foraging Habitat**
  - Foraging - High Value
  - Foraging - Moderate Value



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Yanchep Rail Extension (Part 2)
Figure 6-2 Black Cockatoo Habitat

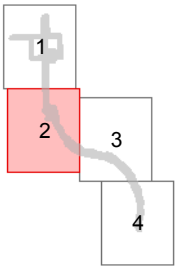
Public Transport Authority

Legend

- Development Envelope
- Black Cockatoo Foraging Evidence
- Black Cockatoo Breeding Trees

Black Cockatoo Foraging Habitat

- Foraging, Breeding and Roosting - Moderate Value
- Foraging - High Value
- Foraging - Moderate Value



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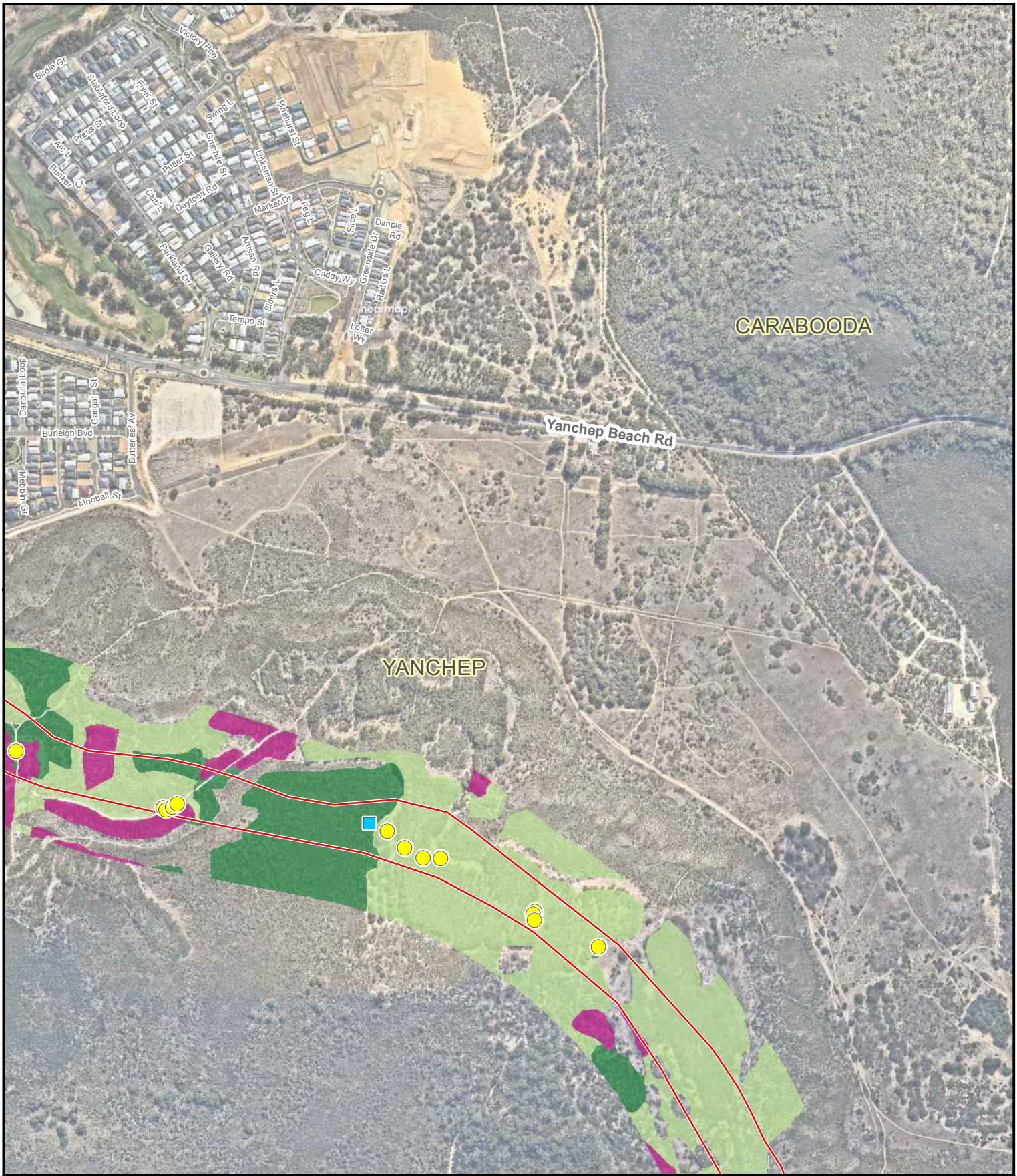


Yanchep Rail Extension (Part 2)
Figure 6-2 Black Cockatoo Habitat

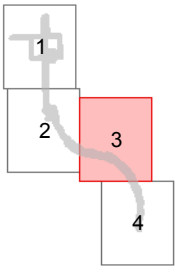
Public Transport Authority

Legend

- Development Envelope
- Black Cockatoo Foraging Evidence
- Black Cockatoo Breeding Trees

Black Cockatoo Foraging Habitat

- Foraging, Breeding and Roosting - Moderate Value
- Foraging - High Value
- Foraging - Moderate Value



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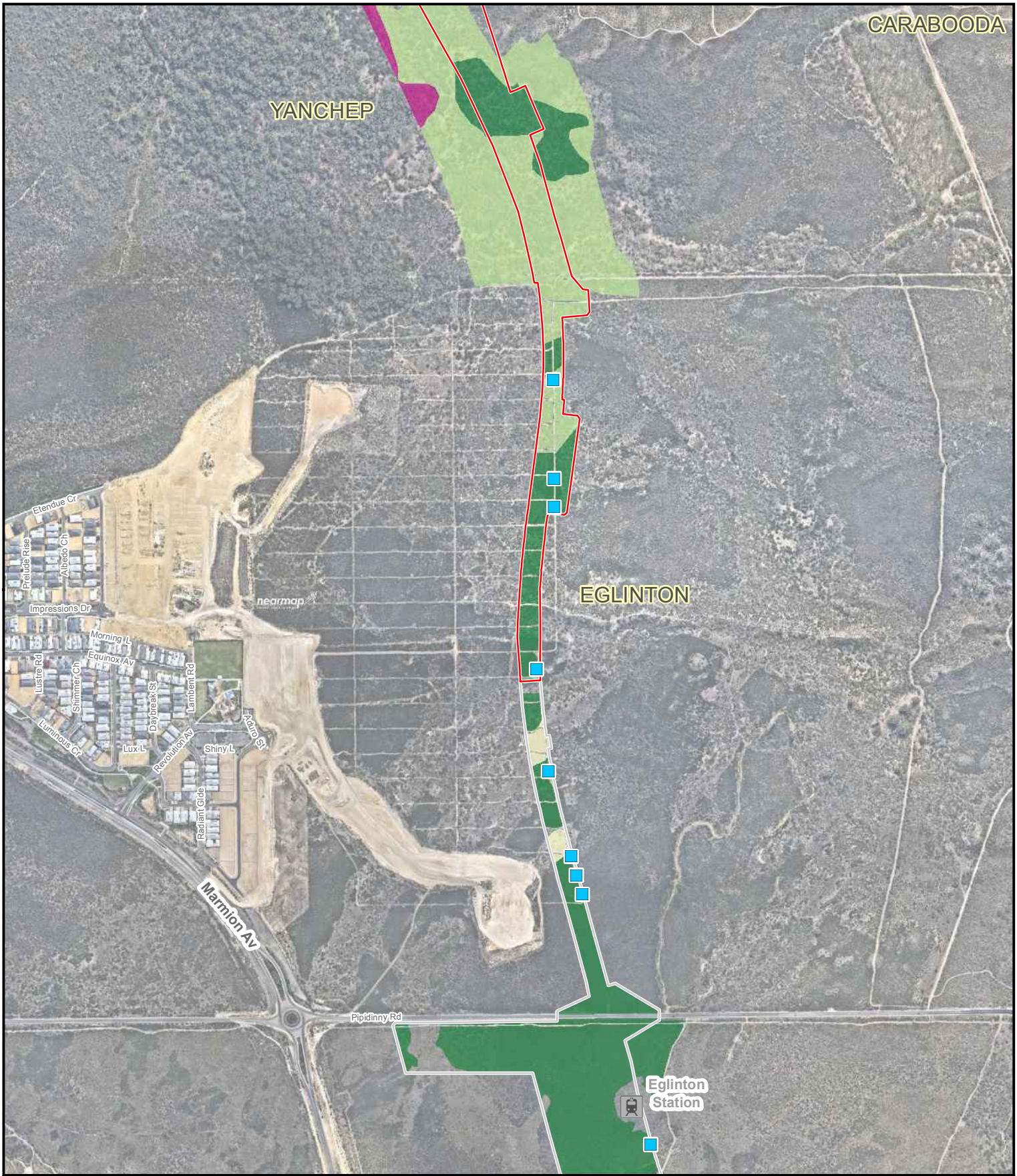
Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community



Yanchep Rail Extension (Part 2)
Figure 6-2 Black Cockatoo Habitat

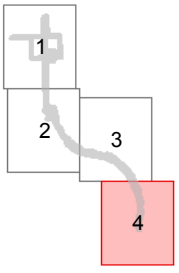
Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Proposed station (YRE Part 1)
- Black Cockatoo Foraging Evidence

Black Cockatoo Foraging Habitat

- Foraging, Breeding and Roosting - Moderate Value
- Foraging - High Value
- Foraging - Moderate Value
- Foraging - Low Value



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Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Pachysaga sp. (Priority 1 ground cricket)

The orthopteran family Tettigoniidae (commonly known as Katydids), inhabit trees and shrubs and can mostly be found in the southern half of Australia in heath or mixed woodland (Invertebrate Solutions 2018a). In the southwest of WA, two closely related species of the genus *Pachysaga* occur: the Vasse Pachysaga (*P. strobila*) and *P. munggai*. The Vasse Pachysaga (Busselton-Donnybrook) is considered a Priority 1 species by DBCA and a SRE, as it has only been observed near Vasse, near Busselton. *P. munggai* is known from a more widespread distribution, from Margaret River to Serpentine.

A ground cricket (*Pachysaga* sp.) was recorded in the development envelope during the GHD (2012) survey. The specimen could not be identified to species level (Invertebrate Solutions 2018a). Due to the larger distribution of *P. munggai* and proximity to nearby records, and as *P. strobila* is only known from the type locality, it is more likely that the specimen observed in the development envelope was *P. munggai*. However, both *Pachysaga sp.* have poorly known distributions and with the currently available knowledge it is impossible to ascertain which species was observed (Invertebrate Solutions 2018a).

The ground cricket was observed in *Banksia sessilis* over low mixed shrubland: 13.81 ha of this habitat is present within the development envelope. Mixed *Banksia* woodland habitat (8.76 ha in the development envelope) may also be suitable for this species (GHD 2018c).

Western Brush Wallaby (Macropus irma) (Priority 4)

The Western Brush Wallaby is found in the southwest coastal region of WA where populations are particularly centralised near the Swan River and the dry sclerophyll Jarrah forests to the east of Perth (Groves 2005). The species is found in some areas of mallee and heathland but is generally uncommon in wet sclerophyll forest further south. It prefers tall open forests or woodlands that supply adequate grazing and open, seasonally damp flat areas with low grasses and open scrubby brushes that allow it to move freely and speedily.

The Western Brush Wallaby is a crepuscular animal, unlike many macropod species, and is active mainly at dusk and dawn (Menkhorst & Knight 2009). It is herbivorous and feeds on many plant species in particular, **Carpobrotus edulis, *Cynodon dactylon*, and *Nuytsia floribunda*. Western Brush Wallabies are commonly recorded around the SCP in suitable habitat. Currently, the Western Brush Wallaby is likely to be adversely affected by the Proposal due to its low density (home range areas of 5 - 10 ha, already heavily fragmented and isolated populations on the SCP, and vulnerability to vehicles. Connectivity is important for the Western Brush Wallaby (Bamford 2019a)

A Western Brush Wallaby was recorded in the mixed tall shrubland habitat (GHD 2018b) in the development envelope. All fauna habitats (61.68 ha) within the development envelope are suitable to be utilised by this species, however the mixed tall shrubland, *Banksia* woodlands and *Eucalyptus* woodlands are of highest value for shelter and foraging (GHD 2018b).

Peregrine Falcon (Falco peregrinus) (Other specially protected fauna)

The Peregrine Falcon is a large bird of prey that occurs throughout WA, from the south near Albany to the north near Kununurra. While considered uncommon, it is widespread across Australia and occurs across all continents (PaWST 2011). The Peregrine Falcon occupies a variety of habitats including inland cliffs, rocky outcrops and gorges, coastal cliffs and islands, open woodlands near water, and can also be found nesting on ledges of high city buildings (PaWST 2011). The Peregrine Falcon is considered likely to occur in the development envelope, as it is highly mobile and the nearest record is within 10 km (GHD 2018b). Given its lack of habitat specificity, this species could use all habitats (comprising 61.68 ha) within the development envelope for opportunistic foraging (GHD 2018b).

Jewelled South-west Ctenotus (Ctenotus gemmula) (Priority 3)

The Jewelled South-West Ctenotus is endemic to Western Australia, and in the Perth region is restricted to the SCP. It is known to occur on sandplains supporting heath in association with *Banksia* or mallee woodlands, where it shelters in leaf litter under trees and shrubs and abandoned stick-ant nests (Bush et al. 2010; Wilson & Swan 2013). The species is known from Ellenbrook to Pearce airbase and Melaleuca Park, to the east of the development envelope.

Limited population data has been documented for this species; however, it is reported to be uncommon on the SCP (Bush et al. 2010). While this species has not been recorded in the development envelope, this is likely due to a lack of current data (GHD 2018b). Mixed *Banksia* woodland (8.76 ha), mixed tall shrubland (22.76 ha) and *Lomandra* herbland on secondary dunes habitat (5.31 ha) are considered suitable habitat for this species (GHD 2018b).

Black striped Snake (Neelaps calonotos) (Priority 3)

The Black-striped Snake occurs on the coastal plain and coastal dune formations supporting low shrublands, heaths, and *Banksia* woodlands between Mandurah and Cataby (Bush et al. 2010). It feeds primarily on burrowing skinks (*Lerista* spp.). It is a seasonal breeder, like most reptiles in the southwest of WA.

While this species was not observed during the field surveys, it is considered likely to occur in the development envelope, as there are multiple records within 5 km from the Proposal (GHD 2018c). Mixed *Banksia* woodland (8.76 ha), mixed tall shrubland (22.76 ha) and *Lomandra* herbland on secondary dunes (5.31 ha) are considered suitable habitat for this species (GHD 2018b).

Quenda (Isoodon obesulus) (Priority 4)

The Quenda, or Southern Brown Bandicoot, is widely but patchily distributed through south-western WA, from around Guilderton to east of Esperance and inland to Hyden. This species prefers low, dense vegetation such as heath and swampy habitat and is often associated with forests, woodland, shrubland and riparian areas (DEC 2012b). Its foraging often extends into adjacent, more open grasslands, pastures, or areas subject to regular burning (DEC 2012b). The species is nocturnal and sleeps during the day in a nest of heaped vegetation with a hollow centre. The nest is usually concealed in a depression or amongst dense vegetation or ground litter. Food is located by digging conical holes with the forefeet and probing with the snout, and includes insects and larvae, worms, bulbs, berries and small vertebrates (Menkhorst & Knight 2009).

The Quenda was not observed during field surveys (GHD 2012, 2018b; Bamford 2019a), however, has been recorded regularly nearby (Burns Beach and Yanchep) (Bamford 2019a). It is considered by Bamford (2019a) to be locally extinct but may have the potential to recolonise the site. Overall, this species is likely to occur (GHD 2018b) and would utilise all fauna habitats (61.68 ha) present in the development envelope.

Graceful Sun-Moth (Synemon gratiosa) (Priority 4)

Graceful Sun-moths are small (less than 30 mm), brightly coloured moths that are active during the day (preferring bright sunshine), usually in warm to hot weather (DEC 2010). Adult sun-moths are only active (and detectable) during a limited period each year (approximately late February through early April). In Perth, they are found in *Banksia* woodland/woolly bush on deep sands, and open areas of herbland, heathland and shrubland on Quindalup soils (sand and limestone) close to the coast. They breed on *Lomandra hermaphrodita* and *Lomandra maritima* (DEC 2010).

The Graceful Sun Moth has not been recorded in the greater YRE Project (GHD 2011) survey. Given the availability of suitable habitat (5.31 ha of *Lomandra* herbland on secondary dunes) and the proximity of nearby records, this species is considered likely to occur in the development envelope.

Austrosaga spinifer (Priority 2)

The tree cricket *Austrosaga spinifer* is known from heath habitats from Perth to Cervantes (Western Wildlife 2008), and is considered likely to occur in *Banksia* woodlands (TSSC 2016). There are only four records of this species on NatureMap; two of the records are from Neerabup National Park, less than 7 km southeast of the development envelope (DBCA 2007-2018). It is considered by Invertebrate Solutions (2018a) likely to be an SRE. Little information is publicly available on its habitat preferences, so therefore conservatively, all habitats within the development envelope are considered suitable for this species. Given the availability of potentially suitable habitat, and the proximity of nearby records, this species was considered to potentially occur in the development envelope (Invertebrate Solutions 2018a).

Woolybush bee (Adenanthos sericeus) (Priority 3)

The Woolybush bee has a distribution that extends from the south coast near Fitzgerald River National Park, to the Mid West near Dongara (DBCA 2007-2018). It has been recorded near the development envelope; the closest record on NatureMap is 10 km south east from the development envelope (DBCA 2007-2018). This species of native bee is known to feed on the flowers of *Adenanthos cygnorum* (Common Woolybush), but has also been collected from the flowers of *Grevillea cagiana, Grevillea* sp. aff. *hookeriana*, *Banksia grossa* and *Banksia attenuata* (Western Wildlife 2008, DBCA 2007-2018). *Banksia attenuata* has been recorded in the development envelope. Given the foraging preferences of this species, *Banksia sessilis* over low mixed shrubland, mixed *Banksia* woodland habitat and mixed tall shrubland habitat (45.3 ha) could constitute suitable habitat for this species. Due to the proximity of nearby records and suitable habitat in the development envelope, this species has the potential to occur (Invertebrate Solutions 2018a).

6.3.7 Short range endemic fauna

The study area for SREs is the same as that outlined or subterranean fauna and is presented in Figure 7-1.

The isolation of invertebrates in specific habitats or bioregions, such as ability and opportunity to disperse, life history, physiology, habitat requirements and habitat availability, leads to endemism at various spatial scales (Invertebrate Solutions 2018a). SRE invertebrates are species with restricted distributions, arbitrarily defined in Western Australia as less than 10,000 km^2 (Harvey 2002).

The development envelope contains approximately 52 ha of habitat with moderate suitability for SREs (0.92% of the locally available moderate habitat) and 21 ha of habitat with low suitability habitat for SREs (1.33% of the locally available low value habitat) (Invertebrate Solutions 2018a). No potential high value SRE habitat was identified within the development envelope (**Figure 6-3**). An assessment by Invertebrate Solutions (2018a) determined that no SRE invertebrates would be restricted to the development envelope, as none of the habitats present would provide habitat isolates. All the vegetation units are laterally continuous within the region and are not limited to the development envelope (Invertebrate Solutions 2018a), as illustrated by the continuation of the aligned regional vegetation associations and complexes, and broad vegetation units (Figure 5-3 in Section 5.3.2).

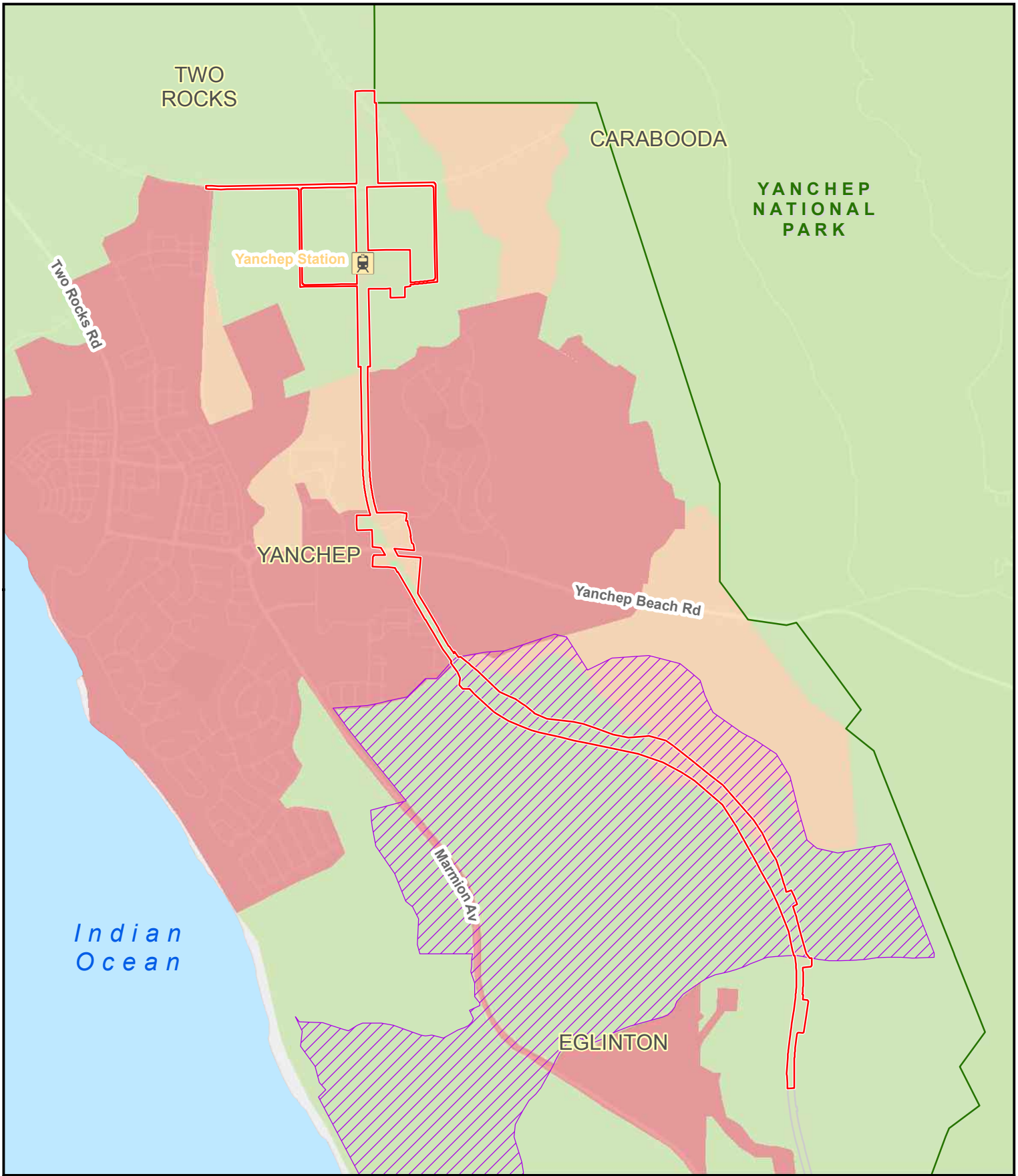
A desktop review assessed the likelihood of SRE invertebrates being present within the development envelope and local area (Invertebrate Solutions 2018a), as summarised in Table 6-9. The two confirmed SRE species likely to occur within the development envelope are discussed in further detail below.

Table 6-9: Likelihood of occurrence for SRE's within the development envelope

SRE invertebrate species	Likelihood of occurrence within development envelope
Millipede (*Antichiropus whistleri*)	Likely
Trapdoor spider (*Idiosoma sigillatum*)	Likely
Pseudoscorpion (*Protochelifer cavernarum*)	Likely – possible SRE status based on molecular evidence.
Three mygalomorph spiders (*Synothele lowei*, *Synothele michaelseni* and *Synothele Taurus*)	Potential
Two slaters (*Buddelundia cinerascens* and *Buddelundia opaca*)	Potential
Tree cricket (*Austrosaga spinifer*) listed as Priority 2 by DBCA.	Potential
Harvestman arachnid (*Bindoona glauerti*)	Potential – possible SRE status due to a deficient dataset.

Idiosoma sigillatum is the most common idiopid trapdoor spider on the SCP, with historical records ranging from Dalyellup north to at least Ledge Point (including Rottnest Island and Garden Island) with the eastern limit of its range along the sandy foothills of the Darling Escarpment, from Boyanup north to at least Gingin (Invertebrate Solutions 2018a). *Idiosoma sigillatum* has a known range of 7,100 km^2, and an area of occupancy of less than 3,000 km^2 (Invertebrate Solutions 2018a), and is a confirmed SRE species. Due to habitat clearing, this species is unlikely to occur through much of its historical distribution in urban areas except in remnant habitats (e.g. Kings Park, Bold Park, and Shenton Park bushland) (Invertebrate Solutions 2018a). As *Idiosoma sigillatum* usually burrows in *Banksia* woodland and heathland on sandy soils, it is considered likely to occur within the development envelope (Invertebrate Solutions 2018a).

The millipede species *Antichiropus whistleri* is a confirmed SRE and has a known historical distribution from Morley north to past Muchea, with additional records near Cataby (Invertebrate Solutions 2018a). It is likely to be more extensively distributed in suitable habitat on the outer urban areas of Perth, such as Yanchep National Park, Ningana bushland (Bush Forever Site No. 289) and Neerabup National Park despite the absence of verified records; numerous *Antichiropus* specimens have been recorded but not identified beyond genera level (Invertebrate Solutions 2018a). Due to the proximity of potential records of this species, it is considered likely to occur in the development envelope (Invertebrate Solutions 2018a).



Yanchep Rail Extension (Part 2)
Figure 6-3 SRE Habitat Suitability in the Development Envelope

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Proposed Station
- Ningana Bushland (Bush Forever Site 289)

SRE Habitat Likelihood

- Moderate
- Low
- Nil

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Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
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6.4 Potential impacts

The Proposal has the potential to directly and indirectly impact on terrestrial fauna during construction and operation phases.

Potential direct impacts of the Proposal to terrestrial fauna are:

- Permanent loss of fauna habitat from vegetation clearing.
- Injury/mortality of fauna during construction and/or operations.
- Fragmentation of fauna habitat due to vegetation clearing.
- Degradation of adjacent fauna habitat during construction and operations.
- Disturbance to fauna from noise and vibrations during construction and operations.
- Change in feral animal abundance and/or movement.

6.5 Assessment of impacts

Sections 6.5.1 to 6.5.6 present an assessment of predicted direct and indirect residual impacts on terrestrial fauna after the mitigation hierarchy has been applied (outlined in Section 6.6).

Impacts have been assigned a level of either 'Low', 'Moderate' or 'High' according to their potential degree to adversely affect the EPA's objective outlined in Section 6.1. Where an impact is designated as 'Low' no further consideration was given to the potential impact.

6.5.1 Permanent loss of fauna habitat

The Proposal will result in the permanent loss of up to 61.68 ha of fauna habitat (GHD 2019) comprising:

- 47.45 ha of high value fauna habitat.
- 14.23 ha of medium value fauna habitat.

The clearing loss associated with the development envelope is estimated to contribute a 3.90% reduction in fauna habitat at a local scale; and 0.11% and 0.01% at a region and subregional scale (GHD 2019) (**Table 6-10**).

Table 6-10: Extent of native vegetation (fauna habitat) at local, regional and bioregional scales

Scale	Pre-European extent (ha)	Current extent (ha)	Current extent remaining %	Extent		
				Development envelope (ha)	Development envelope (%)	After Proposal development (ha)
Perth IBRA subregion	1,117,336.01	465,369.28	41.65	61.68	0.01	465,324.28 (41.65%)
NW subregion	77,112.88	42,581.90	55.22	61.68	0.11	42,536.90 (55.16%)
1 km buffer	2,062.77	1,155.34	56.01	61.68	3.90	1,110.34 (53.83%)

Adapted from GHD (2019).

Habitat for conservation listed fauna species

Up to 61.68 ha of fauna habitat will be cleared as a result of the Proposal. This vegetation is considered habitat for a range of conservation listed fauna species. The total loss of potential habitat for individual conservation listed fauna species and the significance of the impact of that habitat loss is described in **Table 6-11.**

Table 6-11: Assessment of significance of impacts from vegetation clearing to conservation listed fauna and habitat

Species	Conservation status	Likelihood of occurrence	Area to be cleared and suitable habitat	Significance of clearing
Western Brush Wallaby *Notamacropus irma*	Priority 4	Present	61.68 ha All habitats presented in **Table 6-2**	**Low impact.** The Western Brush Wallaby is a highly mobile animal and has the potential to opportunistically utilise all habitats within the development envelope. The Western Brush Wallaby is widespread and would utilise habitats in the surrounding areas. It is not expected that the Proposal will have a significant impact on this species and cause this species to become rare or endangered. The residual impact to the Western Brush Wallaby is not significant.
Quenda *Isoodon obesulus* subsp. *fusciventer*	Priority 4	Likely	61.68 ha All habitats presented in **Table 6-2**	**Low impact.** Remnant vegetation within the development envelope has the potential to be utilised by Quenda. The Proposal will result in the loss of habitat at the local scale for this species. The species is widespread and is expected to occur in adjacent habitats. It is not expected that the Proposal will have a significant impact on this species and cause it to become rare or endangered. The residual impact to the Quenda is not significant given the proximity of the development envelope to larger areas of similar or better quality habitat and the number of records in the vicinity of the Proposal.

Species	Conservation status	Likelihood of occurrence	Area to be cleared and suitable habitat	Significance of clearing
Carnaby's Cockatoo *Calyptorhynchus latirostris*	Endangered under EPBC Act and BC Act	Recorded	56.31 ha • *Banksia sessilis* over low mixed shrubland • *Eucalyptus* woodland • Mixed *Banksia* woodland • Mixed tall shrubland • Planted *Eucalyptus* woodland	**High impact.** The Proposal will result in the removal of 56.31 ha (approximately 77% of the development envelope) of Carnaby's Cockatoo habitat, including: • Loss of a total of 56.31 ha of Carnaby's Cockatoo habitat (22.56 ha of high value and 33.75 ha medium value habitat foraging habitat), including 2.13 ha of potential breeding habitat; and 45 potential breeding trees. Carnaby's Cockatoo is listed as Endangered under the EPBC Act and BC Act. Despite the representation of appropriate habitat in conservation areas, this species is under significant threat of decline. The residual impact to Carnaby's Cockatoo from habitat clearing from the Proposal is significant based on the Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan (DPaW 2013) and the WA Environmental Offset Guidelines (Government of Western Australia 2014).
Peregrine Falcon *Falco peregrinus*	Other specially protected fauna under the BC Act	Likely	61.68 ha All habitats presented in **Table 6-2**	**Low impact.** The Peregrine Falcon is a highly mobile species with a large home range. It would only be a transient visitor to the development envelope and would not rely on the habitat present for breeding or foraging. Given the substantial extent of potential habitat available locally, it is not expected that the Proposal will have a significant impact on this species and cause it to become rare or endangered. The residual impact to the Peregrine Falcon is not significant.

Species	Conservation status	Likelihood of occurrence	Area to be cleared and suitable habitat	Significance of clearing
Jewelled South-west Ctenotus *Ctenotus gemmula*	Priority 3	Likely	36.82 ha • Mixed *Banksia* woodland • Mixed tall shrubland • *Lomandra* herbland on secondary dunes habitat	**Low impact.** The Proposal will result in the local loss of potential habitat for this species. Given the proximity of the development envelope to larger areas of similar or better quality habitat locally, and the lack of records on the northern SCP (there are only four records consisting of multiple individuals within 40 km (DBCA 2007-2018), it is not expected that the Proposal will have a significant impact on this species and cause it to become rare or endangered. The residual impact to the Jewelled South-west Ctenotus is not significant.
Black Striped Snake *Neelaps calonotos*	Priority 3	Likely	36.82 ha • Mixed *Banksia* woodland • Mixed tall shrubland • *Lomandra* herbland on secondary dunes habitat	**Low impact.** The Proposal will result in the local loss of potential habitat for this species. Given the proximity of the development envelope to larger areas of similar or better quality habitat locally, it is not expected that the Proposal will have a significant impact on this species and cause it to become rare or endangered. The residual impact to the Black Striped Snake is not significant.

Species	Conservation status	Likelihood of occurrence	Area to be cleared and suitable habitat	Significance of clearing
Ground cricket *Pachysaga* sp.	Priority 1 (*Pachysaga strobila* only), confirmed SRE	Recorded	22.56 ha • *Banksia sessilis* over low mixed shrubland • Mixed *Banksia* woodland habitat	**Low impact.** The Proposal will result in the local loss of potential habitat for this species. It is unlikely the Proposal would result in an increase to its conservation status. *P. strobila* is a poorly known, understudied species, and the record of this individual would extend its distribution by over 250 km. Therefore, it is not expected that additional populations of this species would exist within this distribution. Given the availability of suitable *Banksia* habitat locally and regionally, and the narrow linear nature of the Proposal, it is considered unlikely that the Proposal will have a significant impact on this species and cause it to become rare or endangered. The residual impact to *Pachysaga* sp. is not significant.
Graceful Sun-Moth *Synemon gratiosa*	Priority 4	Likely	5.31 ha • *Lomandra* herbland on secondary dunes habitat	**Low impact.** The Proposal will result in the removal of a small area of Graceful Sun-Moth habitat, causing affects to the Graceful Sun-Moth population. However, while this species is restricted to the coast, the distribution of records extends for over 600 km. Given the availability of habitat regionally, it is not expected that the Proposal will have a significant impact on this species and cause it to become rare or endangered. The residual impact to the Graceful Sun-Moth is not significant.
Tree cricket *Austrosaga spinifer*	Priority 2, potential SRE	Potential	61.68 ha All habitats presented in **Table 6-2**	**Low impact.** The Proposal will result in the removal of potential *Austrosaga spinifer* habitat, causing effects to the population, if present in the development envelope. Given the narrow linear nature of the Proposal, and as similar habitat values are likely to be present in surrounding vegetation, including conservation estates, it is not expected that the Proposal would result in the local extinction, or have a significant impact on this species and cause it to become rare or endangered. The residual impact to the *A. spinifer* is not significant.

Species	Conservation status	Likelihood of occurrence	Area to be cleared and suitable habitat	Significance of clearing
Woolybush bee *Hylaeus globuliferus*	Priority 3	Potential	61.68 ha All habitats presented in **Table 6-2**	**Low impact.** The Proposal will result in the loss of potential habitat for this species. Given the narrow linear nature of the Proposal, the proximity of the development envelope to larger areas of similar or better quality habitat, and the presence of other records in the vicinity of the Proposal, it is not expected that the Proposal will have a significant impact on this species and cause it to become rare or endangered. The residual impact to the Woolybush bee is not significant.

Carnaby's Cockatoo (Calyptorhynchus latirostris)

The Proposal will result in the removal of 56.31 ha of Carnaby's Cockatoo habitat (GHD 2019) (Table 6-12) (22.56 ha considered high value and 33.75 ha considered medium value foraging habitat), including 2.13 ha of potential breeding habitat and 45 trees of suitable DBH for potential Carnaby's Cockatoos breeding. At a local scale (1 km radius around the development envelope), this habitat clearing will contribute a 9.26% reduction in potential foraging Carnaby's Cockatoo habitat. Within the NW subregion, the Proposal will account for a loss of less than 0.22% of potential Carnaby's Cockatoo habitat (GHD 2019) **Table 6-12**).

The majority of the remaining Carnaby's Cockatoo habitat at local and subregional scales is located in conservation areas and therefore has some level of protection from development; almost 85% of the remaining Carnaby's Cockatoo foraging habitat and almost 80% of breeding habitat falls within conservation areas at a subregional scale (Table 6-8; GHD 2018c). Locally, Carnaby's Cockatoo foraging and potential breeding habitat occurs in the adjacent Neerabup and Yanchep National Parks (Yanchep National Park contains confirmed breeding sites), in addition to a number of Bush Forever Sites located in proximity to the development envelope (see Table 5-7 in Section 5.3.5).

Table 6-12: Extent of Carnaby's Cockatoo foraging habitat[1] at local and regional scales

Scale	Pre-European extent (ha)	Current extent (ha)	Remaining %	Development envelope (%)	After Proposal development (ha)
NW subregion	N/A	25,808.75	N/A	56.31 (0.22)	25,752.44
1 km buffer	N/A	766.99	N/A	56.31 (9.26%)	710.68

Source: GHD 2019

Breeding habitat

The Proposal will result in the direct loss of up to 45 potential breeding trees. The number of trees with a suitable DBH in a local or regional context is not known. However, potential breeding habitat is known to be locally present surrounding the development envelope (in Ningana Bushland), and in the broader region (GHD 2019). Estimates demonstrate approximately 10,062.67 ha of potential breeding habitat for Black Cockatoos in the NW subregion (GHD 2019).

There are no important surface water sources for black cockatoos within or immediately adjacent to the development envelope. The nearest important water source is located at Loch McNess approximately 1.9 km northeast of the development envelope. No groundwater impacts are predicted as no dewatering and abstraction are required for this Proposal (impacts to surface water and groundwater are discussed further in Section 9.3.3.) As such, the Proposal will not directly or indirectly impact any nearby surface water bodies that may support breeding habitat.

Cumulative impacts on fauna habitat (including Carnaby's Cockatoos)

Fauna habitat

There may be substantial pressure on the remaining fauna habitat at a local and regional scale primarily due to future residential, commercial and industrial development (GHD 2019). Approximately half of the

development envelope (26.36 ha) for the Proposal has been considered for future development in the Perth and Peel ULDO (GHD 2019). Table 6-13 outlines the cumulative impacts on the fauna habitat from foreseeable future development at local and regional scales.

The predicted cumulative impact will result in a 10.70% reduction to fauna habitat at a regional scale and 49.34% reduction to fauna habitat at a local scale (**Table 6-13**). The combined impact of the Part 1 and Part 2, by comparison is predicted to reduce the current extents of fauna habitat by 4.98% at the local scale and 0.19% at the regional scale (GHD 2019).

Table 6-13: Cumulative impacts to fauna habitat at local and regional scale

Scale	Current extent (ha)	Extent in YRE Part 1 (ha)	Extent in YRE Part 2 (ha)	Extent in ULDO areas (ha)	Cumulative extent (ha)
NW subregion	42,581.90	54.97 (0.13%)	61.68 (0.15%)	4,477.76 (10.52%)	4,598.85 (10.80%)
1 km buffer	1,155.34	11.81 (1.02%)	61.68 (5.39%)	513.53 (44.45%)	587.61 (50.86%)

Note: Table adapted from GHD (2019) and predicted utilising the Perth and Peel ULDO dataset for 2016/17

Carnaby's Cockatoos

Table 6-14 outlines cumulative impacts on Carnaby's Cockatoo foraging habitat at a local and regional scale. At a local scale, the YRE Project will reduce the available habitat for Carnaby's Cockatoo foraging by 7.47% (GHD 2019).

The Proposal will clear up to 56.31 ha of Carnaby's Cockatoo potential foraging habitat of which 15.49 ha intersects areas likely to support future development (GHD 2019). The predicted cumulative impact will result in a 9.77% reduction to Carnaby's Cockatoo foraging habitat at a regional scale (GHD 2019) (**Table 6-14**). Furthermore, at a regional scale there is greater than 78% of the current extents of available habitat for Carnaby's Cockatoo foraging in conservation areas (GHD 2019) (**Table 6-8**).

Conservation areas will continue to provide protection for fauna habitat in the northwest corridor. As the fauna habitats mapped within the development envelope are reserved within conservation areas at the subregional and regional level, it is considered that the potential direct residual impacts to the persistence of the fauna habitat from the implementation of the Proposal are not significant.

Overall there are no foreseeable impacts to Carnaby's Cockatoo potential breeding and foraging habitat from future development at a local scale (GHD 2019) (**Table 6-14**).

Table 6-14: Cumulative impacts to Carnaby's Cockatoo foraging habitat at local and regional scale

Scale	Current extent (ha)	Extent in within YRE Part 2	Extent in within YRE Part 1	Extent in ULDO areas	Cumulative extent (ha) (%)
NW subregion	25,808.75	56.31 (0.22%)	48.21 (0.15%)	2,426.39 (9.40%)	2,521.51 (9.77%)
1 km buffer	766.99	56.31 (9.26%)	10.71 (1.26%)	371.70 (48.46%)	452.37 (58.98%)

Source: GHD (2019)
Note: cumulative impacts to be breeding habitat are not available as there is no comparable regional data for the Proposal's impact to 45 potential breeding trees (with no hollows), which are scattered within potential foraging habitat.

6.5.2 Injury/mortality of fauna

Injury and mortality of fauna can result from both direct and indirect impacts from the Proposal.

Fauna can be directly impacted from construction activities. This includes:

- Fauna being injured/killed by collisions with earthmoving equipment and/or vehicles during construction works.
- Vegetation clearing, which reduces the extent of fauna habitat and may result in the loss of individual fauna.
- Ground disturbance activities, which may result in the direct removal of nests and nest young.

Indirect impacts from construction activities can result from noise and vibration, which has the potential to interrupt fauna behaviour and movement.

The risk of injury/mortality to fauna is lower during operations as the railway reservation will be continuously fenced.

The potential impacts to fauna from collisions will not affect the conservation status of any of the species present and are not expected to be significant.

6.5.3 Fragmentation of fauna habitat

Fragmentation, the process by which initially contiguous areas of habitat are interrupted and/or separated into two or more smaller areas, reducing habitat for individual species (WALGA 2004), this can result in the following detrimental impacts to fauna (Bamford 2019a):

- Remaining smaller parcels of land are unable to support viable populations of species (predominantly larger fauna) as availability of resources is reduced.
- Local extinction of species without the resilience to be self-sustaining due to their:
    - density;
    - reproductive strategy and/or limitations;
    - genetic isolation leading to unviable genetic bottlenecking or genetic drift; or
    - smaller populations of remaining small group of animals succumbing to a singular event, such as influx of predators, disease, or weather event.
- Local extinction of species due to fire, climatic events or disease.
- Disruption of natural behaviour such as dispersal of young, migration etc.
- Additional pressures or hazards on the remaining small populations through:
    - competition for resources;
    - increased concentration of predators due to smaller habitat;
    - fencing limiting fauna movement/escape;
    - proximity to infrastructure and development associated with the Proposal introducing noise, vibrations, lighting, spread of weeds, disease and other edge effects (refer to Section 5); and
    - indirect introduction of additional feral animals such as cats due to future surrounding urbanisation.

The Proposal will fragment fauna habitat through vegetation clearing. Fragmentation of the east-west regional ecological linkage through Ningana Bushland (previously outlined in Section 5.3.7) will impact the viability of local populations of fauna to varying degrees. The impact from fragmentation at the

northern end of the development envelope is expected to have less of an impact given the remaining connection with bushland to the north.

Potential impacts to fauna populations from fragmentation of Ningana Bushland and potential contribution to local declines and extinctions was evaluated for a range of species occurring or with the potential to occur in Ningana Bushland by Bamford (2019a). Given that there are no apparent fauna movement corridors within Ningana Bushland, this evaluation does not discuss disruption of fauna movement corridors but instead focuses on the potential effects of habitat fragmentation.

The Proposal may adversely affect the Brush Wallaby due to its inherently low density (home range areas of 5 to 10 ha, possibly exclusive for males) and inability for the remaining portion of Ningana Bushland to support a viable population and already heavily fragmented and isolated populations on the SCP (Bamford 2019a).

Despite occurring in higher densities that larger macropods, and viable populations potentially being supported in the remaining portion of Ningana Bushland, the Quenda will be vulnerable and could rapidly become locally extinct where the remaining portion of Ningana Bushland is not managed properly.

Habitat fragmentation has a much greater potential to affect SRE species that may be present in the development envelope due to their inherent lack of dispersal capability. This fragmentation of habitat could lead to the restriction of genetic flow within the populations of these SRE species (Invertebrate Solutions 2018a). Other more mobile species have higher dispersal capabilities to move between remnant vegetation patches in an urban mosaic.

Other species that may be impacted by fragmentation include some large reptiles at low population densities (e.g. Carpet Python), birds that may be reluctant to fly across the development (White-breasted Robin, Splendid and White-winged Fairy-wrens, White-browed Scrubwren) and some mammals (Western Grey Kangaroo, Echidna, Brush-tailed Possum, Honey Possum, Moodit (Bush Rat) (Bamford 2019a).

Fragmentation may not impact small invertebrates or reptiles with poor dispersal, as they can maintain viable populations in fragmented landscapes, some birds that can fly over the development and animals such as the Common Brushtail Possum who could potentially cross the rail corridor. Where the Jewelled Ctenotus and Black-striped snake are present, the remaining portion of Ningana Bushland could support a viable population without connectivity (Bamford (2019a). The Graceful Sun Moth is likely to disperse across the proposed rail alignment, however, no evidence has been provided to date to support this assumption. Ningana Bushland is likely to support viable populations of many smaller fauna, though effective management of the reserve may also be required in some cases (Bamford 2019a).

Although the remaining portion of Ningana Bushland could support a viable population of the Grey Kangaroo, vegetation within Ningana Bushland would benefit from exclusion of the species due to the degradation of vegetation that can result from grazing and trampling, particularly where grazing is more concentrated (Bamford 2019a).

In the short term (prior to future urban development), connectivity will remain both within the fragmented portions of Ningana Bushland and also to adjacent remnant vegetation in a north-south direction on either side of the development envelope. It is noted that with future urban development, the east-west connectivity through Ningana Bushland associated with the regional ecological linkage may increase in importance for fauna movements.

In the northern end of the development envelope around the proposed Yanchep Station area, remnant vegetation is already highly fragmented by tracks and new developments associated with the expansion of Yanchep. Remnant patches of native vegetation are smaller and therefore likely to have already been

subject to the effects of fragmentation. Impacts from the Proposal are likely to continue this trend along with continued urban development. However, impacts to habitat connectivity between larger scale landscape features (e.g. connection between the coast and Yanchep National Park) are lower in this area given the availability of habitat immediately to the north of the development envelope.

6.5.4 Degradation of adjacent fauna habitat

The Proposal has the potential to cause indirect impacts to fauna habitat adjacent to the development envelope, from hydrocarbon spills, the alteration of surface water flows and increased sedimentation, introduction of dieback and weed incursions.

Altered surface water flows

There are no surface water features such as rivers, creeks, streams or wetlands mapped within the development envelope. Surface runoff is considered minimal with rainfall rapidly infiltrating the soil and recharging the superficial aquifers (CRC for Water Sensitive Cities 2014). However, the removal of vegetation and excavations for cuttings and the construction of roads, buildings and other hardstand areas could still alter local surface water flows, and earthworks could increase sedimentation in the adjacent vegetation. These processes can impact SRE species such as mygalomorph spiders (if present) by obstructing or flooding their burrows, which are located on the ground (Invertebrate Solutions 2018a). After appropriate stormwater design incorporating WSUD are accounted for during design (see Section 10.6), the risk from these indirect impacts to SRE fauna is low (Invertebrate Solutions 2018a).

Ground and surface water contamination

Invertebrate Solutions (2018a) identifies that contamination of surface water and groundwater during construction and operations could impact SRE fauna habitat adjacent to the development envelope. 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 2018a). It is considered that risks of contamination will be minimised to as low as reasonably practicable by employing appropriate mitigation measures such as bunding and spill management procedures during construction. The risk of contamination by hydrocarbons during operations is minimal as the passenger railway is powered by overhead electrified wires rather than fuel. The trains contain only small quantities of transmission oil with minimal risk of contamination impacts. Without management, the appropriate storm water design alone would reduce the risk of hydrocarbon contamination of water to be low (Invertebrate Solutions 2018a).

Increased spread of weeds and/or disease

Increased local weed incursion and the introduction of dieback into the fauna habitat adjacent to the development envelope may cause the degradation of fauna habitat values. This could have a significant impact upon SRE species that rely on sometimes small microhabitats within the landscape. Weed species and dieback are most likely to be introduced during construction activities.

The potential residual impacts to terrestrial fauna are not expected to be locally or regionally significant.

Increased spread of weeds and/or disease impacts are discussed in Sections 5.5.5 and 5.5.7.

6.5.5 Fauna disturbance

Potential noise and vibration impacts

Noise generated by machinery during construction may disrupt fauna behaviour; however, given the short-term and localised nature of construction noise, it is anticipated that the impacts of noise on fauna will be negligible.

Vibration and noise due to construction and rail operations have the potential to impact terrestrial fauna within direct proximity to the proposed rail alignment. Without management, the risk of vibration during construction and operations impacting terrestrial fauna is expected to be low.

Potential lighting impacts

Research and anecdotal evidence indicate potential for artificial lighting to influence the behaviour of both nocturnal and diurnal species. Without management, light pollution may impact terrestrial fauna species and result in behavioural changes.

6.5.6 Change in feral animal abundance and/or movement

Eight introduced species were recorded during the field survey, including six mammals and two bird species. These were the Red Fox, European Rabbit, House Mouse, Feral Cat, Laughing Kookaburra, Dog (*Canis lupus familiaris*), Feral Pig (*Sus scrofa*), and Laughing Dove (*Spilopelia senegalensis*). All six species are known from the region, however the Dog is likely present as roaming local pets.

The area surrounding the development envelope is already subject to several feral animal species with fox and cat tracks encompassing the development envelope (Bamford 2019b). As such the abundance of these animals is not expected to change following implementation of the Proposal, however is expected to increase with increasing urbanisation. Feral animal movement however may change based on the presence of newly cleared areas from the proposed railway alignment, fragmentation, introduction of fauna crossings, fencing and increasing urbanised areas.

The introduction of a fauna crossing as a proposed mitigation for other impacts (see Section 6.6.1) may change feral animal movements and behaviour along the development envelope. Crossings have been shown to benefit feral predators in facilitating their movement across linear infrastructure and increase their potential to prey on native species that use fauna crossings (Bamford 2019b). This is discussed in further detail in Section 6.6.1.

Without management, feral animals may have a detrimental impact on local native fauna species as a result of the Proposal.

6.6 Mitigation

Table 6-17 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to Terrestrial Fauna to address key potential impacts. (Table 6-17 is located at the end of Section 6.6.1 following the discussion on fauna crossings).

Specific management plans including a CEMP will be developed and implemented for construction and operation of the railway. The CEMP aims to address potential impacts to Terrestrial Fauna and their habitat during the construction phase. The NVMP addresses potential impacts from noise and vibration on sensitive receptors (residential premises) during railway operation, however it may have some indirect benefits for the protection of terrestrial fauna.

6.6.1 Fauna crossings

Initial planning for fauna crossings

A fauna crossing is a connection of at least two significant habitat areas through purpose built, natural corridors or other man-made infrastructure to allow species to move between significant habitat areas separated by human activities or structures.

During early planning of the Proposal, the PTA included the potential to install up to four fauna underpasses within Ningana Bushland to mitigate potential fragmentation impacts. These underpasses

were nominally a box culvert design 1.2 m high x 3 m wide, based on similar underpass designs previously used on other projects in the greater Perth area. The location of these underpasses was restricted to four specific locations along the 2.9 km of rail through Ningana Bushland due to the undulating nature of the existing ground level, cut and fill requirements to install the rail at grade and the design and location of rail infrastructure such as drainage. The width of the rail corridor and development envelope also resulted in proposed fauna underpass length reaching up to 70 m in some locations.

Assessment of initial fauna underpass Proposal

Bamford Consulting Ecologists were engaged by the PTA to review the proposed placement and design of four proposed underpasses to assist in refining the fauna crossing concept. The review considered the following aspects, with findings summarised below:

- The importance of maintaining a connection between the fragmented portions of Ningana Bushland considering the species present or likely to be present.
- The likely efficacy of the four box culvert fauna underpasses, with emphasis on their design and location within Ningana Bushland.
- Potential limitations or negative effects of the fauna underpasses.
- Fauna crossing alternatives to the four box culvert underpasses in Ningana Bushland, including their potential benefits and limitations.
- The potential for fauna to use road bridges over the railway in areas where adjacent urban development has not commenced.

Underpasses are often proposed as a solution to fragmentation but should only be constructed where evidence to support their potential use and positive outcomes outweigh detrimental outcomes. Fauna underpasses are often not suitable as:

- Not all (or even a majority of) fauna species will utilise fauna underpasses.
- Not all fauna are comfortable entering tunnel structures especially if they are long, narrow or offer little/no shelter.
- Incorrect placement or shape potentially poses a hazard or may result in them being unused.
- There is unlikely to be a design/type that would suit all species capable of using the fauna crossing.
- Some fauna species have limited mobility and underpasses may not be accessible because of barriers such as open ground, the underpass is beyond the dispersal range of an individual or are not precisely placed for optimum access.
- Underpasses can equally be utilised by pests or introduced predators to navigate through linear infrastructure; and predators have been shown to prey on native fauna using the underpasses.
- The presence of introduced species around fauna crossings may deter native species from using them or severely impact populations.

An assessment of the potential impacts of fragmentation on key species is provided in Section 6.5.3. No species known to use Ningana Bushland and that would benefit from purpose-built crossings (underpass or overpass) are considered Threatened under State or Commonwealth legislation. Bamford (2019b) identified that the Brush Wallaby and Quenda (Priority fauna) may require or could benefit from maintaining connectivity between the two fragmented stands of habitat.

In some instances, it may be more beneficial to manage remaining fragmented areas rather than install underpasses Bamford (2019b). This includes circumstances where the introduction of underpasses may result in the localised extinction of native species, such as the Quenda, due to predators adapting to targeting Quenda utilising the fauna underpasses. However, Bamford (2019b) suggests that

underpasses would have some conservation application in the Ningana Bushland, primarily for some frogs, larger reptiles and medium-sized mammals (although the latter appear to be absent currently).

Bamford (2019b) drew several conclusions on the likely effectiveness of the proposed box culvert underpasses and compared this with the effectiveness of alternatives. These are summarised in Table 6-15.

Considering Bamford's advice and the narrow design and long length of the four proposed box culvert fauna underpasses initially considered, it is likely constructing the fauna underpasses as originally proposed would result in limited conservation benefit to fauna in Ningana Bushland. Targeted on-ground management may be more critical to biodiversity conservation within Ningana Bushland than maintaining a physical ecological connection across the alignment.

Bamford 2019b considered other fauna crossing options, including alternative fauna underpass designs such as buried arch tunnels, vegetated fauna overpasses, 'natural' (rail bridge) underpasses and rope bridges. **Table 6-15** summarises the advantages and disadvantages of box culvert fauna underpasses for selected species and groups of species and suggests other fauna crossing options.

Table 6-15: Summary of advantages and disadvantages of box culvert fauna underpasses for selected fauna or groups of fauna

Fauna species	Predicted use of underpasses (box culverts)	Potential impact to species without underpasses (box culverts)	Preferred fauna crossing infrastructure (see next section for discussion)
Brush Wallaby *Notamacropus Irma* (Priority 4, DBCA)	Will use box culverts readily	Ningana Bushland may be too small to support a viable population without connectivity	Will use a range of structures: underpasses, vegetated overpasses and bridges.
Quenda *Isoodon fusciventer* (Priority 4, DBCA)	Will use box culverts readily	Ningana Bushland could support a viable population without connectivity, but would be at risk of local extinction from events such as fire	Will use a range of structures: underpasses, vegetated overpasses and bridges.
Jewelled Ctenotus *Ctenotus gemmule* (Priority 3, DBCA)	Use of box culverts probably limited	If the species is present, Ningana Bushland could support a viable population without connectivity	Vegetated overpasses.
Black-striped Snake *Neelaps calonotos* (Priority 3, DBCA)	Use of box culverts probably limited	If the species is present, Ningana Bushland could probably support a viable population without connectivity	Vegetated overpasses.
Graceful Sun-Moth *Synemon gratiosa* (Priority 4, DBCA).	Unlikely to use box culverts	Ningana Bushland could support a viable population without connectivity	Vegetated overpasses but could fly across rail.
Common Brushtail Possum *Trichosurus vulpecula*	Will use box culverts (but may be very vulnerable to predation on the ground	Ningana Bushland may be too small to support a viable population without connectivity, but individuals could scale fencing and cross the proposed rail alignment. The Proposal would not form a barrier	Underpasses, vegetated overpasses, bridges and rope bridges.
Emu *Dromaius novaehollandiae*	Will not use box culverts as proposed	Ningana Bushland too small to support a viable population without connectivity	Large underpasses (minimum approximate 2 m height), vegetated overpasses and bridges.

Fauna species	Predicted use of underpasses (box culverts)	Potential impact to species without underpasses (box culverts)	Preferred fauna crossing infrastructure (see next section for discussion)
Echidna *Tachyglossus aculeatus*	Will use box culverts readily.	Ningana Bushland too small to support a viable population without connectivity.	Underpasses, vegetated overpasses and bridges.
Western Grey Kangaroo *Macropus fuliginosus*	Will use box culverts; possibly only young females.	Ningana Bushland could support a viable population without connectivity, but the population could cause degradation of the native vegetation.	Underpasses, vegetated overpasses and bridges.
Large lizards and snakes	May readily use box culverts.	Species such as Gould's Goanna and Carpet Python may not persist in Ningana Bushland without connectivity. Fence may present a barrier to large specimens but some animals may be able to cross this barrier.	Underpasses, vegetated overpasses and bridges.
Small to medium lizards and snakes	Use of box culverts probably limited. Use assisted by provision of 'furniture' in underpass.	Ningana Bushland could support viable populations without connectivity.	Underpasses, vegetated overpasses and bridges.
Bats	Unlikely to use box culverts for movement, but may roost in them.	Box culverts not needed for connectivity.	Would use vegetated overpasses and bridges, but would fly over railway.
Small, sedentary birds (e.g. White-breasted Robin, White-browed Scrubwren, Splendid Fairy-wren, Grey Shrike-thrush)	Use of box culverts probably limited.	Box culverts of limited value but birds would occasionally fly over the railway.	Would use vegetated overpasses and bridges but would fly over railway at least occasionally.
Moaning Frog *Heleiporus eyrei*	Would readily use box culverts.	Assuming fence of cyclone mesh or similar, the rail would not present a barrier to movement.	Underpasses, vegetated overpasses and bridges. Could also cross proposed rail alignment if fence allows passage.

Source: Bamford (2019b)

Refinement of fauna crossing Proposal

Fauna crossing planning will take into consideration the following aspects:

1. **Fauna.** The fauna crossing will consider potential use by key conservation significant fauna present or likely to be present in Ningana Bushland including species diversity, abundance and usage of Ningana Bushland. Species include:
    a. Brush Wallaby – *Notamacropus irma* (Priority 4, DBCA);
    b. Quenda – *Isoodon fusciventer* (Priority 4, DBCA);
    c. Jewelled Ctenotus – *Ctenotus gemmula* (Priority 3, DBCA);
    d. Black-striped Snake – *Neelaps calonotos* (Priority 3, DBCA); and
    e. Graceful Sun-Moth – *Synemon gratiosa* (Priority 4, DBCA).

    The fauna crossing will also consider the risk of predation from feral animals.
2. **Design.** The number, shape, length, width, vegetation, lighting, fencing, landscaping and furniture of the fauna crossing needs to be considered in relation to predicted use by target fauna and to maintain connectivity. The design will also consider drainage, entry and exit design, fencing, maintenance and landscaping/revegetation requirements.
3. **Location.** In the absence of well-defined fauna movement corridors in Ningana Bushland, the fauna crossing should be placed in an area that links the same habitat on either side of the crossing or in a valley that may provide more shelter (Bamford 2019a). The crossings are intended to be located in areas with topography sympathetic to the crossing infrastructure, i.e. the overpass will preferentially be located in an area where the railway is in a cutting, and the underpass in an area of fill. Engineering constraints, public access and safety are also considerations for location.
4. **Cost.** The associated cost to construct and maintain the fauna crossing will also need to be considered.
5. **Management.** Fauna crossings will require a degree of ongoing management. Additionally, while fragmentation will have some impacts for some individuals or populations of some species, (as discussed above) Bamford (2019a) also found that targeted on-ground management may be more critical to biodiversity conservation within Ningana Bushland than maintaining a physical ecological connection across the alignment and that most fauna crossings would benefit from the ongoing management of Ningana Bushland.

Design alternatives and contingencies

The PTA rail design engineers and environmental planners have considered different options including a ‘natural’ (rail bridge) underpass, vegetated fauna overpass, box culvert or buried arch tunnel underpass designs. **Table 6-16** compares types of fauna crossings and outlines key advantages and disadvantages of each and provides the basis for fauna crossing planning discussions. These considerations, as well as those outlined in the previous section, will continue to inform the planning for fauna crossings including contingencies for alternative design options should the current fauna crossings Proposal need to be amended. In all cases, the PTA will consider how best to mitigate the impacts of fragmenting fauna habitat in Ningana Bushland.

Table 6-16: Fauna crossing types being considered and their potential advantages and disadvantages in Ningana Bushland

Type	Description	Advantages	Disadvantages
No crossing			
No crossings	Most small species would not need the limited population connectivity provided by fauna crossings to maintain genetic diversity across decades, and isolation effects upon larger species (Quenda, Grey Kangaroo) could be offset by occasional management of Ningana Bushland. Suitable management of reserves can help control stressors on fauna from urbanisation. Maintenance and improvement of habitat quality and restrictions on uses of Ningana Bushland which may otherwise lead to degradation and compromise wildlife survival would be key to maintaining the highest carrying capacity of any reserve whether fragmented or not. Of significant importance for maintaining populations of smaller mammals, reptiles and birds is the incursion of introduced species such as foxes, cats and rats. Maintenance of reserves for fauna requires intensive control of all introduced predators.	• No cost for installation and management • Minimises human access • No additional clearing • Will not encourage feral predators or increase predation pressure on target species such as Quenda	• Combined with fencing, the Proposal will be a barrier for some species and possible local extinction for a few fauna species (e.g. Brush Wallaby) • Will require more active management of some species to allow species to persist or to limit population size

Type	Description	Advantages	Disadvantages
Overpasses			
Rope bridges	Referred to as “rope ladders”. Rope bridges can span 25 metres or more and can be staged across the railway linking vegetation on both sides of the development envelope.	• Cover large distances • Can be staged across the railway linking vegetation on both sides • Rope bridges can be used on one or more tower	• Implementation and location highly constrained by railway regulations, mainly because of overhead electrified wires • Several towers are required to raise the rope bridge above railway and any other infrastructure, plus shelters or resting platforms would also be required • Location of rope bridges to be easily accessible to adjacent trees • Suitable for limited number of fauna
Vegetated fauna overpasses	This type of overpass is vegetated on top of the structure and designed to allow for sustained plant growth.	• Offer a semi-natural shelter and foraging opportunities for a wide range of species including birds and herpetofauna • Highly effective	• High investment in design to ensure sustained plant growth • Expensive • Provides short-term connections for species • Exposure and vulnerability to predation • Foxes and cats will adapt to open concreted surfaces • Provides short-term connections for fauna species

Type	Description	Advantages	Disadvantages
Underpasses			
'Natural' (rail bridge) underpasses	Natural vegetation that is recreated below any bridge to maintain habitat connectivity and provide shelter and foraging opportunities. These large areas of habitat created can offset the total area of habitat lost to the Proposal.	• High use by diverse range of species due to the large opening provided by these bridges • Clearing beyond rail footprint may not be required • Vegetation can be retained and/or revegetation can be implemented • Drainage infrastructure not required • Low maintenance cost	• Expensive • Habitat under bridges is limited to where light levels can be maintained for photosynthesis • Difficult to control human access • Will be used by feral predators that may target native fauna

Type	Description	Advantages	Disadvantages
Box culverts	Box culverts are constructed from reinforced concrete and are designed to take traffic loading at a reduced height of fill. Box culverts consist of a U-shaped section with a separate lid slab. For the purpose of fauna crossings, the U-shape section is inverted onto a concrete base (or footing) to form a tunnel. These underpasses been used as underpasses in Europe, Canada, the USA and, more recently, in Australia. 	• Box culverts ranging in size up to approximately 3 m x 3 m allows for use by species such as kangaroos, wallabies and possums • Allow for unobstructed views of habitat on each side of the passage • Lowest cost of fauna connection options • Can be fitted with 'furniture' to provide cover • Clearing beyond development envelope not required • Limited human access depending on size	• Landscaping around the entrance of the underpasses is required to ensure fauna can move from the natural bushland to the entrance of the underpass without being deterred from crossing open space • May be subject to inundation if located in drainage lines • May be subject to puddles or pond formation deterring species from using the passage • Subject to substrate washout • Concrete floor does not allow for vegetation growth • Feral predators may target fauna using underpass • Length will limit fauna use • Restricted location options along the proposed rail alignment • May require fauna monitoring • May require ongoing maintenance.

Type	Description	Advantages	Disadvantages
Buried arch tunnels	There are two types of buried arch tunnels used as fauna connections: • precast concrete arch (referred to as BEBO tunnel) • multi plate steel arch. These two systems are often used in conjunction with box culverts, particularly when facilitating movement by a wide range of fauna species along long stretches of highway. The arch tunnels are commonly used to traverse creeks when bridge structures are impractical, or where it is important to gain the maximum width and height for the underpass design. 	• Large, open underpasses documented to be very successful as they are used by a diverse range of native species • Potential to be improved with the placement of 'furniture' • Openness allows adequate light • Provides greater view to habitat at each end • Small 'courtyards' that are open to sunlight could be formed between the railway lines which may help some vegetation grow half way through the tunnel and effectively reduce the length of the underpass • In situations where the tunnel length will exceed 20 m, buried arch style underpasses that provide openings greater than 6 m can allow the passage of the greatest number of species.	• Entrances should be Sited close to vegetation or vegetation planted up to the tunnel entrances to give shelter for species that don't readily cross open ground • Size may be overwhelming for some animals, because large areas of open ground need to be traversed • Accessibility to prey by predators is higher because of the open areas.

Adapted from Bamford (2019b).

Table 6-17: Application of mitigation hierarchy for terrestrial fauna

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Loss of fauna habitat	• Development envelope was modified during the design phase to avoid the direct impacts to Bush Forever site No. 130, Bush Forever Site No. 288 and nearby parks and reserves potentially containing fauna habitat • 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 Local Structure Plan, to avoid direct impacts to native vegetation which may have otherwise been able to be retained within future Public Open Space (POS) reservations.	• Implementation of a CEMP that will include the following measures as a minimum: • restrict clearing to the approved development envelope to avoid over-clearing and to minimise indirect impacts to adjacent remnant vegetation and Carnaby's Cockatoo habitat • SRE management measures including: ○ weed management measures ○ dieback management actions ○ revegetation using locally endemic species and replacement of topsoil which may allow any eggs/larvae/dormant stages of some SRE's to recolonise previously cleared areas ○ dust control ○ chemical and hydrocarbon storage and management ○ managing changes to surface hydrology as far as practical and preventing additional water discharge into non-impact areas during construction • Should the batters be of a suitable gradient and material and not required	Not applicable	• Permanent loss of a total of 61.68 ha of terrestrial fauna habitat, consisting of 47.5 ha of high value and 14.2 ha of medium value habitat. • Permanent loss of 56.31 ha of Carnaby's Cockatoo habitat, consisting of 22.56 ha of high value and 33.75 ha of medium value foraging habitat, including 2.13 ha of potential breeding habitat and permanent loss of 45 potential breeding trees.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		for operational infrastructure purposes, they will be stabilised with planting of locally endemic species where possible and/or bioengineering controls. Species selection will be considerate of creating habitat for Carnaby's Cockatoo in areas further than 10 m from the railway.		
Injury/mortality of fauna	• Not applicable.	• Implementation of a CEMP that will include the following measures: • undertake progressive clearing to allow fauna to move away from clearing activities • pre-clearing survey for potential black-cockatoos prior to construction works • accurately delineating the approved clearing boundary to provide accuracy to the limits of the allowable clearing lines • further contingency measures to be developed in consultation with DBCA and implemented to avoid or minimise impacts to significant fauna if identified during searches	Fauna injured during fauna habitat clearing will be rehabilitated by a wildlife carer, where practicable.	Loss of fauna individuals during clearing of fauna habitat.
Fragmentation of fauna habitat	• Not applicable	• Installation of two fauna crossings to maintain the local east-west habitat connectivity for the long-term movement of native fauna in Ningana Bushland.	Not applicable.	• Loss of 28.82 ha of Bush Forever site 289, consisting of 27.71 ha of native vegetation in Degraded or better condition with the

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
				remaining 1.09 ha comprising native vegetation in Completely Degraded condition, planted species and cleared areas. • Permanent fragmentation of Ningana Bushland and regional ecological link No. 0.
Adjacent fauna habitat degradation	• Not applicable	• Stormwater and surface water management measures and controls will be designed with consideration of best practice WSUD principles, maximising infiltration at source. • Preparation and implementation of a CEMP that includes the following management measures: • fuel and other chemicals will be stored in correctly labelled containers and used in designated areas only. • disposal of hazardous materials to be in accordance with regulatory requirements; • provision of spill kits at the designated storage and use areas; and • provision of training where required, in the safe use, handling and disposal of hazardous materials	Not applicable.	No predicted residual impacts.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		• restrict clearing to the approved development envelope to avoid over-clearing and to minimise indirect impacts to adjacent remnant vegetation • weed management measures • dieback management actions • dust control.		
Fauna disturbance	• Not applicable	• Implement the NVMP (Lloyd George Acoustics 2018a; Appendix L) to address the potential noise and vibration social impacts during the operation of the railway line. These mitigation measures are also applicable to terrestrial fauna, including: • regular inspections of the rail condition and rail rectification / grinding by the PTA to remove excessive roughness or corrugation which may develop over time • installing ballast matting adjacent to all existing and approved future residential developments to address experiences with structure-borne regenerated noise issues (rumbling) as trains pass by. • A CEMP will also be implemented during construction to ensure that noise will be managed through the *Environmental* Protection (*Noise)*	Not applicable.	Potential risk for excessive noise and vibration is as low as reasonably practicable.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		Regulations 1997 Regulation 13 – "Construction sites"		
Change in feral animal abundance and/or movement.	• Not applicable	• Feral animal management measures are being considered in parallel with the fauna crossing option and will form part of the overall fauna crossing commitment and strategy.	Not applicable	Change in feral animal movement and/or behaviour due to Proposal.

Current fauna crossing Proposal

Initial considerations for fauna crossings have evolved with the development of the Proposal. A workshop was held involving the Proposal's design team, technical advisors Bamford Consulting Ecologists and a representative from DWER (EPA Services) on 7 March 2019. Design parameters of both the Proposal and potential fauna crossings were refined to maximise the predicted use by fauna at Ningana Bushland.

The PTA will install two fauna crossings within Ningana Bushland. The current fauna crossing Proposal is for:

- one vegetated fauna overpass in the northern part of Ningana Bushland; and
- one fauna underpass in the southern part of Ningana Bushland.

The fauna overpass is intended to have the following design characteristics:

- the minimum width traversable by fauna is 3 m;
- fencing at the edges of the overpass;
- drainage design with intention to minimise erosion impacts;
- vegetation plantings to be investigated by the PTA based on the available topsoil depth;
- shelter for fauna on the overpass;
- public access to be limited to pedestrian access only.

The fauna underpass is intended to have the following design characteristics:

- a maximum length (entry to entry) of 70 m but with the possibility of reducing length to as short as 40 m to maximise fauna use subject to further design;
- a maximum height of 1.2 m (internal) to allow for optimal usage by a wide range of species including the Western Grey Kangaroo and Quenda, as well as to inhibit public access;
- a minimum width of 2.4 m and optimal width of 3 m, to allow for more open space for Western Grey Kangaroo usage and areas with shelter for smaller species of lizards and frogs;
- landscaping or revegetation around entry and exit points to provide cover for fauna and maximise usage, with potential to include artificial shelter;
- provision of shelter or other 'furniture' within the underpass to increase the likelihood of usage by smaller species. Natural furniture may include recycled logs, rocks and leaf litter. Artificial furniture may include PVC pipes;
- installation of drainage to prevent pooling of water within the underpass, with potential for construction of an elevated area along the length of the underpass. Adjacent drainage infrastructure will be fenced to prevent fauna access;
- installation of fencing to direct fauna to the underpass opening and prevent access to the railway; and
- natural lighting of the underpass will be facilitate through entry and exit design. Skylights and artificial lighting will not be installed due to design restrictions beneath an operating railway.

Following the workshop on 7 March 2019, Bamford Consulting prepared a memorandum considering the suitability of the above proposed design for the two fauna crossings (Bamford Consulting 2019c; Appendix R). The Bamford Consulting (2019c; Appendix R) memorandum advised that the above design characteristics would be suitable for maintaining the connectivity of populations in Ningana Bushland, recommended installation of cover, fencing drainage to maximise fauna usage. Bamford Consulting (2019c) indicates that the application of these fauna crossing design principles will maximise the usefulness of the crossings by fauna.

The PTA notes that this fauna crossing Proposal is subject to change as the Proposal is further refined.

6.7 Predicted outcome

The residual impacts of the Proposal in relation to terrestrial fauna include:

- Permanent loss of
  - A total of 61.68 ha of terrestrial fauna habitat, consisting of 47.45 ha of high value and 14.23 ha of medium value habitat.
  - 28.82 ha of Bush Forever Site No, 289 (Ningana Bushland).
  - 56.31 ha of Carnaby's Cockatoo habitat, consisting of 22.56 ha of high value and 33.75 ha of medium value foraging habitat, including 2.13 ha of potential breeding habitat, and 45 potential breeding trees.
- Fragmentation of fauna habitat within Bush Forever Site No. 289 (Ningana Bushland).
- Injury and/or mortality of fauna during clearing activities and construction and operation of the proposed railway.

The following potential impacts will be managed through the implementation of a NVMP and CEMP:

- Degradation of adjacent fauna habitat during construction and operations.
- Disturbance to fauna from noise and vibrations during construction and operations.
- Change in feral animal abundance and/or movement.

Through the implementation of the EPA's mitigation hierarchy (Section 6.6 and **Table 6-17**), the residual impacts of the Proposal to terrestrial fauna and their habitats are as low as reasonably practicable. With the exception of impacts to Carnaby's Cockatoo, where there is a loss in potential foraging and breeding habitat considered necessary to maintain the species, residual impacts are not considered significant. Offsets are proposed to counterbalance the significant residual impacts to Carnaby's Cockatoo associated with habitat clearing. The appropriateness of the proposed offset to achieve this objective is discussed in Section 13.

The PTA has undertaken fauna studies and assessments, considered mitigation to reduce potential impacts to fauna, is proposing to implement a Proposal specific NVMP and a CEMP to further reduce the potential impacts to fauna, and residual impacts to Carnaby's Cockatoo will be addressed via the provision of an Offset Strategy in accordance with EPA and DoEE requirements.

Given this and the PTA's past performance in implementing appropriate mitigations measures as part of the construction and operation of railway projects, the PTA considers that the Proposal can be managed to meet the EPA's objective for terrestrial fauna.

7 Subterranean fauna

7.1 EPA objective

The EPA's objective for subterranean fauna is to protect subterranean fauna so that biological diversity and ecological integrity are maintained (EPA 2018e).

7.2 Policy and guidance

The following policies and guidance are relevant to the Subterranean Fauna factor:

- *Environmental Factor Guideline – Subterranean Fauna* (EPA 2016g)
- Technical Guidance – Subterranean fauna survey (EPA 2016h)
- Technical Guidance – Sampling methods for subterranean fauna (EPA 2016i).

7.3 Receiving environment

Subterranean fauna is a collective term referring to animal species that live beneath the surface of the earth across their entire lifecycle (EPA 2016h). There are two types of subterranean fauna:

- Stygofauna: aquatic subterranean species that live in groundwater systems such as interstitial spaces, vugs and fissures
- Troglofauna: terrestrial subterranean species that live in subsurface voids such as caves and breathe air.

The presence of subterranean fauna is strongly linked to the geology and hydrology of the surrounding environment, e.g. the availability of suitable air-filled voids, or aquifers that are not hypersaline (EPA 2016h).

7.3.1 Previous studies

Three desktop and field studies have been undertaken to determine the likelihood of subterranean fauna occurring within the development envelope and surrounding regional area. These studies are as follows:

- Northern *Suburbs Railway Alignment Butler to Yanchep Environmental Investigation* (GHD 2012):
  - desktop assessment for the YRE Project and field assessment for a portion of the development envelope (YRE Part 2) comprising 22.42 ha between the southern boundary of Bush Forever Site 289 (Ningana Bushland) and Yanchep Beach Road to assess the presence of surface expressions of karstic features which would indicate presence of suitable habitat for subterranean fauna; and
  - field work comprised one day in November 2010 and October 2012.
- *Geotechnical Investigation Report - Yanchep Rail Extension* (Advisian 2017):
  - desktop assessment and geotechnical field survey for the extent of the YRE Project (YRE Part 1 and Part 2 development envelopes); and
  - field work comprised four days in March 2017.
- Desktop Review and Risk Assessment of Subterranean Fauna for the Yanchep Rail Extension, Western Australia (Invertebrate Solutions 2018b):
  - desktop study area defined spatially using a rectangle bounded by the northwest corner (31°21'00"S 115°30'00"E) and the southeast corner (31°54'00"S 116°10'15"E);

- desktop study area is similar in size to the spatial extent of the northwest Sub-region; and
- desktop review was undertaken in May 2018.

The likelihood assessment of subterranean fauna at the local scale has focussed on Yanchep National Park, Ningana Bushland and Neerabup National Park, while assessments at the regional scale included the SCP (Figure 7-2).

The studies conducted to date are considered adequate to inform the regional and local significance of subterranean fauna habitat from the Proposal as:

- field survey effort across the studies cover the entire YRE Project;
- studies have been informed by the collective use of a range of sources of information including:
  - review of published and unpublished reports concerning subterranean fauna from the region;
  - available geological maps and geotechnical and hydrogeological information known to correlate with the presence of subterranean fauna habitat;
  - use of government databases including Protected Matters Search Tool (PMST) from the Federal Government's DoEE; and
  - records of fauna held by the Western Australian Museum
- studies are relatively consistent in terms of likelihood for subterranean fauna within and surrounding the development envelope.

Assessment of potential impacts to subterranean fauna at a regional or local scale has been undertaken using existing information presented in previous studies. Additional surveys for subterranean fauna specific to the Proposal are not necessary based on the low diversity and abundance of subterranean fauna in the local area and across the SCP (T. Moulds 2018, pers. comm. 13 December) (further outlined in Sections 7.3.2 and 7.3.3). Furthermore, the scope of the Proposal has not changed since previous studies were undertaken so there are no new potential impacts to be considered for assessment, and the Proposal has a low likelihood of impact to both stygofauna and troglofauna due to:

- The shallow depth of excavation (approximately 5 m within Tamala limestone).
- No groundwater dewatering or abstraction is proposed for this Proposal.

7.3.2 Regional context

Regional context for subterranean fauna has been considered at the scale of the study area assessed by Invertebrate Solutions (2018b) presented in **Figure 7-1**. The known and potential habitat for subterranean fauna in the region was inferred by the geology and geomorphology present. The region's geology is predominantly sands, of which a significant proportion has been cemented to form limestone rock and conversely, some of which has weathered and eroded back into sands (Advisian 2017). There is a close association between the surface distributions of the various geological units in the area with particular geomorphic divisions (i.e. the Spearwood dune system is generally associated with Tamala Limestone and Tamala Sand geological units, and the Quindalup dune system is predominantly associated with the Safety Bay Sand geological unit) (Advisian 2017). Within the Tamala Limestone, post-depositional features associated with leaching and dissolution of carbonate from the limestone are common and can result in open cavities and voids (Advisian 2017) which may provide habitat for both stygofauna (if within the saturated zone and water quality is suitable) and troglofauna (Invertebrate Solutions 2018b). In contrast, the Tamala Sand and Safety Bay Sand units provide limited habitat potential for subterranean fauna due to their unconsolidated nature and lack of interstitial voids (Invertebrate Solutions 2018b).

Known subterranean diversity on the SCP is low compared with other regions of Western Australia such as the Pilbara and Mid-West (Invertebrate Solutions 2018b). Regionally, however, significant subterranean fauna habitat exists within the Yanchep National Park and immediately adjacent areas which include over 400 cave systems and known occurrences of the State endorsed TEC and EPBC Act listed '*Aquatic Root Mat Community of the Swan Coastal Plains TEC'* (Aquatic Root Mat Community TEC) associated with root mats from Tuart trees (*Eucalyptus gomphocephala*) in pools and streams fed by groundwater from the Gnangara Mound (Invertebrate Solutions 2018b). These areas are also associated with areas which have a higher likelihood of karstic geological features (**Figure 7-2)**.

Troglofauna are known to occur within void spaces or fractured geological units, especially where transmissivity is high such as in karst. There is a low likelihood of troglofauna being present within the Safety Bay Sands due to a lack of interconnected voids (Invertebrate Solutions 2018b). It is still possible that troglofauna may occur within micro and meso-caverns or interstitial spaces not necessarily associated with large karstic features (GHD 2012) and; therefore, it is likely lower value habitat exists regionally, particularly where karstic Tamala Limestone is present (Invertebrate Solutions 2018b).

7.3.3 Local context

Records of subterranean fauna

No stygofauna or troglofauna records are present within the development envelope (Invertebrate Solutions 2018b). Previous studies identify that subterranean fauna are not restricted to the development envelope, and there is high value habitat present in adjacent conservation areas (GHD 2012, Advisian 2017, Invertebrate Solutions 2018b).

Potential habitat

The development envelope intersects potential lower value habitat to the west of Yanchep National Park (Invertebrate Solutions 2018b) (Figure 7-2) outside the high-risk karst area. No large scale karstic features such as sinkholes or caverns, which provide potentially significant habitat resources for subterranean fauna were identified within, or close to the Proposal (GHD 2012, Advisian 2017). The development envelope broadly comprises Safety Bay Sand and lake deposit geological units. Safety Bay Sand provides limited habitat potential for subterranean fauna due to the unconsolidated nature and lack of interstitial voids. However, surrounding areas from the Proposal contain Tamala Limestone, which commonly contains dissolutions (voids and cavities) which may provide potential habitat for both stygofauna (in saturated zones) and troglofauna (above groundwater level) (Invertebrate Solutions 2018b). As the Proposal predominantly comprises Safety Bay Sand (**Figure 7-3**) there is limited potential for karstic voids and cavities to form habitat for subterranean fauna. In addition, no troglofauna or stygofauna records were identified within the development envelope (Invertebrate Solutions 2018b). As such the Proposal contains limited habitat for subterranean fauna species.

Extensive surveys since the mid-1990s have been undertaken to locate additional records of the Aquatic Root Mat Community TEC; however, only six locations within high likelihood karstic geological areas within Yanchep National Park were identified (Invertebrate Solutions 2018b) and none of the identified locations of the Aquatic Root Mat Community TEC occur within the development envelope (Invertebrate Solutions 2018b).

The development envelope does not intersect Yanchep National Park (**Figure 7-3).** The Aquatic Root Mat Community TEC is directly associated with Tuart tree roots, which are almost completely absent from the development envelope (Invertebrate Solutions 2018b). The total area of Tuart vegetation within the development envelope comprises 2.13 ha of *Eucalyptus gomphocephala* tall woodland (VT06), located

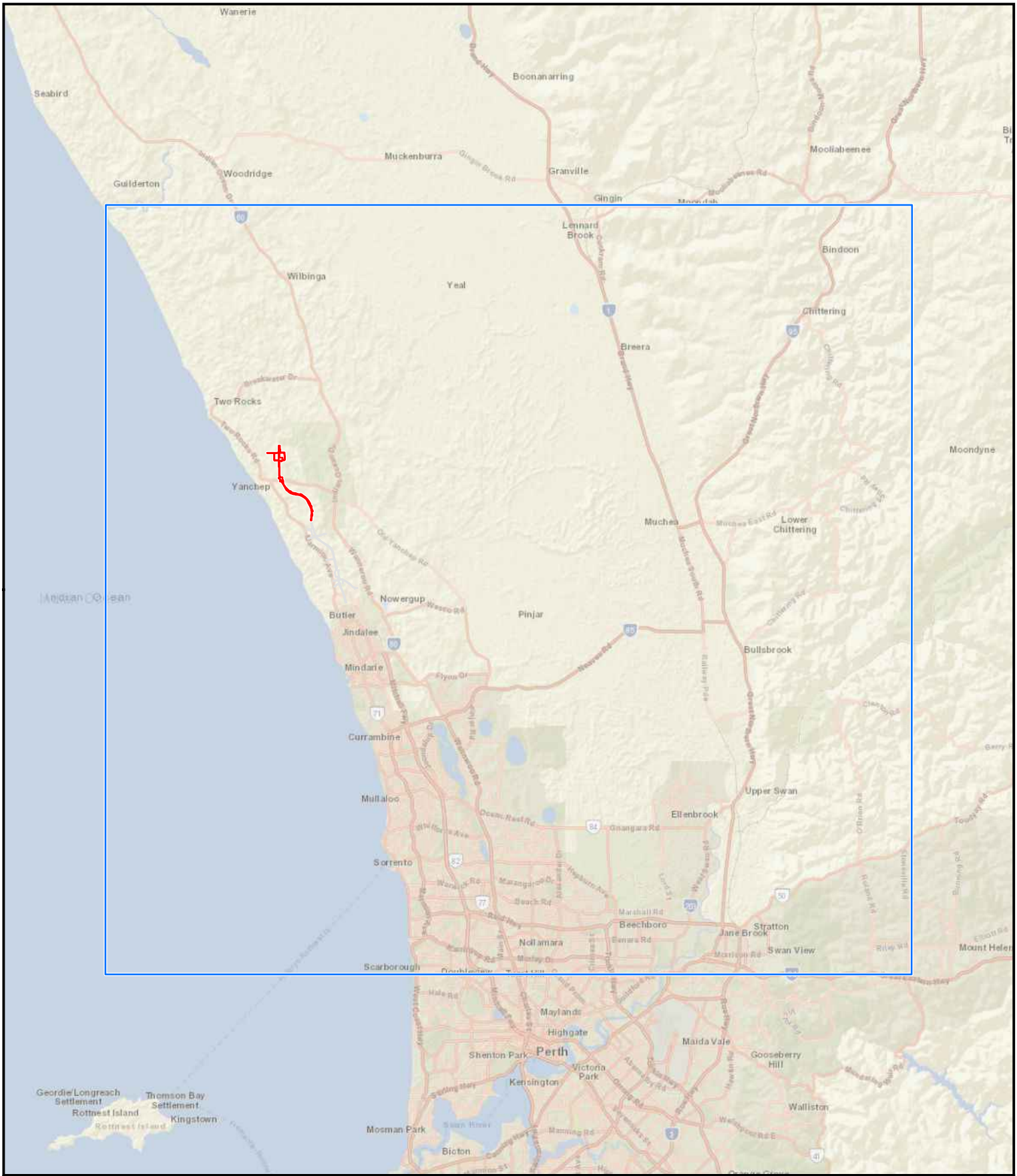
on low karst risk areas (Invertebrate Solutions 2018b). As a result, it is considered highly unlikely that the Aquatic Root Mat Community TEC occurs within or close to the development envelope for the following reasons:

- all occurrences of Tuart vegetation are located in low likelihood karstic geological areas
- extensive historical survey for the Aquatic Root Mat Community TEC confirms their absence outside caves within and adjacent to Yanchep National Park
- none of the identified locations of the Aquatic Root Mat Community TEC occur within the development envelope
- the high depth to groundwater within the development envelope.

The Aquatic Root Mat Community TECs are therefore not discussed further within this chapter.

In summary, the potential for subterranean fauna habitat within the development envelope is limited as:

- there are no established caves or areas of clay flats within the development envelope
- there are no records of troglofauna or stygofauna within the development envelope
- the development envelope comprises predominantly Safety Bay Sand, where there is limited potential for karstic voids and cavities to form habitat for subterranean fauna
- the development envelope does not intersect Yanchep National Park or any high-risk karst areas that could provide potentially significant habitat resources for subterranean fauna
- no Aquatic Root Mat Community TECs occur within the development envelope and groundwater dewatering and abstraction are not proposed for this Proposal.



Yanchep Rail Extension (Part 2)
Figure 7-1 Subterranean Fauna Study Area

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Desktop Study Area

Date Printed: 23/01/2019
Created By: David Fotheringham
Scale 1:400,000

N

0 0.25 km

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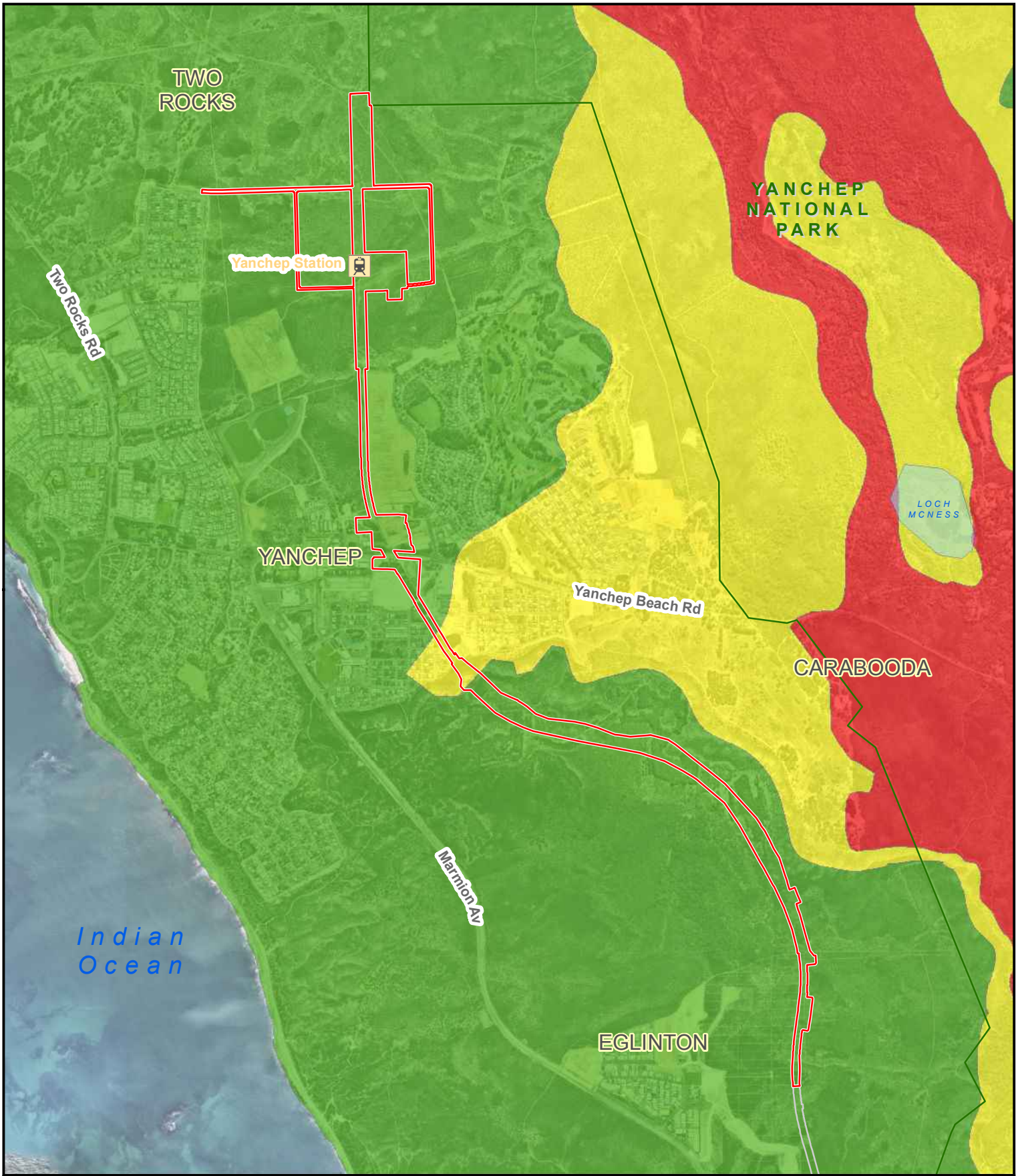
Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community



Yanchep Rail Extension (Part 2)
Figure 7-2 Karstic Geology Likelihood

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Surface Water Feature
- Proposed Station

Likelihood of Karstic Geology

- High
- Medium
- Low

Date Printed: 12/12/2018
Created By: David Fotheringham
Scale 1:30,000

N

0 0.25 0.5 1km

Reference: City of Wanneroo Local Biodiversity Plan 2018/19-2023/24 (360 Environmental, 2018)

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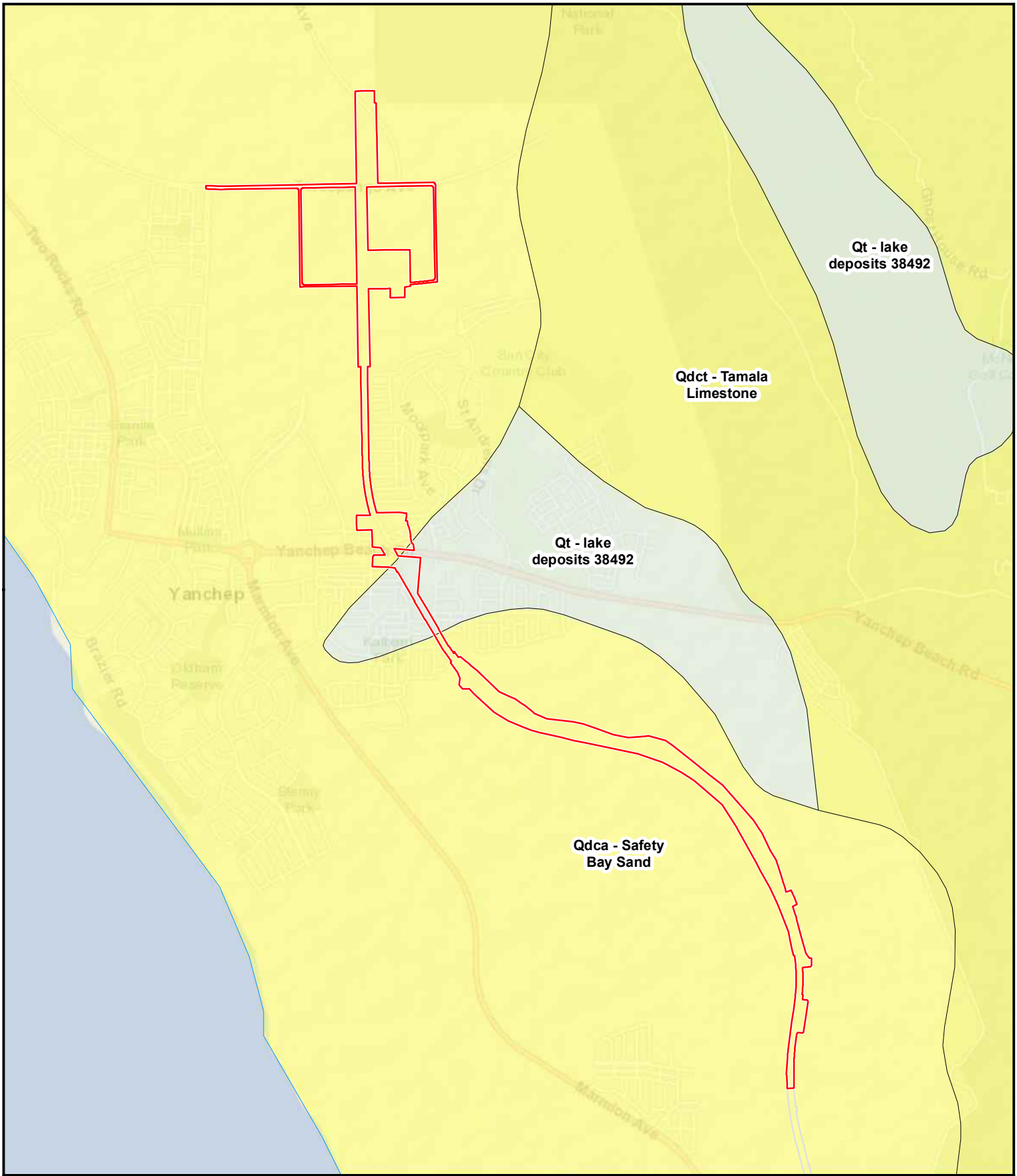
Base Data: Nearmap 2018, City of Wanneroo Local Biodiversity Plan 2018/19-2023/24, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community



Yanchep Rail Extension (Part 2)
Figure 7-3 Geology Representation

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1

WA Surface Geology lines - 1:1,000,000

- Coastline
- Geological boundary

WA Surface Geology polygons - 1:1,000,000

QUATERNARY

- Qdca
- Qdct
- Qt

Date Printed: 23/01/2019
Created By: David Fotheringham
Scale 1:30,000

N

0 0.25 0.5 1km

Geological Data
© State of Western Australia (Department of Mines, Industry Regulation and Safety) 2017

Document Path: Y:\ENVIRONMENTAL\Sam\06_Yanchep\02_MXDs\20181128_ERDReportFigures_Part2\Fig7_3_Geology.mxd
Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
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7.4 Potential impacts

The Proposal has the potential to directly and indirectly impact on subterranean fauna during construction and operation phases.

The permanent loss of subterranean fauna habitat due to excavation during the construction phase has been identified as a direct impact to potentially occur.

The following indirect impacts to subterranean fauna habitat have the potential to occur:

- Alteration of surface and subsurface hydrology due to clearing, excavations, construction of roads, building and other hardstand areas during construction may increase sedimentation into the subsurface environment.
- Fragmentation of subterranean fauna habitat and loss of ecological connectivity.
- Elevated concentrations of contaminants in water due to chemical or hydrocarbon spills during construction and/or operation.

7.5 Assessment of impacts

Sections 7.5.1 to 7.5.5 present an assessment of predicted direct and indirect residual impacts on Subterranean Fauna after the mitigation hierarchy has been applied (outlined in Section 7.6).

Impacts have been assigned a level of either 'Low', 'Moderate' or 'High' according to their potential degree to adversely affect the EPA's objective outlined in Section 7.1. Where an impact is designated as 'Low' no further consideration was given to the potential impact.

7.5.1 Permanent loss of subterranean fauna habitat due to excavation and construction activities

Construction activities associated with the Proposal have the potential to reduce subterranean fauna habitat from clearing of native vegetation and cut and fill activities. Overall impacts are expected to be low (Stygofauna) to moderate (troglofauna) due to the generally shallow depths of excavation (Invertebrate Solutions 2018b).

The Proposal involves excavation within the development envelope approximately 25 m above the local groundwater level. The maximum depth of excavation from the natural surface is 13 m at chainage 51.5 km, which is located in the northern section of Ningana Bushland, whilst the average depth is between 5 to 6 m (Invertebrate Solutions 2018b). Excavation will directly remove habitat for troglofauna, and indirectly affect troglofauna due to increased drying of rock surrounding excavation areas. The removal of vegetation may also contribute to a reduction of organic carbon entering the subterranean environment (Invertebrate Solutions 2018b). Ongoing operation of the railway may also result in vibration impacts to the surrounding environment. These impacts are considered to be moderate as impact will be limited generally to the upper few metres below natural ground level and mostly will be removing sand units (Safety bay Sands) in low likelihood of karstic geological feature areas that contain no troglofauna habitat (Invertebrate Solutions 2018b).

The destruction of significant caves or large voids during construction or excavation works may also have potential impacts upon subterranean fauna, especially troglofauna. The discovery of significant caves or voids during excavation will be specifically addressed in the CEMP.

In a regional context, the removal of small amounts of Tamala Limestone would be negligible in terms of its extent on the SCP. In addition, cumulative impacts on the SCP are expected to be minimal as the

known subterranean diversity is low compared with other regions of Western Australia (Pilbara and Mid-West) (Invertebrate Solutions 2018b).

Given the narrow linear nature of the Proposal and better quality subterranean habitat values in surrounding conservation estates such as Yanchep National Park the Proposal and the cumulative impact of the YRE Project to subterranean fauna is anticipated to be minimal. In the northwest subregion, ULDO data shows approximately 1,350 ha of developments in next five years with 848 ha (63%) conditionally approved. Within 1 km of the Proposal, these figures are 410 ha and 109 ha (27%) respectively. Given the similar geology and geomorphology of the local and regional area and assuming some excavation and dewatering will be required to service future developments, there is significant potential for excavation of the underlying Tamala Limestone to impact on potential subterranean fauna habitat. Considering that the combined YRE Project will have a development envelope of 143.11 ha, the Proposal and the greater YRE Project is a small contributor to the likely cumulative impacts to subterranean fauna in the short and long terms when considering the extent of future residential developments proposed for areas adjacent to the alignment.

The average depth to groundwater from the natural ground surface within the development envelope is approximately 23 m. The minimum depth from ground level to the groundwater level is approximately 10 m within Ningana Bushland (Invertebrate Solutions (2018b) and ranges between 28 to 48 m in the surrounding area. Cut and fill activities will generally occur within approximately 5 m of the natural ground surface and therefore no dewatering is proposed as part of the Proposal. As such, the average depth to groundwater from the natural ground surface (approximately 23 m) is significantly greater than the average cutting works required within the development envelope. In addition, the PTA has removed the requirement for groundwater abstraction from this Proposal. In summary the temporary loss of subterranean fauna habitat is expected to be low as dewatering and abstraction are not required for the Proposal.

7.5.2 Alteration of surface and subsurface hydrology

The alteration of surface and subsurface hydrology from excavation and construction of roads, buildings and other hard stand areas within the development envelope may potentially increase sedimentation into the subsurface environment (Invertebrate Solutions (2018b).

These indirect impacts have the potential to have a moderate impact upon troglofauna by filling micro and meso caverns habitats. Construction of the Proposal and the installation of infrastructure also has the potential to result in altered infiltration of rainfall and subsequent groundwater recharge, locally.

However, no dewatering is proposed for the construction of the Proposal, and through the application of appropriate stormwater design incorporating WSUD initiatives and implementation of a CEMP the potential impact is considered by Invertebrate Solutions (2018b) to be low.

Likely cumulative impacts to surface and subsurface hydrology include those described above, in addition to impacts expected to arise from approved and proposed future residential developments. These will likely include altered infiltration of rainfall, altered groundwater recharge and surface water flows. When considering the impacts of future residential development, the Proposal will be a minor contributor to local and regional cumulative impacts to surface and subsurface hydrology.

7.5.3 Fragmentation of subterranean fauna habitat and loss of ecological connectivity

Given the narrow linear nature of the Proposal and the high depth to groundwater it is considered unlikely that the project will impact on stygofauna and troglofauna habitat and therefore presents no risk to the

fragmentation of habitat. As there are similar or better subterranean habitat values present in surrounding conservation estates (including Yanchep National Park), it is not expected that the Proposal would result in local extinction of subterranean fauna species.

The risk of fragmentation of subterranean fauna habitat and loss of ecological connectivity from the Proposal is therefore considered low.

7.5.4 Groundwater contamination due to spills

Contamination of groundwater from hydrocarbon/chemical spills during construction and operations may indirectly impact subterranean fauna habitat. The potential for contamination during construction is limited to isolated areas of chemical storage and small quantities of hydrocarbons where machinery or generators are operating. The risk of contamination during operations is minimal as the passenger railway operates via electricity supplied by overhead wires, rather than stored fuel on the trains. The trains contain small quantities of transmission oil and; therefore, present minimal risk of contamination.

The majority of the development envelope is remnant native vegetation with few or no sources of potential groundwater contamination other than potential, isolated illegal dumping which is expected to be minimal. Given the limited reliance on chemicals and fuel, the Proposal is considered unlikely to contribute to cumulative impacts to groundwater contamination.

7.5.5 Cumulative impacts from the Proposal

Cumulative impacts on the SCP are expected to be minimal as the known subterranean diversity is low compared with other regions of Western Australia (Pilbara and Mid- West). The primary cumulative impacts from the Proposal is land clearance and altered hydrology, however, these developments are relatively small in the scale of northern SCP, so cumulative impacts are assessed as being low. No abstraction or dewatering is required for the Proposal. It is not anticipated that the Proposal will add significantly to the cumulative impacts to subterranean fauna in the local area.

7.6 Mitigation

The key mitigation strategies to minimise direct and indirect impacts to subterranean fauna include avoidance of excavation and disturbance work below the local groundwater level, no use of dewatering or abstraction to facilitate construction of the Proposal and implementation of a CEMP to manage direct and indirect impacts from the Proposal to subterranean fauna and their habitat during the construction phase. The PTA also operates in accordance with their environmental management system, which establishes standard environmental management practices. Construction contractors will be required to prepare CEMPs in accordance with the environmental management system.

Table 7-1 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to Subterranean Fauna to address key potential impacts.

Table 7-1: Application of mitigation hierarchy for subterranean fauna

Potential Impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Permanent loss of subterranean fauna habitat due to excavation and construction activities.	Excavation and disturbance works occur above groundwater, avoiding direct impacts to groundwater. Proposal avoids disturbance works in high karst risk areas associated with high value subterranean fauna habitat.	Implementation of a CEMP – action items to include: • Measures to address the destruction of significant caves or large voids during construction. • Prior to the commencement of construction activities, a further detailed geotechnical investigation will be undertaken to supplement and validate the preliminary baseline findings. • Actions to address the discovery of significant caves or voids during excavation. • Clearing/disturbance to remain within approved development envelope.	Not applicable.	Following the application of mitigation measures, no predicted residual impacts are expected from excavation/disturbance activities. The Proposal can be managed to meet EPA's objective for subterranean fauna through the implementation of a CEMP. The Proposal will not result in significant residual impacts to subterranean fauna from excavation/disturbance activities.
The alteration of groundwater levels during construction due to abstraction may impact on subterranean fauna habitat.	Dewatering and abstraction are not proposed for the construction of the Proposal.	Implementation of best practice WSUD principles in the detailed design phase and the stormwater management approach for the Proposal will facilitate at-source infiltration to maintain the predevelopment hydrological regime and control the quality of stormwater recharged to the groundwater aquifers.	Not applicable.	Following the application of avoidance and mitigation measures, no predicted residual impacts are expected to groundwater levels during construction. The Proposal can be managed to meet EPA's objective for subterranean fauna through the implementation of a CEMP. The Proposal will not result in significant residual impacts to subterranean fauna.

Potential Impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Alteration of surface and subsurface hydrology may increase sedimentation into the subsurface environment	Dewatering and abstraction will not be required to facilitate construction of the Proposal.	Implementation of best practice WSUD principles in the detailed design phase and the stormwater management approach for the Proposal will facilitate at-source infiltration to maintain the predevelopment hydrological regime and control the quality of stormwater recharged to the groundwater aquifers.	Not applicable.	Following the application of mitigation measures, minor predicted residual impacts are expected to local surface and no impacts to subsurface hydrology. The Proposal can be managed to meet EPA's objective for subterranean fauna through the implementation of a CEMP. The Proposal will not result in significant residual impacts to subterranean fauna.
Fragmentation of subterranean fauna habitat and loss of ecological connectivity.	Proposal avoids areas associated with high value subterranean fauna habitat such as high karst risk areas.	Implementation of a CEMP – action items to include: • Measures to address the destruction of significant caves or large voids during construction if encountered. • Clearing/disturbance to remain within approved development envelope.	Not applicable.	Following the application of mitigation measures, the Proposal is expected to result in the removal of subterranean fauna habitat with low karst values, and therefore low value habitat for troglofauna. The removal of subterranean fauna habitat with low karst values, and therefore low value habitat for troglofauna habitat is not expected to significantly change the scale of root mat communities remaining at a local or regional scale. Given the narrow linear nature of the Proposal, and similar or better subterranean habitat values present in surrounding conservation estates (including Yanchep National Park), it is not expected that the Proposal would result in local extinction of subterranean fauna species. The Proposal can be managed to meet EPA's objective for subterranean fauna through the implementation of a CEMP.

Potential Impact	Avoidance	Minimisation	Rehabilitation	Residual impact
				These mitigation strategies are expected to be effective in mitigating potential impacts to subterranean fauna. The Proposal will not result in significant residual impacts to subterranean fauna from fragmentation.
Indirect impacts to subterranean fauna from elevated concentrations of contaminants in water due to chemical or hydrocarbon spills.	Not applicable.	Implementation of a CEMP – action items to include: • Fuel and other chemicals will be stored in correctly labelled containers and used in designated areas only. • Chemical and fuel storage measures such as bunds that can capture 110% of the volume of the container. • Disposal of hazardous materials to be in accordance with regulatory requirements. • Provision of spill kits at the designated storage and use areas. • Provision of training where required, in the safe use, handling and disposal of hazardous materials.	Not applicable.	Following the application of mitigation measures, minor predicted residual impacts are expected from increased contamination risk. The Proposal can be managed to meet EPA's objective for subterranean fauna through the implementation of a CEMP. The Proposal will not result in significant residual impacts to subterranean fauna from excavation/disturbance activities.

7.7 Predicted outcome

Predicted direct residual impacts as a result of the Proposal will involve minimal loss of low value troglofauna habitat and no loss of stygofauna habitat. Further to the low diversity and abundance of subterranean fauna in the development envelope and the region, the Proposal has a low likelihood of impact to both stygofauna and troglofauna due to the shallow depth of excavation (approximately 5 m within Tamala limestone).

The vertical extent of potential troglofauna habitat will be retained below the proposed excavation level therefore the Proposal will have no impact to the continuity of potential habitat across the proposed rail alignment. In addition, the anticipated bulk earthworks will involve the disturbance/removal of Safety Bay Sand, which is not expected to provide habitat for subterranean fauna.

There will be no significant residual impacts to subterranean fauna from contamination of groundwater from railway operation. No dewatering or abstraction are proposed for the construction of this Proposal. It is not anticipated that the Proposal will add significantly to the cumulative impacts to subterranean fauna in the local area.

Key mitigation strategies to minimise clearing of potential subterranean fauna habitat include:

- proposed construction methods avoid the requirement for dewatering during construction;
- prior to the commencement of construction activities, a further detailed geotechnical investigation will be undertaken to supplement and validate the initial findings baseline investigations to further validate areas to avoid; and
- implementation of a CEMP to ensure clearing/disturbance is restricted to the approved development envelope.

Through the implementation of the EPA's mitigation hierarchy (Table 7-1), the residual impacts of potential direct and indirect impacts of the Proposal to subterranean fauna are as low as reasonably practicable and are not expected to be significant. With reference to the WA Environmental Offsets Guidelines, residual impacts will not affect areas of high subterranean fauna diversity, threatened or specially protected subterranean fauna or result in species being listed as such. As such, no offsets are proposed. It is considered that biological diversity and ecological integrity of subterranean fauna will not be affected by the Proposal and that the Proposal can be managed to meet the EPA's objective for subterranean fauna.

8 Landforms

8.1 EPA objective

The EPA's objective for landforms is to maintain the variety and integrity of distinctive physical landforms so that environmental values are protected (EPA 2018e).

8.2 Policy and guidance

The following guidance is relevant to the landforms factor:

- Environmental Factor Guideline: Landforms (EPA 2018a).

8.3 Receiving environment

Landforms are a component of the landscape and are defined by the combination of geology (composition) and morphology (form) (EPA 2018a). The EPA considers landforms as distinctive, recognisable physical features of the earth's surface, having a characteristic shape produced by natural processes (EPA 2018a).

8.3.1 Previous studies

Six studies have been undertaken to assess landform values within and surrounding the development envelope, including the potential impacts of the Proposal. These studies are as follows:

- *Northern Suburbs Railway Alignment Butler to Yanchep Environmental Investigation* (GHD 2012) – desktop assessment and field survey over one day in November 2012.
- *Aboriginal Heritage Survey of Proposed Northern Suburbs Railway Extension Alignment* (R. & E. O'Connor Pty Ltd 2017a; Appendix M) – Aboriginal heritage survey including desktop assessment, consultation with Whadjuk representatives of the South West Aboriginal Land and Sea Council and site inspections over one day to identify potential Aboriginal cultural heritage values in the development envelope that may be of significance to the Whadjuk people.
- *Geotechnical Investigation Report - Yanchep Rail Extension* (Advisian 2017) – geotechnical study including desktop assessment and field survey over four days in March 2017 providing an overview of the regional physiography and geology, a preliminary assessment of the geological profile, and an assessment of the presence of karstic features (sink holes, caves and large voids).
- *Yanchep Rail Extension Biological Assessment* (GHD 2018c; Appendix D) – included a preliminary overview of the soil types and landscapes within and surrounding the development envelope.
- *Environmental Impact Assessment* – Yanchep Rail Extension*, Part 2 – Eglinton Station to Yanchep Station* (RPS 2018a) – considered the potential direct and indirect impacts of the Proposal to parabolic dune formations based on information presented in Advisian (2017) and GHD (2018a).
- *Yanchep Rail Extension Part 2 Biological Factors* (GHD 2018a) – additional desktop analysis and assessment of potential impacts to landforms including local, regional and cumulative considerations.

8.3.2 Regional Context

The geomorphological background information summarised in this and the following section has been principally derived from review of text presented in Gozzard (2007), Semeniuk (1989) and Gozzard (1982) and from research of publicly available datasets.

The main group of landforms intersected and impacted by the Proposal are those associated with the Quindalup dune system. The Quindalup dune system is the most westerly coastal dune system of the SCP. Geologically, the sands that form the dunes and other landforms within the Quindalup dune system are generally part of the Safety Bay Sand member and consist of unconsolidated calcareous sands that may be weakly consolidated at their core. The Quindalup dunes overlie the sand and calcarenite of the Spearwood Dunes, the aeolian component of the Tamala Limestone.

The Quindalup dune system is the youngest coastal dune system of the SCP and represents Holocene (~11,700 years to present) aged coastal dunes. There are many Holocene aged coastal dunes present in Western Australia. However, the term 'Quindalup' in a soil and landform sense generally refers to Holocene aged coastal dune systems between Dunsborough in the south and Dongara in the north.

The current understanding and classification of Holocene coastal dune systems along the coast of Western Australia and within the southwest region is by no means exhaustive or complete. Many dune systems remain completely unclassified or only partially classified. Classification systems for the Quindalup system are not necessarily consistent and a combined classification for the entirety of the 'Quindalup dune system' has not been undertaken to date. However, within the northwest Sub-region of the Perth metropolitan area where the Proposal occurs, the dunes and their extents are well classified.

Semeniuk et al. (1989) suggests that changes in the shape and character of the Quindalup dunes from Dunsborough to Dongara are likely related to differences in climate with drier conditions and stronger winds in the north. Semeniuk et al. recognises a unique set of coastal landforms within the Quindalup dune system stretching between Whitfords and Lancelin, with this section displaying 'moderate landform complexity with its range of blowouts, parabolic dunes, plains, shore-traverse ridges etc.'. The perched parabolic dunes, however, comprise the dominant landform within the region and are not exclusive to this section of the Quindalup dune system, occurring right across the system.

A parabolic dune is a sand dune that generally has a long U- or V-shaped form in plan view with a convex rim in the downwind direction and horns or arms pointing upwind. Parabolic dune systems are reasonably common at various locations along the Western Australia coastline. It is thought that these dunes grow from blowouts in existing sand ridges or other dunes and develop in areas of prevailing unidirectional winds by ongoing erosion of sand from underlying sediments. In the case of the Quindalup parabolic dunes, formation possibly involved erosion of the Spearwood dune system or other beach sand. Semeniuk et al. (1989) suggests a relationship between the size of Quindalup parabolic dunes and beach size. It is also thought that vegetation pays a significant role in parabolic dune development by protecting the arms from erosion while allowing the central rim to develop.

The Quindalup dune system in the Perth region has been classified as having four main cycles or phases (Q1 to Q4) of dune formation. Dune formation cycles appear to be separated by periods of stability when soil horizons form. In the nomenclature the first phase (Q1) is the oldest while the fourth phase (Q4) is the youngest. As with many geomorphic processes, the younger phases have in part eroded and overprinted the older phases. No method of precise dating has been undertaken on the dunes to date, but Gozzard (2007) infers that the oldest phase of these dunes (Q1) may be roughly 6,500 years old while the youngest phase (Q4) may still be forming at present in certain locations. Climate also plays a role in dune development and Gozzard (2007) suggests that the local climate during the formation of the Q1 and Q2 dune cycles may have been drier with stronger prevailing winds.

The four phases of dune formation are characterised as follows:

- 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 and has organic matter to at least 30 cm deep, with white sand below which shows cementation at approximately 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 is present to 10 cm deep and cementation is minimal.
- Quindalup South youngest phase (Q4): dunes are generally asymmetric with gentle inner slopes and steep outer surfaces. The outline is very jagged with many deep scallops and irregularities. The soils show very little pedological development other than slight organic matter accumulation at the surface.

To illustrate regional context, the pre-European distribution of parabolic dunes in the Perth northwest Sub-region is shown in Figure 8-1. The pre-European extent of parabolic dunes at a regional scale based on Department of Primary Industries and Regional Development (DPIRD 2018a) mapping is estimated to be 5,435 ha.

Residential and commercial developments in the region have changed landforms as well as altered wind patterns and sediment supply. To estimate the current extent of parabolic dunes the Quindalup dune phase soil units (Q1 to Q4) have been combined with the native vegetation extent dataset (DPIRD 2018b) as an indicator of land that has not been disturbed. This approach to estimating current extent has been validated by comparing the mapping results against recent aerial imagery (Nearmap 2018) and GHD (2018c) vegetation mapping for the development envelope. Visual examination of the refined mapping within the development envelope, within a 1 km buffer and at a regional scale has confirmed that the refined mapping is generally accurate. Some discrepancies were identified and manually reintroduced into the refined mapping, e.g. areas of farming land where vegetation has been cleared but the underlying landform remains. Using this data, the current regional extent is approximately 3,131 ha (approx.58% of the pre-European extent). Note that this value may differ from those given by GHD (2019) due to the different methods employed. Table 8-2, Table 8-3 and Table 8-4 below further describe the calculated impacts to the parabolic dune system.

GHD (2019) used datasets for DBCA managed lands and Bush Forever Sites to indicate the percentage of parabolic dunes (pre-European extent) within conservation areas. Regionally, GHD found that 1,057.5 ha, or 19.46%, of the pre-European extent of parabolic dunes are within conservation areas. This equates to 29.82% of the current extent in the region.

8.3.3 Local context

A 1 km buffer around the development envelope (shown in Figure 8-2) has been used for the consideration of local context. At this local scale, the Spearwood Dune System is distributed across the majority of the landscape. Overlying this in places are the parabolic dune formations of the Quindalup dune system. At a local scale, the parabolic dune formations of the first (Q1) and second (Q2) phases of the Quindalup dune system are more extensive than the younger third (Q3) and fourth (Q4) phases. These dune phases are principally vegetated and are generally described as no longer active (Semeniuk et al. 1989), however little is known about the movement rates of parabolic dunes around the globe. Gutierrez (2013) provides estimated rates ranging between 0.05 m/year in zones of dense vegetation to 13 m/year in active coastlines. From this perspective and on a geological time scale, these dunes may be more accurately described as being in state of extremely low activity.

Within the 1 km buffer, the remaining extent of parabolic dune formations is 319 ha, comprising 66.5% of the mapped pre-European extent. The remaining area has been altered, largely as a result of residential development. Dunes within this buffer (Q2 and Q3 phases) are also dissected in places by the alignment of Marmion Avenue.

GHD (2018a) reported that locally 151.37 ha, or 31.56%, of the pre-European extent of parabolic dunes are located within conservation areas. This equates to 47.45% of the current extent within the 1 km buffer.

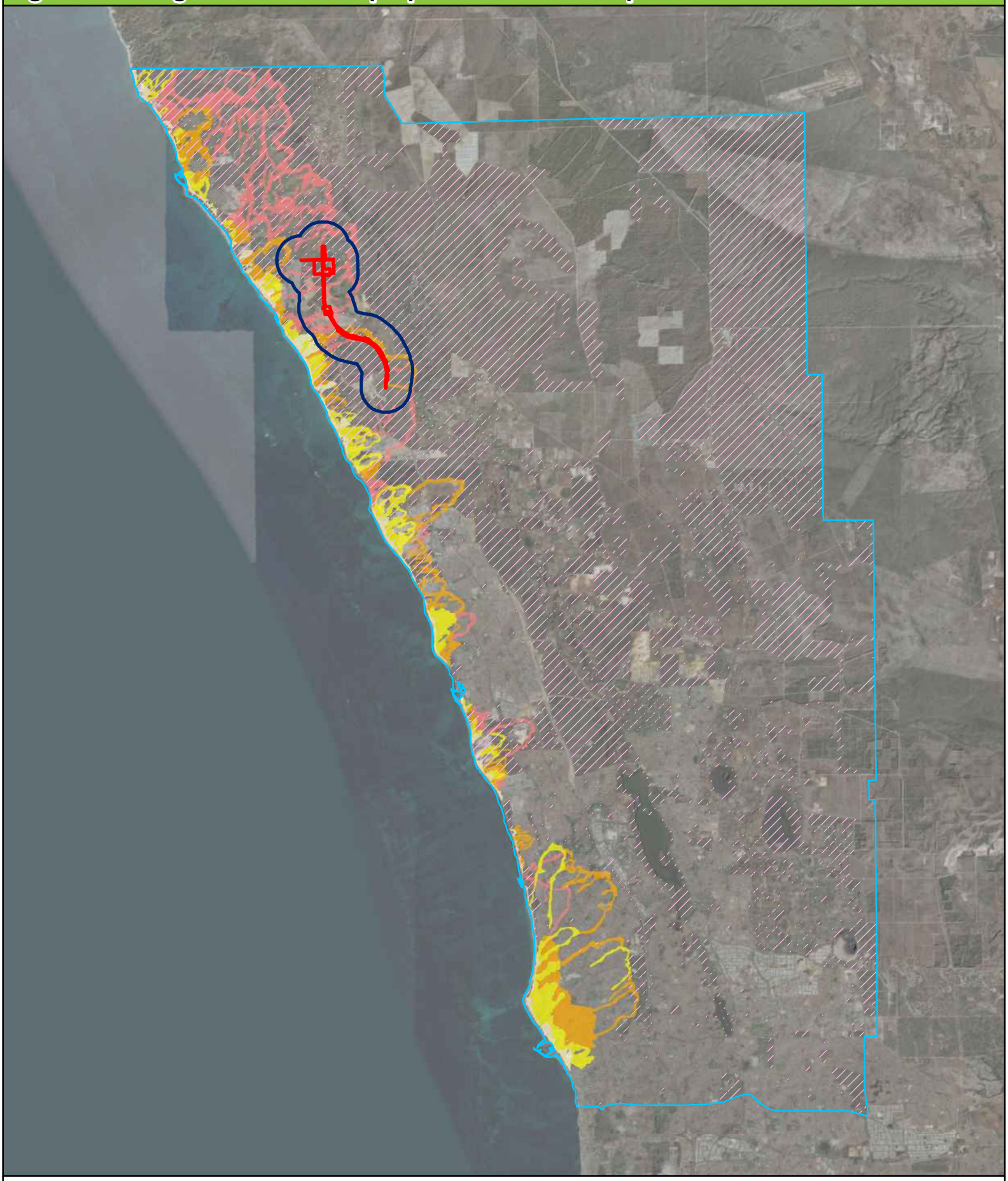
No cave systems or large scale karstic features such as sinkholes or caverns were identified within, or in close proximity to, the Proposal (GHD 2012 and Advisian 2017). The nearest known cave systems and significant karstic features are in Yanchep National Park, which is approximately 1 km to the east of the development envelope. The development envelope is also located within a predominantly low likelihood area for karstic geological features compared to the high likelihood areas of Yanchep National Park (see **Figure 7-2**). Tamala Limestone, underlying the development envelope, is likely to support smaller karstic features (Advisian 2017). However, based on geotechnical investigation by Advisian (2017), the probability of caves or cave systems with significant environmental and social value within or in close proximity to the development envelope is low.

8.3.4 Significance of the Quindalup parabolic dune landforms

In accordance with its guidance for landforms, EPA assesses significance of impacts to 'significant landforms'. Within the development envelope, the Quindalup parabolic dune formations are considered worthy of further consideration as a significant landform. The EPA identifies six criteria (variety, integrity, ecological importance, scientific importance, rarity and social importance) to assist in assessing the significance of a landform (EPA 2018a). An assessment of the Quindalup dune system against each of these criteria is provided in Table 8-1.

Based on the assessment of the Quindalup dunes above, it is not considered that the Quindalup dune system represents a 'significant landform'. While the PTA does not consider the Quindalup dunes of the area to represent a significant landform, an assessment of impacts to the dunes has been provided nonetheless in the sections below.

Figure 8-1: Regional context of proposal in relation to parabolic dune landforms



Legend

- Part 2 Development Envelope
- Part 2 Development Envelope 1km Buffer
- North-West Subregion
- Remnant Vegetation (DPRID-005)

Quindalup soil units (local context)

- Quindalup South oldest dune Phase (Q1)
- Quindalup South second dune Phase (Q2)
- Quindalup South third dune Phase (Q3)
- Quindalup South youngest dune Phase (Q4)

0 2 4 8
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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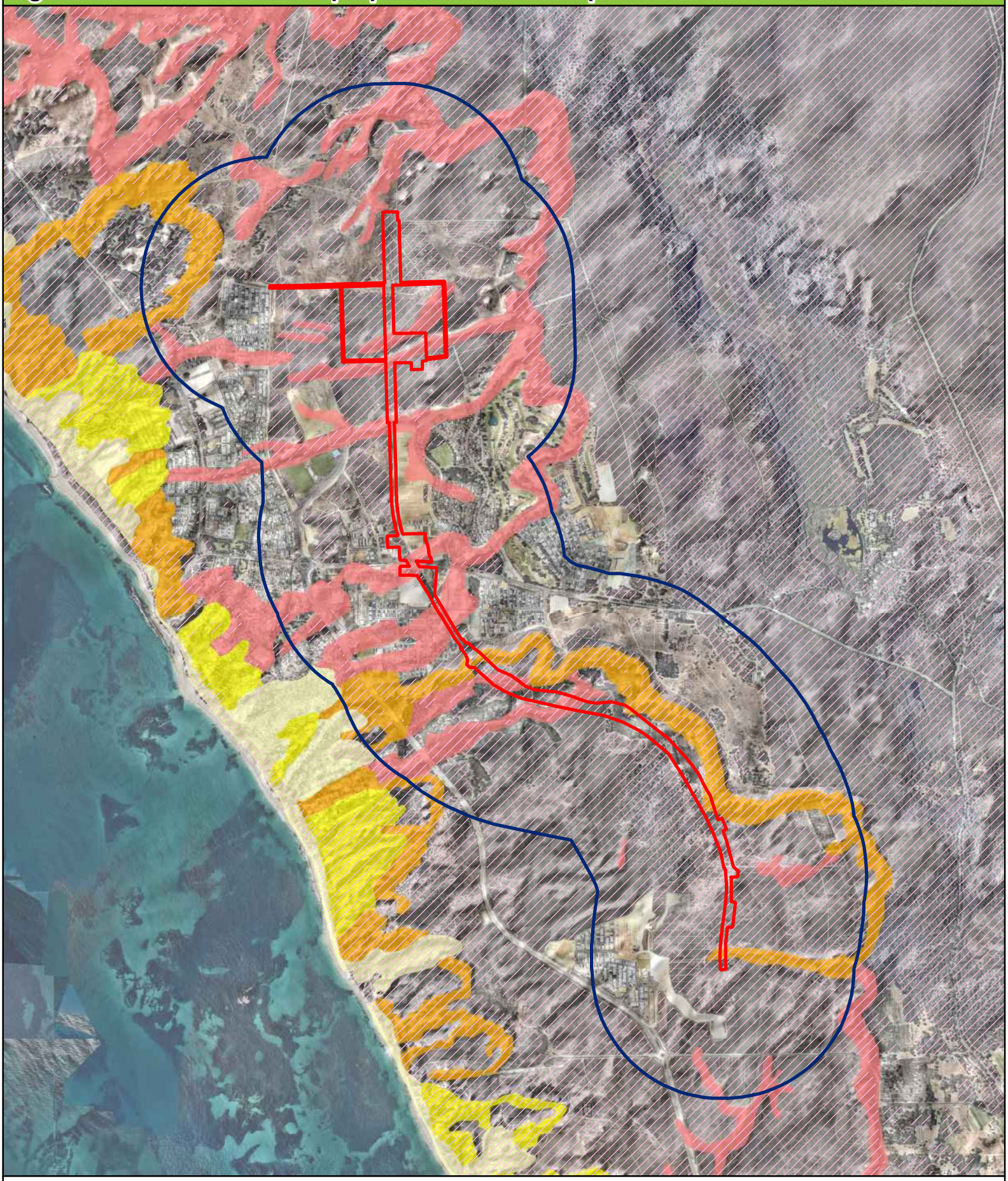
Prepared by: SM Date: 4/12/2018

Figure 8-2: Local context of proposal in relation to parabolic dune landforms



Legend

- Part 2 Development Envelope
- Part 2 Development Envelope 1km Buffer
- Remnant Vegetation (DPRID-005)

Quindalup soil units (local context)

- Quindalup South oldest dune Phase (Q1)
- Quindalup South second dune Phase (Q2)
- Quindalup South third dune Phase (Q3)
- Quindalup South youngest dune Phase (Q4)

0 250 500 1,000
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

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Prepared by: SM Date: 4/12/2018

Table 8-1 Assessment of significance of the Quindalup dunes

Criteria	Pre-European extent (ha)
Variety	Semeniuk et al. (1989) notes that the landforms within the Quindalup dune system do change form from north to south, suggesting that each locality will have, at least to some degree, its own local variety. However, this variety is more associated with the expression of various landforms as opposed to the exclusive presence of landforms within a certain zone.
Integrity	Sections 8.3.2 and 8.3.3 provide an indication of the integrity of the Quindalup dune system. A significant portion of the dune complexes have been altered to date through human actions, primarily through urban land development. Regionally, only 57.61% of the mapped pre-European extent of Quindalup dunes remains, and locally this figure is 66.52%. This indicates significant impacts to the integrity of the landforms.
Ecological importance	The Quindalup dune system offers microhabitats for flora and fauna associated with their slope, aspect, wind protection and soils. The predominant vegetation type associated with the mapped dunes is the *Lomandra* herbland on secondary dunes vegetation community (VT5). This vegetation type provides medium habitat value for a number of conservation significant fauna although it is not listed as a TEC or Priority Ecological Community (PEC) and is well represented locally and regionally. Remnant vegetation occurring within and in proximity to the Proposal supports ecological values including conservation significant ecological communities and flora and fauna species. These include Banksia woodlands (TEC) / Banksia dominated woodlands (PEC), Northern Spearwood shrublands and woodlands (SCP24) (PEC), *Melaleuca huegelii – M. systena* shrublands on limestone ridges (TEC) and Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP (PEC). The occurrence of these values is discussed in detail in Sections 5.3 and 6.3. However, it is not considered that the parabolic dunes within and surrounding the development envelope have a distinctive or exclusive role in maintaining these ecological values. Because the dune landforms form local topographical highs and are relatively well vegetated, they may have an effect on the rate of rainfall infiltration and may contribute to slight alterations in groundwater level or flow through regulation of rainfall infiltration.

Criteria	Pre-European extent (ha)
Scientific importance	The dune landforms do provide a means of evaluating previous geological process and climate in Western Australia and the NW subregion of the Perth metropolitan Area. However, classification and study of these landforms has already occurred in greater detail than many dune systems along the coast of Western Australia. In addition, the integrity of the system has been comprised to some extent by existing development, making complete scientific study of the dune systems in this area more difficult. A geoheritage site has 'geological features considered to be unique and of outstanding scientific and educational value within Western Australia' (DMIRS 2018). The Alkimos dune system that exists approximately 3 km to the south of the development envelope has been mapped by DMIRS as a geoheritage site, in recognition that it provides an 'exceptional example of the development of a parabolic dune complex of the Quindalup dune system' and is 'probably the best example in the Perth Region that has not been encroached on by urbanisation and is still accessible for scientific study' (Gozzard 2007). It is considered by the EPA to have national and world significance (EPA 2018a). A similar geoheritage classification has not been assigned to the parabolic dunes within the development envelope or 1 km buffer.
Rarity	The landforms in the development envelope have not been previously identified as having regional or national significance and parabolic dune systems are reasonably common at various locations along the Western Australia coastline. From this point of view, the landforms are not considered rare.
Social importance	It is not considered that the Quindalup dunes within the development envelope support significant cultural or heritage values. The study by R. & E. O'Connor Pty Ltd (2017a; Appendix M) did not find any Registered Aboriginal Site or Heritage Places. Likewise, a walkover with representatives of the Whadjuk people did not identify any ancestral landforms in Part 2 of the alignment. It is noted that as high points in the landscape dunes can contribute amenity values by providing vantage points for hikers, and that four-wheel drive tracks through the area tend to be concentrated along the crests of the dunes, possibly for the same reason. The Quindalup dune landforms do support some amenity values in this way.

8.4 Potential impacts

The Proposal has the potential to directly and indirectly impact on the Quindalup dune system during the construction phase.

The following direct impact has the potential to occur:

- Permanent loss of or alteration of shape to parabolic dune formations within the development envelope due to cut and fill works during the construction phase.

The following indirect impact has the potential to occur:

- Earthworks such as cutting could permanently alter the stability of the dune system, leading to dune erosion, blowouts or sand deposition outside of the development envelope.

8.5 Assessment of impacts

8.5.1 Alteration to the localised shape of the parabolic dune formations

Construction within the development envelope will involve excavation of parts of the Quindalup dunes as well as the sand flats and the surrounding shallow soils. A typical cross-section of the alignment, where the deepest cuttings into the ground are proposed, is provided in Figure 2-3 to illustrate the interaction of the Proposal with the existing landform and dune system.

Figure 8-2 shows that the development envelope of the Proposal intersects portions of the Q1 and Q2 phase parabolic dunes as well as associated sand flats, shallow soils and underlying bedrock. The Q1 and Q2 phases intermittently intersect the development envelope. In general, the development envelope runs perpendicular to dune arms which largely run east-west, dissecting the arms at right angles and avoiding the majority of any one dune complex.

The development envelope for the Proposal will result in direct, permanent alteration to approximately 17.54 ha of the parabolic dunes; approximately 9.82 ha and 2.77 ha of the Q1 and Q2 phases, respectively.

Local and regional consideration

Table 8-2 provides a summary of the impacts to the Quindalup dune system at a local and regional scale. The proposed direct impacts to the Quindalup dune system represent approximately 3.95% of the current extent of the dunes mapped locally (within 1 km of the development envelope) and 0.40% of the current extent of the dunes mapped regionally (within the northwest Sub-region). The Proposal will reduce the occurrence of the dunes from 57.61% to 57.38% of the mapped pre-European extent regionally and from 66.52% to 63.89% of the mapped pre-European extent locally (Table 8-2).

Approximately 19.46% of the pre-European extent is within conservation areas at the regional scale and 31.56% at the local scale (i.e. DBCA Legislated Lands and Bush Forever; Table 8-3).

Cumulative consideration

As a standalone Proposal, YRE Part 2 will have an insignificant impact on parabolic dune formations, with direct impacts limited to 12.59 ha (0.40% of the current extent regionally). The cumulative loss resulting from the YRE Project is also minimal at 20.38 ha of parabolic dunes (0.65% of current extent regionally) (**Table 8-4**).

Further analysis on cumulative losses has been undertaken using the Perth and Peel ULDO 2016/17 – staging (DOP-096) spatial data. Urban land development represents by far the biggest impact to the dune landforms in the region. Cumulative impacts have been calculated based on development across the entire ULDO forecast period.

When urban development is taken into consideration, the cumulative impacts to parabolic dunes are of greater significance. Cumulative impact when considering future urban development will directly reduce the extent of parabolic dunes regionally by 1,920.09 ha (from 57.61% to 35.33% of pre-European extent) (Table 8-4). These impacts are similarly substantial at a local scale, with a reduction in extent of 155.20 ha (66.52% to 31.56%).

The Proposal and the greater YRE Project is a minor contributor to the likely cumulative impacts resulting from future urban development in close proximity to the Proposal.

Table 8-2: Extent of parabolic dune formation at local and regional scales

Scale	Pre-European extent (ha)	Current extent (ha)	Pre-European extent currently remaining (%)	Current extent within development envelope (ha)**	% of current extent within development envelope	Extent after development of the Proposal (ha)	% pre-European extent after development of Proposal
Northwest Sub-region	5,435.18	3,131.37	57.61	12.59	0.40	3,118.78	57.38
1 km buffer	479.56	319.0	66.52	12.59	3.95	306.41	63.89

Note: values in this table include all four Quindalup dune phase units (Q1-Q4).

**Values in this column reflect only Quindalup dune phases Q1 and Q2 as they are the only phases that occur within the development envelope.

Table 8-3: Extent of parabolic dune formation in conservation areas

Scale	Current extent (ha)	Current extent (%)	Current extent in conservation areas[1] (ha)				
			DBCA Managed Lands	Bush Forever	Total (ha)	% of current extent	% of pre-European extent
Northwest Sub-region	3,131.37	57.61	59.76	997.75	1,057.50	33.77	19.46
1 km buffer	319.0	66.52	12.39	138.98	151.37	47.45	31.56

Note: values in this table include all four Quindalup dune phase units (Q1-Q4).

1. DBCA extent and BF extent sourced from publicly available data sets (DBCA-011, DBCA-012 and DOP-071) and taken from GHD (2018d)

Table 8-4: Likely cumulative impacts to parabolic dunes

Scale	Current extent (ha)	Current extent within development envelope (ha)**	Current extent within YRE Part 1 (ha)	Current extent within ULDO areas (ha)	Cumulative impact (ha) (% of pre-European extent remaining)
Northwest Sub-region	3,131.37	12.59	8.08	1,899.91	1,920.09 (35.33%)
1 km buffer	319.0	12.59	0.87	141.74	155.20 (32.36%)

Note: values in this table include all four Quindalup dune phase units (Q1-Q4).

**Values in this column reflect only Quindalup dune phases Q1 and Q2 as they are the only phases to occur within the development envelope.

8.5.2 Altered dune stability

Without management, indirect impacts could occur in the form of alteration to the stability of the dune system leading to dune erosion, blowouts or sand deposition. Disruption of dune stability may lead to increased geomorphological activity in the dunes and long-term alteration from their current form.

Dune stability could be altered by:

- Removal of stabilising vegetation, soil, sand and rock during construction as well as through ongoing erosion and potential ecosystem degradation.
- Increasing human activity in the area through an increase in service vehicles.
- Increased human use as a result of greater public access.

Previous works required for Marmion Avenue construction have intercepted the Q1 and Q2 parabolic dune systems, located to the south of the development envelope. Batters created during the construction of Marmion Avenue were rehabilitated with locally endemic species. RPS reported that visual observation of this linear infrastructure corridor and adjacent lands indicated that the construction of Marmion Avenue has not had a detrimental impact on the stability of the adjacent Quindalup dune system (RPS 2018a). The construction of Marmion Avenue provides a relevant example illustrating the relative stability and robust nature of the Quindalup dune system (RPS 2018a). Based on previous development of Marmion Avenue and the PTA's proposed structural controls, indirect impacts to the parabolic dune formations outside of the development envelope are considered unlikely.

An increase in human activity and use of the railway may also result in impacts to the dune system, however, these are considered to be minor and therefore unlikely to cause a significant impact to the dune system.

8.6 Mitigation

Table 8-5 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied during Proposal design and in the development of appropriate mitigation and management strategies to address the key potential impacts to landforms. Relevant mitigation measures for landforms are set out in **Table 8-5**.

Avoidance of the parabolic dune formation is not feasible as some disturbance and alteration is required for the Proposal. Mitigation has therefore been directed towards minimising the extent of disturbance, creating a stable landform post-construction and a program of inspections to confirm ongoing stability of the dunes outside of the development envelope. A CEMP has been developed for the construction and operation of the railway (Appendix P), which specifically addresses management actions to mitigate direct and indirect impacts to landforms.

Further geotechnical investigation and detailed engineering design will inform the structural controls to stabilise the landform, with options to include battering the excavation or use of retaining walls. Revegetation of batters or any areas of the parabolic dunes adjacent to the development envelope that are indirectly impacted is proposed where practicable using native species and a range of measures that will improve revegetation success. While revegetation is the preferred method of slope stabilisation, it may not be used if slopes are too steep, batters are in areas of outcropping limestone, or the area is required for operational infrastructure purposes.

The rail corridor and associated infrastructure, such as service roads and parking areas will be securely fenced and managed to ensure that additional public access to the dune system is not provided, and therefore it is considered unlikely that increased human activity will result in further impacts to the dune system.

The PTA also operates in accordance with an environmental management system, which establishes standard environmental management practices. Construction contractors will be required to prepare CEMPs in accordance with the environmental management system.

Table 8-5: Application of the mitigation hierarchy for landforms

Potential Impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Direct alteration of the parabolic system	Within the given alignment avoidance of the parabolic dune landforms is not possible.	Implementation of a CEMP – action items to include: • Implement structural controls to minimise excavation by using retaining walls. • Minimise excavation and development footprint within Ningana Bushland by raising vertical alignment of the railway in this area to stabilise the landform, including battering the excavation or using retaining walls, informed by the geotechnical investigation and detailed engineering design. • Measures to ensure that clearing is restricted to the development envelope.	Not applicable	Alteration of approximately 12.59 ha of parabolic dunes.
Indirect alteration of the dune system	Not applicable.	Implementation of a CEMP – action items to include: • Implement structural controls to stabilise the landform, including battering the excavation or using retaining walls, informed by the geotechnical investigation and detailed engineering design to avoid blowouts of adjacent dune formations. • Monthly visual inspections for evidence of erosion of parabolic dune formation outside the development envelope (inspections of first 10 m outside development envelope). • Stabilise affected parabolic dune formations by the planting of locally endemic flora species or bioengineering controls, as practicable.	Not applicable	With appropriate management, potential impacts are considered unlikely.

8.7 Predicted outcome

The Proposal will permanently alter approximately 12.59 ha of the Quindalup dune system with direct removal of portions of the Q1 and Q2 phase parabolic dunes. Within a regional context and considering the current state of the landform and planned future development in the area, this impact is as low as reasonably practical. With the inclusion of mitigation measures outlined in the previous section, potential indirect impacts to the Quindalup dune system are considered unlikely to occur as a result of the Proposal.

Furthermore, based on an assessment of the variety, integrity, ecological importance, scientific importance, rarity and social importance, it is not considered that the Quindalup dune system represents a 'significant landform'. Given that the Quindalup dune system is not a significant landform and the permanent residual impacts to the dune system are small, there will not be a significant residual impact to landforms as a result of the Proposal. In addition, with reference to the WA Environmental Offsets Guidelines, landforms do not generally meet the description of values for which significant impacts may require offset. As such, no offsets are proposed. The Proposal is consistent with the EPA's objective to maintain the variety and integrity of distinctive physical landforms so that environmental values are protected. The PTA considers that the Proposal can be managed to meet the EPA's objective for landforms.

9 Inland waters

9.1 EPA objective

The EPA's objective for inland waters is to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected (EPA 2018e).

9.2 Policy and guidance

The following policies and guidance are relevant to the inland waters factor:

- Environmental Factor Guideline: Inland Waters (EPA 2018b).
- Statement of Planning Policy No. 2.7 Public Drinking Water Source Policy (Government of Western Australia 2003).

9.3 Receiving environment

For the purposes of environmental impact assessment, the EPA defines the inland waters factor as (EPA 2018b):

> *The occurrence, distribution, connectivity, movement, and quantity (hydrological regimes) of inland water including its chemical, physical, biological and aesthetic characteristics (quality).*
>
> *Inland waters include groundwater, such as superficial and confined aquifers, and surface water,* such *as waterways, wetlands and estuaries. A 'waterway' is any river, creek, stream or brook, including its floodplain and estuary or inlet. This includes systems that flow permanently, for part of the year or occasionally, and parts of the waterway that have been artificially modified.*

9.3.1 Previous studies

A desktop hydrological assessment was undertaken in May 2018 to characterise the geomorphology and hydrological environment of the development envelope and its surrounds, and to assess the potential impacts of proposed abstraction of groundwater for dust control and compaction during construction of the Proposal (RPS 2018b; Appendix J). In May 2019, the PTA removed the requirement for abstraction from this Proposal, however the results of the groundwater study are still relevant to the existing environment for this Proposal and are summarised below.

The study was underpinned by information from the Draft Yanchep YB80 H3 Hydrogeological Assessment (Water Corporation 2015). This regional assessment included groundwater modelling of the superficial aquifer within the Yanchep and Eglinton groundwater management sub-areas, including the development envelope.

9.3.2 Hydrogeology

The development envelope sits within the Perth Basin, a regional sedimentary basin up to 12 km thick with several significant aquifers. 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 is the unconfined Superficial aquifer, which includes Safety Bay Sand and Tamala Limestone formations. These formations are highly

transmissive and have a saturated thickness of approximately 20 to 30 m in this region (Advisian 2017). The Superficial aquifer is primarily recharged through rainfall infiltration.

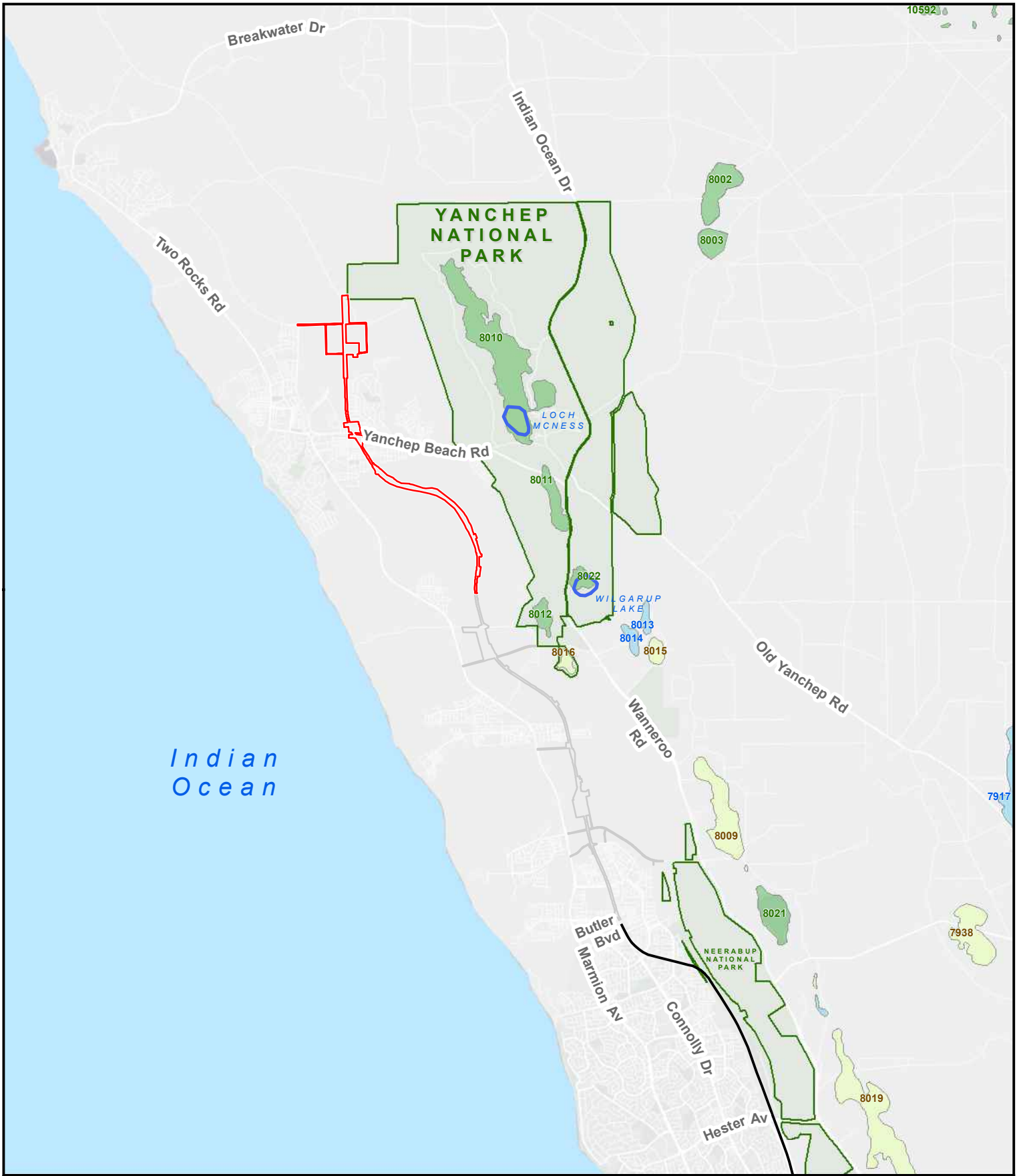
The Perth Groundwater Map (DWER 2018a) shows that depth to groundwater level fluctuates with the undulating local topography across the development envelope, from approximately 11 m in the south to around 32 m to the east of the Yanchep Beach Road and Marmion Avenue intersection and approximately 26 m north of Toreopango Avenue. Groundwater flows in a westerly direction towards the coast, where groundwater discharges over a saline wedge (Advisian 2017).

Groundwater salinity below the development envelope is estimated to vary from 250 to 1,000 mg/L, which is suitable for garden bores and irrigation. There is low risk of iron staining and no known acid sulfate soil risk (DWER 2018a).

9.3.3 Surface water

The southern half of the Proposal is located predominantly along the western edge of the Yanchep Coastal Lakes hydrographic catchment, while the northern half is within the Coastal hydrographic catchment. There are no surface water features such as rivers, creeks, streams or wetlands mapped within the development envelope. The nearest surface water features to the development envelope are the wetlands located within Yanchep National Park. This includes Conservation Category wetlands Loch McNess, more than 2.5 km northeast of the envelope, and Lake Wilgarup, approximately 2.2 km to the east of the development envelope (Figure 9-1). The lack of surface water features in the development envelope is a direct result of the soils of the area, which are highly permeable. Surface runoff is minimal, with rainfall rapidly infiltrating the soil and recharging the superficial aquifers (CRC 2014).

Figure 9-1 also identifies mapped Resource Enhancement wetlands and Conservation Category wetlands in the broader region in relation to the development envelope. These wetlands are included within the Geomorphic Wetlands of the SCP dataset managed by the DBCA.



Yanchep Rail Extension (Part 2)
Figure 9-1 Geomorphic Wetlands in Relation to the Development Envelope

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Existing Railway

Wetlands

- Conservation
- Multiple Use
- Resource Enhancement

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Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
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9.3.4 Associated values and beneficial uses

The development envelope is entirely located within the Priority 3 (P3) Perth Coastal Underground Water Pollution Control Area (UWPCA), a public drinking water source area (Figure 9-2). The P3 Perth Coastal UWPCA generally extends from Warwick at its southern end to Two Rocks at its northern limit (DoW 2012).

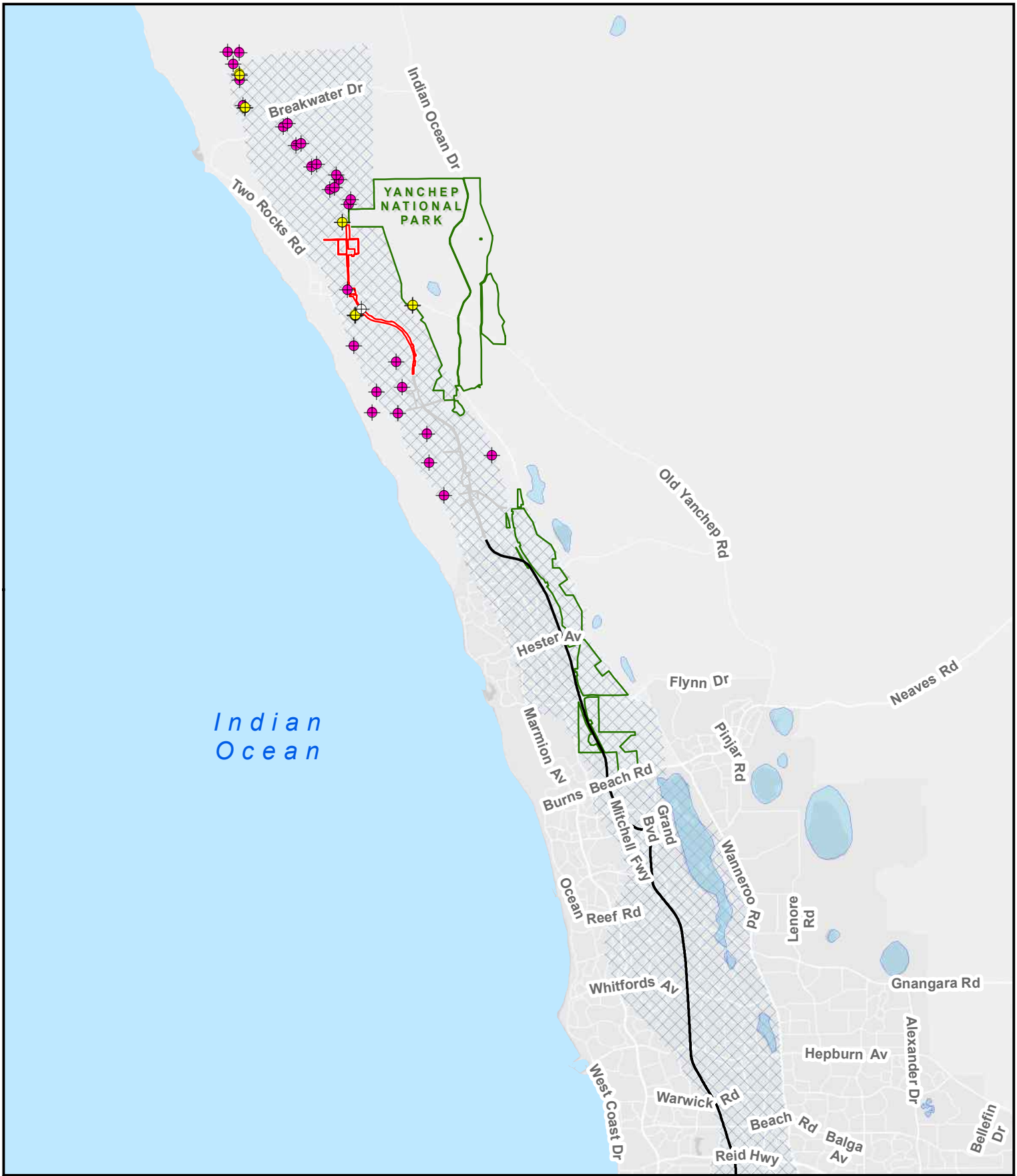
There are over 35 Water Corporation production bores in the Perth Coastal UWPCA that draw public drinking water from the underlying aquifers (DoW 2012). WHPZ are declared around these production bores to protect the groundwater from contamination threats in the nearby area. The location of existing and proposed production bores and WHPZ in closer proximity to the development envelope are shown in Figure 9-2. Note that production bores and WHPZ further away from the Proposal are not shown.

Within 1 km of the development envelope there are three existing Water Corporation production bores and three proposed production bores (see Figure 9-2 and Figure 9-3). The development envelope overlaps with the WHPZ of the one existing Water Corporation bore and with three of the proposed bores and their associated WHPZ.

The unconfined Superficial aquifer beneath the development envelope is considered a significant resource for beneficial uses. The DWER online Water Register (DWER 2018b) identifies licensed groundwater users of the unconfined Superficial aquifer near the development envelope. In addition to the Water Corporation, other major groundwater users in proximity to the development envelope include the Housing Authority, LandCorp and private developers.

Wetlands to the east of the development envelope within Yanchep National Park intersect groundwater and are largely dependent on groundwater to sustain their ecological values. Froend and Loomes (2004) report that it is highly likely that Loch McNess and Lake Wilgarup are entirely dependent on groundwater to support biophysical processes, habitat and consumptive use. The Aquatic Root Mat Community in Caves of the Swan Coastal Plain threatened ecological community also occurs within Yanchep National Park, with known extent limited to seven caves where groundwater fed stream or pools support an assemblage of aquatic invertebrates living in root mats of *Eucalyptus gomphocephala* (tuart). These locations are clustered around Loch McNess, Yonderup Lake and Wilgarup Lake within the National Park.

Where shallow depth to groundwater occurs, there is the ability for these areas to support terrestrial ecosystems that rely on seasonal or occasional interactions with groundwater for their survival. These terrestrial systems are commonly referred to as groundwater dependent ecosystems (GDEs). A review of the Groundwater Dependent Ecosystem Atlas's terrestrial GDE mapping (BoM 2019) shows that the development envelope occurs predominantly within an area identified as being of low potential for GDEs, with a small portion located in the area identified as having moderate potential for GDEs (Figure 9-4). The area mapped as moderate potential for the occurrence of GDEs has an estimated depth to groundwater of between 26 and 36 mbgl and is therefore unlikely to support GDEs in this location. No known GDEs occur within the development envelope.



Yanchep Rail Extension (Part 2)
Figure 9-2 Public Drinking Water Source Area & Water Corporation Bores

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Proposed PTA Bores
- Water Corporation Production Bore
- Proposed Water Corporation Production Bore
- National Park
- Surface Water Feature
- Priority 3 (P3) Perth Coastal and Gwelup Underground Water Pollution Control Area
- Existing Railway

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Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
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Yanchep Rail Extension (Part 2)
Figure 9-3 Groundwater Bores & Surface Water Features

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Water Corporation Production Bore
- Proposed Water Corporation Production Bore
- National Park
- Surface Water Feature
- Wellhead Protection Zone
- Proposed Station

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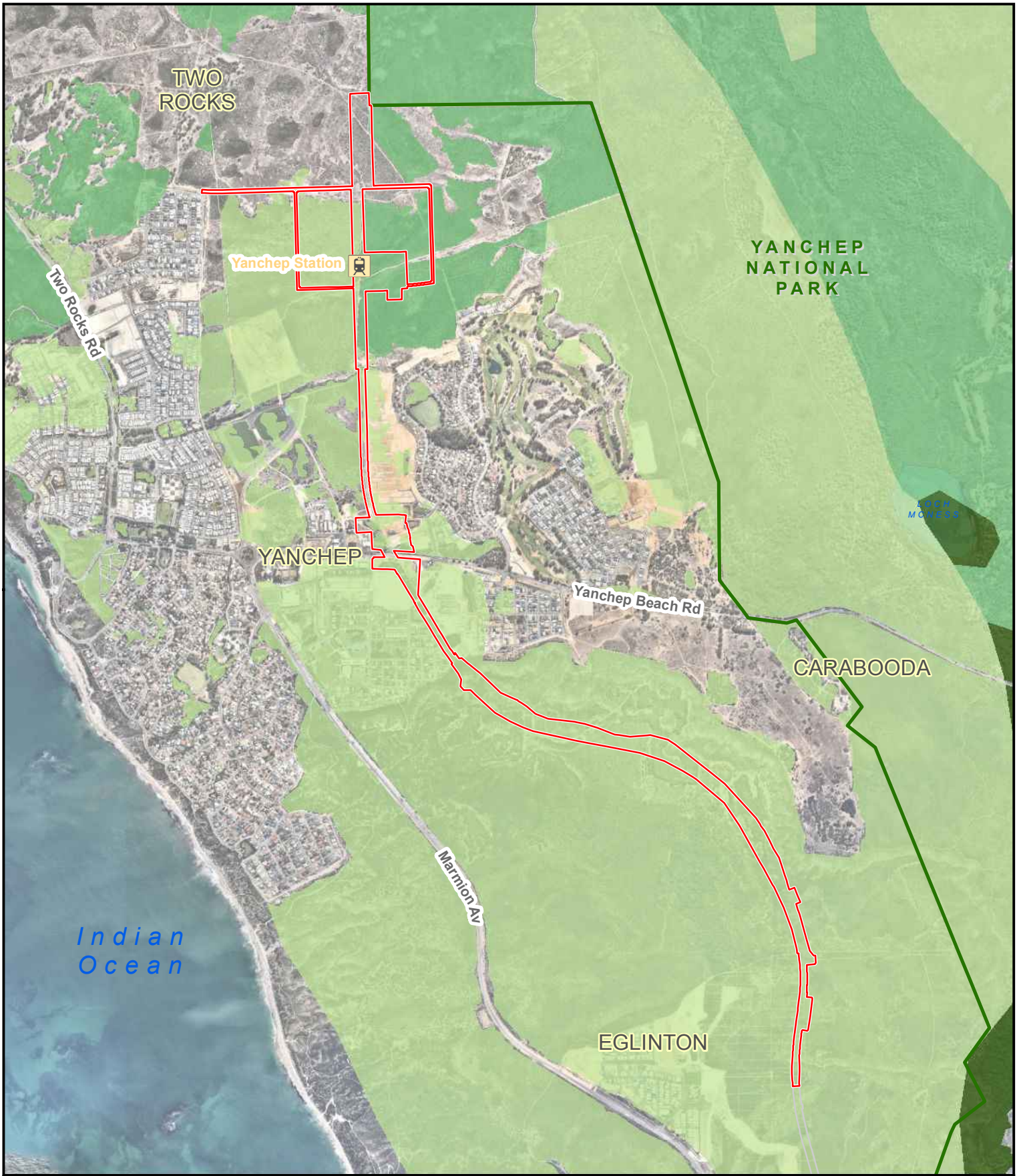
Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Yanchep Rail Extension (Part 2)
Figure 9-4 Groundwater Dependent Ecosystems

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- Proposed Station
- National Park

Terrestrial Groundwater Dependent Ecosystems

- Known GDE - from regional studies
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment

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Base Data: Nearmap 2018, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

9.4 Potential impacts

The Proposal has the potential to directly and indirectly impact on inland waters during construction and operation phases.

Potential impacts to inland waters as a result of the Proposal include:

- Changes to surface water flow paths, recharge locations or infiltration rates during rainfall events, as a result of alteration of landscape from construction earthworks, vegetation clearing or construction of hardstand areas.
- Water pollution impacts to Perth Coastal and Gwelup UWPCA (P3) from construction activities and chemical and hydrocarbon spills.

9.5 Assessment of impacts

9.5.1 Groundwater dewatering

The average depth to groundwater from the natural ground surface (approximately 23 m) is significantly greater than the average cutting works required for the Proposal (5 m). Dewatering will not be required during construction due to sufficient separation of the earthworks from groundwater and modification to the local groundwater aquifers from dewatering will be avoided. In May 2019 the PTA modified this Proposal to remove the requirement for groundwater abstraction.

9.5.2 Changes to surface water flow paths and groundwater recharge

The soils in the development envelope are naturally highly permeable with little runoff occurring and surface water features within the development envelope are absent. The alteration of existing surface water flow paths during rainfall events is unlikely to result in significant impacts to the existing local hydrological regimes. Given the distance between the development envelope and surrounding local and regional surface water features (see Figure 9-1), the surface water flows to these features would not be altered by the Proposal.

Construction of the railway and associated hardstand areas may result in changes to rainfall infiltration rates and recharge patterns at these locations during operation. The Proposal will minimise the volume of water directed to drainage basins through maximising infiltration at source within the railway corridor open drains. Stormwater systems will incorporate WSUD to facilitate infiltration at source. Given the highly permeable soils and linear nature of the Proposal, runoff, localised modification to infiltration locations and infiltration generated from hardstand areas is unlikely to result in significant changes to the existing local hydrological regimes and is therefore also unlikely to contribute to cumulative impacts.

9.5.3 Potential contamination of groundwater or stormwater runoff

There is a low risk that groundwater could be contaminated during proposed construction and operation activities with potential sources including (but not limited to) uncontained spills such as during refuelling, maintenance and plant and vehicle fluid leaks. During operation of the railway and stations, there is a low risk of contaminated stormwater runoff resulting in contribution of contaminants to groundwater in the local vicinity. The likely potential for groundwater contamination is not expected to be substantially or materially different from the impacts of existing railway operations and stations across the Perth metropolitan area.

DWER's *Land Use Compatibility Tables for Public Drinking Water Source Areas* (DoW 2016) identifies that the land uses of 'Railway' and 'Railway Station' are 'Acceptable' and 'Compatible with Conditions' within UWPCA P3 areas respectively.

9.6 Mitigation

The Proposal has no potential to impact on groundwater as no dewatering or abstraction is required, and a very low potential to impact on surface water values. Due to the shallow depth of excavation required for the installation of the railway infrastructure (on average less than 5 mbgl) the construction activities do not require dewatering and the development envelope does not intersect any surface water features.

As an area under continuing urban expansion, the PTA acknowledges that the Water Corporation is continually planning future water production requirements in the Alkimos and Eglinton areas. The PTA will continue to liaise with the Water Corporation to understand the location of future production bores, associated Wellhead Protection Zones and related potential impacts from the Proposal.

The key issues for ongoing management are implementation of Water Sensitive Urban Design (WSUD) principals during detailed design and appropriate management of potentially contaminating activities and materials/chemicals. The application of the mitigation hierarchy for inland waters is outlined in Table 9-1.

The risk of groundwater contamination is low and will be mitigated through the implementation of the CEMP, the PTA's standard spill response framework for rail corridors and associated infrastructure during operation, and the PTA's EMS.

The CEMP is consistent with the following Water Quality Protection Notes (WQPN) 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.
- Roads near Sensitive Water Resources.
- Tanks for Mobile Fuel Storage in Public Drinking Water Source Areas.

The stormwater drainage philosophy for the Proposal recognises the benefits of incorporating WSUD principles into the overall project design. 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 P3 Perth Coastal UWPCA. Further information about WSUD is provided in Section 9.6.1.

Table 9-1: Application of mitigation hierarchy for inland waters

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Dewatering and abstraction of groundwater during construction reduces the availability of groundwater for local ESAs including nearby GDEs.	Construction of this Proposal does not require dewatering. In May 2019, the PTA modified this Proposal to remove the requirement for groundwater abstraction to remove the potential for impacts to local ESAs.	Not applicable.	Not applicable.	No residual impacts as the Proposal does not require dewatering or abstraction of groundwater.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Alteration of the existing landscape within the development envelope during construction which in turn alters the surface water flow paths and recharge locations during rainfall.	• No surface water features or drainage lines are located within the development envelope.	• Best practice WSUD principles will be incorporated into the design • The stormwater management approach for the proposed railway and station infrastructure will maintain the existing local hydrological flows and protect groundwater quality. • Stormwater design will incorporate WSUD to facilitate infiltration at source. Refer to Section 9.6.1 for further WSUD details. • The volume of water directed to drainage basins will be minimised through maximising infiltration at source within the railway corridor open drains. • 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 of WSUD infrastructure will be undertaken by the PTA on an as-required basis.	Not applicable.	• No change to surface water features. • Minor change to rainfall runoff and recharge within the development envelope. • This impact is not considered significant.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Changes to infiltration rates from the construction of hard stand areas resulting in changes to rainfall runoff and infiltration rates / recharge patterns during operation.	Not applicable.	• Best practice WSUD principles will be incorporated into the design. • The stormwater management approach for the railway and station infrastructure will maintain the existing local hydrological flows and protect groundwater quality. • Stormwater design will incorporate WSUD to facilitate infiltration at source. Refer to Section 9.6.1 for further WSUD details. • The volume of water directed to drainage basins will be minimised through maximising infiltration at source within the railway corridor open drains. • 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 will be undertaken by the PTA on an as-required basis.	Not applicable.	• Minor change to rainfall runoff and recharge within the development envelope. • This is not expected to cause a significant residual impact on the hydrological regime or dependent environmental values.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Contamination of groundwater during construction activities with potential sources including uncontained spills, refuelling and plant and vehicle fluid leaks.	• Storage of unnecessary types and volumes of hazardous materials will be avoided where practicable.	Implementation of the CEMP to minimise the risk of contamination, including: • Installation of drainage diversion around chemical storage areas. • Implementation of drainage controls to prevent offsite discharge of runoff. • Spill response procedures and training. • Storage of fuels or chemicals in bunds capable of storing 110% of the capacity of the largest storage tank. • Secondary spill containment around tanks (with a perimeter bund) with sufficient freeboard capacity to contain all captured rainwater from a 20-year average return interval, 72-hour storm. • Spill kits located in storage and refuelling areas. Implementation of the PTA's standard spill response framework for operational rail corridors.	Not applicable.	Contamination risk is managed with no significant residual impact to inland water quality.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Contaminated stormwater runoff from the operational railway and stations affecting groundwater quality.	• No fuel stored within the development envelope for during operation. • Fuel use will be restricted to vehicles operating and parking within the station.	• Implement drainage controls to prevent offsite discharge of runoff. • Implement the PTA standard spill response procedures, training and infrastructure for rail corridors. • Stormwater and surface water management measures and controls will be designed with consideration of best practice WSUD principles, maximising infiltration at source. Drainage basins will be established to cater for high rainfall events (refer to Section 9.6.1 for further WSUD details).	Not applicable.	Contamination risk is managed with no significant residual impact to inland water quality.

9.6.1 Water sensitive urban design principles

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

- Maintenance of hydrological regimes by maximising infiltration at-source.
- Reduction of stormwater runoff volumes and peak flow rates.
- Prevention of water quality impacts on groundwater and receiving water bodies.
- Enhancement of public amenity through implementation of waterwise landscape designs.

The PTA has consulted with the DWER Urban Water Branch and the Water Corporation throughout the conceptual design development for station drainage and the general railway alignment. The adoption of WSUD and management of impacts to the Perth Coastal UWPCA and associated existing and future WHPZ have been key considerations in the early planning phase. This consultation will be ongoing through the construction phase of the YRE Project and into operations. The conceptual location of drainage infrastructure is provided in Figure 9-5.

The following WSUD strategies will be implemented where practicable on the Proposal:

- Management of the first 15 mm of rainfall at-source as much as practicable.
- Minimising the volume of water directed to large drainage basins (Figure 9-5) through maximising infiltration at source within the railway corridor open drains.
- Selection of water-efficient fixtures and appliances to reduce the use of mains water and water consumption.
- Adoption of waterwise landscape design and installation of water-efficient irrigation systems within the station sites.
- Provision of flood protection of critical infrastructure, to enable the railway to remain operational during major flood events.

The Proposal is not yet at the detailed engineering design phase where WSUD principles will be applied more fully. However, WSUD considerations incorporated into the conceptual drainage designs for the Proposal are described in Table 9-2.

Table 9-2: Water sensitive urban design principles incorporated into the Proposal's conceptual design

Drainage system	Description
Open surface 'V' drains	A standard 500 mm or 375 mm deep drain is proposed for areas adjacent to passenger railway lines. The design of the open drain changes according to the available space by varying the width and depth while maximising hydraulic efficiency. In some areas pit and pipe drainage will be used to ensure design requirements related to flooding depth are maintained at acceptable levels.
Pit to pipe	A pit to pipe system, where water is collected and transported for discharge elsewhere, is used where space restrictions constrain the installation of a surface V drain or where an area needs to be filled for infrastructure or access requirements. Based on conceptual designs, pit to pipe may be used to longitudinally convey stormwater along the railway corridor located directly under the open swale drains.

Drainage system	Description
Open infiltration basins and closed detention basins	Basins are included in the conceptual design to reduce post-development flows to pre-development levels and to maintain flood immunity. Locations for basins are chosen based on suitable availability of adjacent land and topography. Basins are proposed on the east side of the rail corridor to reduce the number of required pipe crossings to convey flows. Conceptual basin storage volumes range from 1,200 m^3 to 12,600 m^3. The PTA is committed to implementing best practice WSUD principles in the design of the stormwater management approach for the railway and station infrastructure. Where there is sufficient clearance from the operating railway, basins will be planted with appropriate species to support improved water quality through biofiltration.

The design process will also consider the following:

Development of 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 (DoW 2007a).
- WSUD brochures published by DWER (available at www.dwer.wa.gov.au).
- Incorporation of WSUD into procurement and contractual documentation.
- Provision of design guidance for development of the station precincts including WSUD requirements.
- Potential groundwater contamination.

The PTA has adopted a strategy for ensuring that WSUD principles are applied and the Perth Coastal UWPCA is protected throughout the design, construction and operation of the Proposal:

1. Develop detailed drainage designs in accordance with the principles contained in the following guidelines:
    a. Decision process for stormwater management in Western Australia, November 2017 (DWER 2017).
    b. Stormwater Management Manual for Western Australia (DoW 2007a).
    c. WSUD brochures published by the DWER (available at http://www.dwer.wa.gov.au).
2. Advice will also be sought from the DWER Urban Water Branch throughout the design and construction of drainage infrastructure.
3. Incorporate the adoption of WSUD guidance documents into procurement and contractual documentation.
4. Implement the following WQPN that are of relevance to 'railway' land uses, as identified in DWER's Land Use Compatibility Tables for Public Drinking Water Source Areas (DoW 2016):
    a. Contaminant Spills – Emergency Response (DoW 2006a);
    b. Roads Near Sensitive Water Resources (DoW 2006b);
    c. Tanks for Mobile Fuel Storage in Public Drinking Water Source Areas (DoW 2013); and
    d. Infrastructure Corridors Near Sensitive Water Resources (DoW 2007b).
5. Incorporate management actions to avoid potential impacts to the groundwater and WHPZ within the CEMP (ELA 2019; Appendix Q).
6. The PTA to maintain the railway stormwater management system and landscaping elements during the operational phase.

Key DWER staff will be invited to attend meetings with proponents early in the procurement phase to assist progressing the next stage of planning and design. The PTA anticipates conditions of development approval for the new train station will require provision of a Water Management Strategy (or similar) to the satisfaction of the approving authority. These documents will be developed with consideration to WSUD design principles and guidelines.

The METRONET office will also provide design guidance for development of the METRONET 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.

Yanchep Rail Extension (Part 2)
Figure 9-5 Conceptual Locations of Drainage Infrastructure

Public Transport Authority

Legend

- Development Envelope
- YRE Part 1
- National Park
- Surface Water Feature
- Indicative Drainage Basin
- Proposed Station

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9.7 Predicted outcome

Inland waters values include the ability of water to sustain vegetation, aquatic fauna and birdlife and the ecological processes that support them, along with beneficial uses including the use of water for drinking and industry.

The Proposal has a very low potential impact on groundwater and surface water values as there is no dewatering required to support construction activities and there is over 11 m to 32 m clearance to groundwater within the development envelope. The Proposal does not intersect any surface water features and the PTA is not proposing abstraction of groundwater for this Proposal.

The predicted residual impacts of the Proposal on inland waters are:

- No change to surface water features and minor change to rainfall runoff and recharge patterns within the development envelope.
- Minor contamination risk that can be appropriately managed, with no significant residual impact to inland water quality.

Through the implementation of the mitigation hierarchy (Table 9-1), the residual impacts of the Proposal to inland waters are not expected to be significant at a local or regional scale. Under the WA Environmental Offsets Guidelines, offsets could be required where these potential changes to the hydrological regime and quality are likely to result in impacts to values including:

- The CCWs within Yanchep National Park (based on existing significant cumulative impacts to CCWs).
- Aquatic Root Mat Communities (protected by statute).
- Groundwater dependent vegetation within Yanchep National Park or Bush Forever sites (areas managed for conservation).
- Water sources necessary to maintain Carnaby's Cockatoo (a threatened species).

Considering the minor extent of the residual impacts identified, these are considered consistent with the maintenance of the environmental values above and other environmental values that are supported by existing hydrological regimes and quality. As such, offsets are not proposed.

Given the above, and the PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects, it is considered that hydrological regimes and quality will be maintained such that the environmental values they support will not be affected and the EPA's objective for inland waters will be met.

10 Social surroundings

10.1 EPA objective

The EPA's objective for social surroundings is to protect social surroundings from significant harm (EPA 2018e).

10.2 Policy and guidance

The following policies and guidance are relevant to the social surroundings factor:

- Environmental Factor Guideline: Social Surroundings (EPA 2016j).
- The PTA's Noongar Standard Heritage Agreement.
- SPP 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning (Government of Western Australia 2009) and accompanying guidelines.
- 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) (Standards Australia 1990).
- A Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Site Remediation and other Related Activities (DEC 2010).
- SPP 3.7: Planning in Bushfire Prone Areas (DoP and WAPC 2015) and associated Guidelines for Planning in Bushfire Prone Areas v 1.3.

10.3 Receiving environment

Social surroundings include the aesthetic, cultural, economic and social values of the environment, which affect or are affected by physical and biological surroundings. They also include Aboriginal heritage and culture, natural and historic heritage and amenity (EPA 2016j). A description of social surroundings relevant to the Proposal is provided below, as well as baseline information for emissions (noise, vibration and dust) and bushfire which have potential to impact on economic and amenity values.

10.3.1 Aboriginal heritage and cultural values

Previous studies

A number of studies have been undertaken to determine the Aboriginal heritage values relevant to the development envelope, including the potential impacts of the Proposal. These studies include:

- John Cecchi Heritage Management Consulting (2013) – *Report on an Archaeological Survey of the Butler to Yanchep Railway Alignment*.
- R. & E. O'Connor Pty Ltd (2017a; Appendix M) – *Aboriginal Heritage Survey of Proposed Northern Suburbs Railway Extension Alignment*.
- R. & E. O'Connor Pty Ltd (2017b; Appendix N) – *Addendum to Report on the Aboriginal Heritage Survey of the Northern Suburbs Railway Extension*.

An Aboriginal Heritage Survey was conducted in April 2017 (R. & E. O'Connor 2017a; Appendix M) to identify potential Aboriginal heritage values in the development envelope that may be of significance to the Whadjuk people, the traditional owners of the area. The survey included:

- A desktop assessment of existing databases
- On-site inspection of areas of proposed works by a qualified anthropologist
- Consultation with Whadjuk representatives nominated by the South West Aboriginal Land and Sea Council (SWALSC)
- Inspection of areas of proposed works by Whadjuk representatives in conjunction with the survey author and the PTA representatives.

In October 2017, Whadjuk representatives, in conjunction with the survey author and the PTA representatives, conducted a second survey of the proposed station sites and associated facilities (R. & E. O'Connor 2017b; Appendix N).

Regional context

Noongar people are the traditional owners of the southwest of Western Australia. The development envelope is located wholly within the Whadjuk region, which is subject to the Whadjuk People Indigenous Land Use Agreement. The Whadjuk region is the name of the dialectal group from the Perth area that includes the major cities and towns of Perth, Fremantle, Joondalup, Armadale, Toodyay, Wundowie, Bullsbrook and Chidlow (SWALSC 2018).

A number of significant sites are present within the Whadjuk Region and include, but are not limited to, Karra katta or Geenunginy Bo (known as Kings Park), Dyarlgarro Beeliear (known as Canning River) and Derbal Yiragan (known as Perth estuary waters) (SWALSC 2018).

A desktop search of the Department of Aboriginal Affairs Aboriginal Heritage Inquiry System, conducted as part of the 2017 Aboriginal heritage survey, identified a number of registered Aboriginal sites in proximity to (at a distance of less than 5 km), but outside of, the development envelope. These sites are identified in **Table 10-1** below.

Table 10-1: Registered Aboriginal sites located within 5 km of the development envelope

Site ID	Site Name	Site type	Location in relation to the development envelope
1018	Doggarch	Mythological, rockshelter, camp	2 km east of development envelope
3186	Yonderup cave	Skeletal Material / Burial, Other: PA 77	3 km east of the development envelope
3742	Loch McNess, Wargardu Spring	Ceremonial, Mythological, Camp, Massacre, Meeting Place, Water Source	3 km east of the development envelope
17451	Pipidinny Lake	Mythological	1.6 km southeast of the development envelope
3394	Yanchep Beach	Artefacts / Scatter	0.6 km west of the development envelope

Source: R. & E. O'Connor (2017a; Appendix M)

Local context

There were no registered Aboriginal sites located within the development envelope. No Aboriginal sites were identified during the site survey undertaken for the Proposal.

10.3.2 Natural and historic heritage values

Previous studies

A desktop search has been conducted of the State Heritage Office's inHerit database and the City of Wanneroo's Scheme Heritage List (RPS 2018a).

Regional context

A search of the inHerit database for State Heritage Places within the City of Wanneroo identified a total of 23 State Registered Places. All of these are located outside of the development envelope.

State Heritage Place, Yanchep National Park Precinct, is located immediately east of the development envelope. The Yanchep National Park Recreation Hall Site is located over 5 km to the east of the development envelope.

Numerous other sites are listed on the City of Wanneroo Scheme Heritage List, however none are located inside the development envelope.

Local context

No heritage places listed on the State Register of Heritage Places or the City of Wanneroo's Scheme Heritage List are located within the development envelope (RPS 2018a).

10.3.3 Existing bushfire risk

No previous quantitative studies have been undertaken to assess potential bushfire impacts associated with the Proposal. A broad characterisation has been undertaken of the current, pre-construction risk of bushfire to people, property and infrastructure along the proposed alignment that could be impacted by bushfire during construction and operation of the Proposal.

The Proposal is situated in a designated bushfire prone area as per the *Western Australia State Map of Bush Fire Prone Areas* (DFES 2018). Existing bushfire risk is present within the proposed alignment given a range of natural and anthropogenic factors including the proximity to road and electrical infrastructure and urbanised areas. Existing likely sources of ignition include:

- Lightning strike;
- Deliberate and accidental human-induced ignitions; and
- Power lines.

Vegetation within and surrounding the proposed alignment includes a combination of shrubland, scrub, woodland, forest and grassland bushfire fuels under varying slopes. As a result, there is existing inherent bushfire risk to majority of the proposed alignment. The development envelope also traverses cleared and urbanised areas where bushfire risk is considered to be greatly reduced due to the absence of bushfire prone vegetation.

10.3.4 Amenity

Previous studies

A noise and vibration assessment was undertaken by Lloyd George Acoustics (2018b) which assessed the noise and vibration levels associated with the operation of the proposed railway upon sensitive receptors. Other previous studies that are relevant to the Proposal include:

- Herring Storer Acoustics (2012a) Northern Suburbs Railway Extension Butler to Yanchep, Noise Assessment.
- Herring Storer Acoustics (2012b) Northern Rail Extension Romeo Road to Yanchep – Ground Vibration Assessment.

Noise monitoring was undertaken on the existing rail alignment south of Butler Station by Lloyd George Acoustics (2018b) and used to inform the noise predictions for the Proposal.

Vibration monitoring was undertaken by Herring Storer Acoustics (2012a) adjacent to the existing Northern Suburbs Railway and used to inform the vibration assessment.

Local and regional context

The development envelope is comprised predominantly of remnant native vegetation, including some Bush Forever sites, reserved for railways under the MRS. It is located adjacent to existing residential development and areas zoned for future urban development and associated uses.

Existing residential developments adjacent to the development envelope are predominantly discrete, single-storey dwellings. Construction of new residential developments in proximity to the existing residential developments may contribute some noise disturbance to the local area. There are no other existing major sources of noise or vibration within or adjacent to the development envelope.

10.4 Potential impacts

The Proposal has the potential to directly and indirectly impact social surroundings during construction and operation phases.

The following direct impacts have the potential to occur:

- Disturbance or damage to artefacts or other items of Aboriginal cultural significance.
- Noise and vibration disturbance to nearby sensitive receptors from Proposal construction and railway and station operation.

The following indirect impacts have the potential to occur:

- Bushfire resulting in damage to people, property or infrastructure.
- Dust disturbance to nearby sensitive receptors as a result of clearing and construction.

10.5 Assessment of impacts

10.5.1 Disturbance or damage to artefacts or other items of Aboriginal cultural significance

A potential direct impact to social surroundings is the disturbance of, or damage to, previously undiscovered or buried artefacts or other items of Aboriginal cultural significance as a result of vegetation clearing and construction activities. Areas of dense scrub vegetation may conceal items on the soil surface, while buried items may be present elsewhere.

Given that the Aboriginal heritage surveys conducted to date in conjunction with Whadjuk representatives have only recorded a low number of isolated quartz scatters in one location associated with YRE Part 1, it is considered unlikely that significant artefacts remain undiscovered, unless they remain below the soil surface.

Engagement of Aboriginal monitors during initial clearing and construction at the Yanchep station site will assist identifying and managing any potential disturbance to previously unidentified artefacts of Aboriginal significance.

Cumulative impacts from the Proposal include the potential disturbance of, or damage to, items of Aboriginal cultural significance. Given the limited findings of previous Aboriginal heritage surveys, and the extensive areas of remnant native vegetation within the development envelope which suggest limited prior disturbance other than a small number of tracks, it is considered likely that previous impacts to Aboriginal cultural values in the development envelope are limited.

10.5.2 Bushfire impacts to people, property and infrastructure

SPP 3.7: Planning in Bushfire Prone Areas (DoP and WAPC 2015) and the associated Guidelines for Planning in Bushfire Prone Areas v 1.3 recognise railways as a high-risk land use which may potentially ignite a bushfire. In the context of social surroundings, a bushfire as a result of the Proposal has the potential to directly impact on the amenity and economic values within and adjacent to the development envelope through impacts to people, property or infrastructure.

No quantitative studies were undertaken to assess potential bushfire impacts associated with the Proposal, however, broad characterisation has been undertaken of the current pre-construction risk of bushfire to people, property and infrastructure along the proposed alignment that could be impacted by bushfire during construction and operation of the Proposal (see Section 10.3.3).

The Proposal, if implemented will remove 49.17 ha of native vegetation along the alignment to allow for the construction of the railway and establishment of the wider railway easement. Removal of vegetation will provide some reduction in risk, by reducing bushfire fuel loads within and directly adjacent to the railway as well as providing a separation between electrical / rail infrastructure and adjoining vegetation. This clearing will create a fire break, particularly within the Bush Forever Site. While the clearing will ultimately reduce the risk of bushfires within the alignment, clearing activities and operation of the Proposal will introduce potential ignition sources within the alignment that are not currently present.

During construction, the movement of machinery, operation of plant and equipment (particularly hot works) and the presence of large numbers of contractors will introduce ignition sources with the potential to ignite a bushfire. During operation of the Proposal, scheduled maintenance works (particularly hot works) as well as sparks from rail grinding during train running have potential to cause ignition of a bushfire event. In addition, there is potential for ignition from overhead electricity feeders caused by a number of events not limited to:

- Vegetation and animals making contact with powerlines
- Wind causing powerlines to make contact with each other or with other objects
- Direct lightning strikes to power lines
- Powerline failures through the breakage of wires, poles and other infrastructure.

Regarding powerline failures, as infrastructure and asset age increases, the risk of infrastructure failure causing bushfire ignition becomes more relevant. A system of prioritised maintenance according to the value/importance of the asset, its risk of causing bushfire ignitions and its vulnerability to bushfire attack is critically important.

A quantitative bushfire risk assessment has not been undertaken, however SPP 3.7 and the associated Guidelines list railways as a high-risk land use. It is therefore considered that there is inherent bushfire risk to and from the Proposal, with the potential to impact people, property or infrastructure, unless appropriate mitigation and management measures are implemented.

10.5.3 Noise and vibration disturbance to nearby sensitive receptors

Potential direct impacts of the Proposal to social surroundings includes noise and vibration disturbance during both the construction and operational phases of the Proposal.

Operation of the proposed railway may result in noise and vibration disturbance to nearby sensitive receptors, while operation of the stations may result in noise disturbance. Noise generated from railway stations will be assessed during the detailed design stage for each station and is not considered further in this document.

To assess noise and vibration impacts from the operation of the proposed railway, modelling was undertaken in accordance with the methodology outlined in Lloyd George Acoustics 2018b. The proposed railway design, planned groundworks and existing topographical data were used in the modelling, including the alignment positioned within a cutting 4 to 7 m deep, allowing a 3-dimensional model to be developed. The modelling considered variables such as expected train speeds, train configuration (length) and numbers of movements, existing noise sensitive premises, future residential developments and existing noise barriers. Modelling showed that without noise mitigation, the noise limits of 60 dB $L_{Aeq(Day)}$ and 55 dB $L_{Aeq(Night)}$ would be exceeded at a number of noise sensitive premises (Lloyd George Acoustics 2018b).

The vibration modelling used specific criteria for ground-borne vibration from the *Australian Standard AS 2670.2-1990: Evaluation of human exposure to whole body vibration – Part 2: Continuous and shock inducted vibration in buildings (1 to 80 Hz).* The vibration assessment for railway operation showed that without vibration management measures, the vibration criterion of 103 dB_v (Curve 1.4) would be slightly exceeded at a number of locations along the alignment. This is considered to be due to the nature of the ground conditions in some locations (Lloyd George Acoustics 2018b).

Cumulative impacts to social surroundings as a result of noise and vibration are expected to relate to current and future residential development, which will give rise to noise from construction of new local

roads and residential properties. Once constructed, increased traffic movements are expected to increase background noise levels. The implementation of management measures and regulatory controls will ensure that this Proposal, combined with other noise sources, will meet both noise and vibration criteria.

10.5.4 Dust disturbance to nearby sensitive receptors

In high wind conditions, dust may be temporarily generated during the construction phase. Dust may be deposited on adjacent sensitive receptors, which are predominantly residential dwellings, some of which are yet to be constructed. The development envelope is within close proximity to a number of established residential areas and residential developments which are currently under construction. These construction areas may contribute airborne dust to the local area. The composition of dust particles will reflect the composition of the materials (sands and limestone) which underlie the area.

Dust generation may arise as a result of construction activities associated with the Proposal. Sources of dust that may be generated include:

- Vegetation clearing activities
- Excavation activities
- Exposed surfaces post land clearing activities
- Construction of infrastructure
- Crushing activities
- Vehicle movements.

Given the majority of the land adjacent to the development envelope supports native vegetation, the potential for dust to cause a nuisance to residents is expected to be low. Dust may be deposited on adjacent sensitive receptors, which are predominantly residential dwellings predominantly in the vicinity of Yanchep Beach Road, Bulburin Parade and Burleigh Boulevard, Yanchep. No quantitative studies were undertaken to assess dust impacts associated with the Proposal.

Dust will be managed in accordance with the CEMP. As a result, potential dust generation is expected to be of a short-duration and will not result in permanent impacts to local amenity. On this basis, it is considered unlikely that the Proposal will result in significant harm to the social surroundings as a result of dust.

Cumulative impacts of the Proposal, as a result of dust, are likely to be minimal. The development envelope is within close proximity to a number of established residential areas and residential developments which are currently under construction. These construction areas may also contribute airborne dust to the local area; however, there are strict dust management guidelines and policies which construction sites must adhere to. With the application of management measures, it is considered unlikely that potential cumulative impacts of dust from the Proposal, combined with existing dust sources, will cause significant harm to the social surroundings of the local area.

10.6 Mitigation

Table 10-2 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to social surroundings to address key potential impacts. Management plans including a CEMP (ELA 2019; Appendix Q) and NVMP (Lloyd George Acoustics 2018a; Appendix L) have been developed for construction and operation of the railway. The PTA also operates in accordance with their environmental management system, which establishes standard environmental management practices

(PTA 2014). Construction contractors will be required to prepare CEMPs in accordance with the environmental management system. Relevant mitigations for impacts to social surroundings from these plans have been replicated in **Table 10-2** and further information on these measures is provided below.

10.6.1 Aboriginal heritage

Consistent with the recommendations made by O'Connor (2017b; Appendix N), the PTA will ensure an Aboriginal monitor is present onsite during clearing of groundcover and initial groundworks at the Yanchep station site, to identify and manage any potential artefacts or objects of Aboriginal significance which may be unearthed during construction, in accordance with the request of the Whadjuk representatives. In the event that objects of Aboriginal cultural significance are identified during construction activities, the number and description of these will be recorded, and reported to the DPLH.

10.6.2 Dust

The PTA will implement a range of dust control measures during construction. These include the application of water to exposed surfaces, unsealed roads and access tracks, the use of hydromulch as required in areas that will remain cleared for extended periods and stockpiles, wind break fencing and implementation of vehicle speed limits, to reduce the potential for dust generation. Daily weather forecasts will be monitored and, where practicable, construction activities will be limited during high wind conditions. Daily visual monitoring of airborne dust will be conducted throughout the duration of construction to identify airborne dust and deliver effective management measures.

Should limestone crushing be required onsite, the PTA may be required to licence the site as a prescribed premise under Part V of the EP Act. The requirement to licence the activity would be based upon the volume of limestone required to be crushed.

10.6.3 Noise and vibration

The CEMP restricts construction of the Proposal to standard construction hours of 7.00 am to 7.00 pm on days other than Sundays and public holidays unless an OHNMP has been prepared and approved by the City of Wanneroo. The OHNMP will identify reasons for the construction work, the type and duration of work to be undertaken, predicted noise emissions, noise management measures to be implemented during the out of hours work, monitoring of noise and vibration and procedures for receiving, handling and responding to any potential noise and vibration complaints. The PTA will implement noise and vibration controls in accordance with *AS 2436-2010 (R2016) Guide to noise and vibration control on construction, demolition and maintenance sites*.

The NVMP (Lloyd George) recommends the construction of noise barriers, façade treatments and/or the combination of both along the rail reserve boundary at all identified and existing noise sensitive premises where noise limits are predicted to be exceeded.

The required extent, location and height of noise walls will be progressively reassessed by a suitably qualified person/consultant/engineer as the following detail becomes available:

- Detailed design levels of the railway
- Detailed design levels and layout of the surrounding future developments
- Confirmation of noise wall and building facade noise control packages implemented by surrounding developments where required as part of the subdivision approval conditions.

Under the policy, building facade noise control packages allow higher noise levels external to the building by maintaining acceptable internal noise levels. While custom facade packages can be designed by an acoustical consultant, the policy guidelines have three "deemed to comply" façade packages, being

Package A, B and C. Package A is required for external noise levels between 55 and 60 dB LAeq(Day), Package B is required for external noise levels up to 63 dB LAeq(Day) and Package C is s required for external noise levels up to 65 dB LAeq(Day). The use of facade protection can result in lower noise walls where considered appropriate.

The responsibility for construction of noise walls will also need to be determined in accordance with Policy recommendations. Where a new rail infrastructure project is to be constructed in the vicinity of a future noise-sensitive land use, the infrastructure provider and developer are both responsible for ensuring that the objectives of the policy are achieved, and a mutually-beneficial noise management plan, including individual responsibilities, should be negotiated between the parties.

The height of the noise barriers will vary based on location but will be built to a maximum height of 4 m where deemed necessary. This height this is considered appropriate to reduce noise levels at noise sensitive premises to below the policy noise limit (Lloyd George Acoustics 2018a; Appendix K). Further detailed modelling will be provided to confirm the height and location of the required walls at detailed design phase for each area. The PTA will work closely with adjoining land developers to develop appropriate noise mitigation measures in locations where no residential development is currently in place.

The previous Butler rail extension resulted in a number of properties experiencing structure-borne regenerated noise issues (rumbling) as trains passed by (RPS 2018a). As a result of this, the PTA has committed to the installation of ballast matting adjacent to all existing and approved future residential developments, regardless of the ground conditions and modelling outcomes, to reduce vibration levels by 10 to 15 dB_V. This will help achieve vibration levels that are well below the acceptable vibration criterion.

10.6.4 Bushfire

In managing its land, the PTA is responsible for ensuring fuel loadings and fire breaks are maintained to an acceptable level in accordance with the *Bush Fires Act 1954*. The PTA have developed a Bushfire Management Strategy (PTA 2018) which responds to this requirement and aims to reduce the risk of bushfire to human settlement, economic, environmental and cultural assets on the PTA land. The strategy applies to all activities and operations undertaken by the PTA and its contractors and subcontractors on the PTA land (including construction, maintenance and operational activities).

Bushfire risk management actions and a full risk assessment will be provided in a Bushfire Risk Management Plan (BRMP) pre-construction as per the requirements of SPP 3.7 and the Guidelines for high-risk land uses. This BRMP will be prepared in accordance with Australian and New Zealand Standard *AS/NZS ISO 31000:2018 Risk Management – Guidelines* (SA & SNZ 2018) which provides an internationally recognised approach to risk management. Methodology for this process is further described in *Risk Management Guidelines: Companion to AS/NZS 4360/2004* (SA & SNZ 2004). AS/NZS ISO 31000:2009 is adopted by DFES, as documented in the agency's Bushfire Risk Management Framework (DFES 2015), to formalise and communicate the approach of managing bushfire risk across the department in the aim of leading to improved coordination and effectiveness of bushfire risk management processes. The BRMP will reference the requirements of the Bushfire Management Strategy (PTA 2018).

Table 10-2: Application of mitigation hierarchy for social surroundings

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Disturbance or damage to artefacts or other items of Aboriginal cultural significance	• No heritage places listed on the State Register of Heritage Places or the City of Wanneroo's Scheme Heritage List were identified within the development envelope.	• A monitor will be on-site during clearing and initial groundworks at the Yanchep station sites, to identify and manage potential artefacts or objects of Aboriginal cultural significance.	Not applicable.	• Potential disturbance to previously unidentified Aboriginal artefacts
Bushfire ignition resulting in damage to people, property and/or infrastructure	Not applicable.	• Bushfire risk management actions and a full risk assessment will be provided in a BRMP pre-construction as per the requirements of SPP 3.7 and the Guidelines for high-risk land uses. The BRMP will reference the requirements of the Bushfire Management Strategy (PTA 2018). • BRMP to be prepared in accordance with Australian and New Zealand Standard *AS/NZS ISO 31000:2018 Risk Management–Guidelines* (SA & SNZ 2018).	Not applicable.	• Residual bushfire risk and therefore potential for impacts to people, property and infrastructure will remain while the railway assets and infrastructure remain in proximity to bushfire prone vegetation. With the proposed minimisation measures and appropriate management, it is considered these risks and impacts can be managed to as low as reasonably practical.
Noise and vibration disturbance to nearby sensitive receptors	Not applicable.	Implementation of a CEMP – action items to include: • Rail alignment to be constructed with an average cutting height	Not applicable.	• No exceedance of noise or vibration criteria during construction or operation.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		of 6 m below existing ground levels (except where Bush Forever Site No. 289 is present). • Limit construction to standard construction hours to avoid after hours noise emissions. • In the event that out of hours construction is required, any works will be undertaken in accordance with an out of hours noise management plan approved by the City of Wanneroo. Implementation of the NVMP – action items to include: • Monitoring of noise to commence within three months of operation of the railway line extension, and again at 18 months to ensure that the noise attenuation measures implemented are effective. • Install ballast matting adjacent to existing and approved future residential developments, to		• Further mitigation of noise may occur as future subdivisions are developed and façade noise control packages are implemented.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		avoid vibration impacts to sensitive receptors. • Design and construct rail stations to meet station noise management targets. • Install noise barrier walls or other mitigation measures along the rail reserve boundary at all noise sensitive premises in consultation with urban developers. • Undertake rail maintenance to reasonably maintain the operational performance of the relevant railway infrastructure and reduce wear to trains. This will involve regular inspection of the rail condition and rail rectification/grinding to remove excessive roughness or corrugation which may develop over time.		

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Dust disturbance to nearby sensitive receptors	Not applicable.	Implementation of a CEMP – action items to include: • Monitor daily weather forecasts and where practicable, in high wind conditions, construction activities may be limited, to avoid dust generation. • Utilise water carts and hydromulch to minimise dust generation. • Enforce vehicle speed limits for all unsealed roads and tracks. • Install wind break fencing to prevent dust in high risk areas, during the construction phase. • Operate limestone crushing in accordance with a Part V Licence should limestone crushing onsite be required.	Not applicable.	• Potential minimal, short-term nuisance dust emissions.

10.7 Predicted outcome

The Proposal has the potential to cause the following impacts to social surroundings:

- Disturbance or damage to previously unidentified Aboriginal artefacts, during construction
- Dust disturbance to nearby sensitive receptors as a result of clearing and construction
- Noise and vibration disturbance to nearby sensitive receptors from Proposal construction, and railway and station operation
- Bushfire ignition resulting in damage to people, property or infrastructure during construction and operation.

Through the implementation of the EPA's mitigation hierarchy (**Table 10-2**), the residual impacts of the Proposal to social surroundings are considered to be as low as reasonably practicable and not significant. In reference to the WA Environmental Offsets Guidelines, social surroundings do not generally meet the description of values for which significant impacts may require offset. As such, offsets are not proposed. Given that the PTA proposes to manage potential impacts to social surroundings through the implementation of a CEMP and the PTA's past performance in implementing appropriate mitigation measures as part of the construction and operation of railway projects, the PTA considers that this Proposal can be managed to meet the EPA's objective for social surroundings.

11 Other environmental matters

The EPA identified a number of other environmental factors and/or matters relevant to the Proposal that must be addressed in this ERD. Project alternatives and air quality are discussed below in Sections 11.1.1 and 11.1.2 respectively. The remaining other matters requested in the ESD are addressed in other parts of this ERD – the principle of waste minimisation in Section 4.1 and MNES in Section 13.

11.1 Project alternatives

11.1.1 Alternative alignments and construction methods in Ningana Bushland

Alternative alignment options were originally considered by the PTA early in the detailed design of the YRE Project. In 2005, GHD was engaged by the PTA to investigate potential alternative railway alignment options for the portion of the alignment that transects Bush Forever Site 289 (Ningana Bushland). Alternative alignments were detailed within Northern Suburbs Railway Alignment Definition (Alkimos to Yanchep) Alignment Definition Report (GHD 2005). Four options were identified:

- Option 1: At grade construction along the referred alignment.
- Option 2: At grade construction along the alternative alignment.
- Option 3: Tunnel bore construction along the referred alignment.
- Option 4: Viaduct (bridges) construction along the referred alignment.

The referred and alternative alignments are shown on Figure 2-1. The referred alignment is generally equivalent to the development envelope for this Proposal.

Following a detailed review of the alternative alignment proposed by GHD, the PTA was unable to accept Options 2, 3 and 4 due to the following reasons:

- Track curvature was severe and below the minimum acceptable standards, which, if adopted, would have:
  - Resulted in speed restrictions that would increase the overall journey time of the trip.
  - Generated wheel squeal, which would result in significant noise impacts to existing and future adjacent residential development areas.
  - Higher operational and maintenance costs for track and rollingstock due to heavy breaking and wear and tear within this portion of the alignment.
- The alignment traversed highly undulating terrain which would require deep cuttings (up to 20 m) within the northern and southern ends of the alignment within Ningana Bushland. These deep cuttings would be required to achieve the required grades resulting in reserve widths approaching 100 m. This scenario would significantly increase the visual footprint of the railway, the total cost of earthworks (and the Proposal), impacts to landforms and the total clearing area of native vegetation and subsequent impacts to flora and fauna habitat.
- The alignment was 369 m longer, resulting in a larger development envelope, greater expense and longer overall travel time for passengers.
- The alignment would be located on the boundary of future residential development areas, presenting greater potential for community complaints, particularly given additional noise from wheel squeal.

- As development had already commenced within the southern Yanchep LSP, it was estimated that approximately 150 properties would need to be acquired to position the alignment on the eastern boundary of Ningana Bushland. Acquisition of land would also increase the total cost of the Proposal.
- To avoid impacts to Ningana Bushland and due to the required width for construction, the development envelope would encroach into land set aside for future urban development. This would result in the remaining corridor of developable land situated to the east between the future freeway and rail corridor no longer considered favourable for urban development by commercial developers due to:
    - Restricted access presented by the location of major transport arteries either side of the land.
    - The limited and narrow nature of the remaining corridor of developable land, which may be undesirable to future land purchasers, thereby reducing its value.

In 2018, the PTA revisited the two alignment options (Options 1 and 2) as part of the environmental planning phase of the Proposal. The alternative construction methods, such as tunnelling (Option 3) and viaducts (Option 4), were also considered again.

Options 3 and 4 were ruled out as they were prohibitively expensive. Option 2 has slightly more favourable environmental outcomes than Option 1, however the same determining factors that led to rejection of alternative options during the earlier planning stages were still significant issues for carrying this option forward. Option 2 was also estimated to be slightly more expensive than Option 1, as well as having unfavourable planning outcomes. Table 11-1 presents a comparison of the four options.

Railway engineering considerations during both construction and operation can impose significant constraints on the feasible choices for the alignment and construction method. The next section (following Table 11-1) provides a fuller discussion of some of these aspects.

Table 11-1: Comparison of alternative railway alignments and construction methods through Ningana Bushland

Aspect	Option 1: Referred alignment, at-grade construction	Option 2: Alternative alignment, at-grade construction	Option 3: Referred alignment, tunnel boring construction	Option 4: Referred alignment, viaduct (bridges) construction
Cut and fill requirements	Significant cut and fill required based on undulating landscape, with some areas of cut potentially requiring cut and cover tunnel sections due to dune height, however, this will be avoided where practicable.	Significant cut and fill required based on undulating landscape, with cutting up to 20 m in the northern and southern portions of the Bush Forever site. Some areas of cut may require cut and cover tunnel sections due to dune height, however, this will be avoided where practicable.	Minimal cut and fill required as the rail corridor will be constructed using a tunnel boring machine. Some cut to install emergency egress shafts and some cut and fill for construction of emergency/maintenance access roads and PSP.	Minimal cut and fill required due to the installation of piles for bridges being the primary construction method. Some cut and fill required for construction of emergency/ maintenance access roads and PSP.
Clearing of Bush Forever	Yes – approximately 28.8 ha.	Yes – approximately 22.1 ha.	Yes – some clearing required to create an entry point for mobilisation of the tunnel boring machine, installation of emergency egress shafts and the construction of emergency/ maintenance access roads and PSP. Total amount would depend on detailed design.	Yes – some clearing required due to install of bridge piles to support the viaduct rail and clearing also required for the construction of emergency/maintenance access roads and PSP. Total amount would depend on detailed design.
Clearing of native vegetation	Yes – approximately 20.7 ha.	Yes – approximately 21.4 ha.	Yes – some potential clearing due to the infrastructure requirements stated above. Total amount would depend on detailed design.	Yes – some potential clearing due to the infrastructure requirements stated above. Total amount would depend on detailed design.
Clearing of TEC	Yes – approximately 4.2 ha.	Yes – approximately 1.6 ha.	Yes – some potential clearing due to the infrastructure requirements stated above. Total amount would depend on detailed design.	Yes – some potential clearing due to the infrastructure requirements stated above. Total amount would depend on detailed design.

Aspect	Option 1: Referred alignment, at-grade construction	Option 2: Alternative alignment, at-grade construction	Option 3: Referred alignment, tunnel boring construction	Option 4: Referred alignment, viaduct (bridges) construction
Clearing of PEC	Yes – approximately 8.1 ha.	Yes – approximately 4.5 ha.	Yes – some potential clearing due to the infrastructure requirements stated above. Total amount would depend on detailed design.	Yes – some potential clearing due to the infrastructure requirements stated above. Total amount would depend on detailed design.
Impacts to landforms	Yes – disturbance/clearing of approximately 5.3 ha of parabolic dune.	Yes – disturbance/clearing of approximately 9.7 ha of parabolic dune.	Yes – potential clearing/disturbance to landforms the entire length of the alignment due to proposed tunnel boring.	Yes – some potential impact to landforms due to the installation of piles and construction of emergency/ maintenance access roads and PSP.
Fragmen-tation of fauna habitat	Yes – the estimated length of alignment through Ningana Bushland is 2.9 km. The alignment is positioned in a central portion of Ningana Bushland, travelling in a northsouth direction and will sever Ningana Bushland into two separate portions of land, leaving approximately 300 ha to the west and 130 ha to the east. Fauna crossing options are currently being considered to mitigate potential fragmentation impacts.	Yes – the estimated length of the alignment through Ningana Bushland is 3.3 km. However, the alignment will be positioned along the eastern edge of Ningana Bushland (with some intercepts in and out of the eastern Ningana Bushland boundary). This will result in severing through an approximately 600 m portion of Ningana Bushland, leaving approximately 410 ha to the west and 32 ha to the east. Therefore, there may be a moderate fragmentation impact.	No – the emergency/ maintenance access road and PSP will bisect Ningana Bushland, however fauna will still be able to move across the track/PSP (depending on the fencing used).	No – fauna will be able to move underneath the viaduct (bridges). The emergency/maintenance access road and PSP will bisect Ningana Bushland, however fauna will still be able to move across the track/PSP (depending on the fencing used).
Drainage / WSUD	Yes – drainage infrastructure required.	Yes – drainage infrastructure required.	Yes – drainage infrastructure required, however, will likely be below surface.	Yes – minimal drainage infrastructure required for bridge structure and PSP.

Aspect	Option 1: Referred alignment, at-grade construction	Option 2: Alternative alignment, at-grade construction	Option 3: Referred alignment, tunnel boring construction	Option 4: Referred alignment, viaduct (bridges) construction
Operational noise and vibration impacts to current and future development	Moderate operational noise and vibration impacts. Operational noise and vibration impacts have been modelled and can be mitigated through the use of noise walls and/or façade treatments.	Potentially high operational noise and vibration impacts as the railway will be positioned closer to the future urban development area. Tight curvature of the rail can also cause greater wheel squeal noise. Can be mitigated through noise walls and/or facade treatments, although mitigation methods for wheel squeal are less effective than for noise from the wheel/rail interface.	Moderate operational noise and vibration impacts are anticipated. Mitigation would likely be required for train users, and for future urban development near tunnel boring machine entry and exit points. Noise impacts could be mitigated through noise walls and/or façade treatments at tunnel entry and exit points.	Moderate operational noise and vibration impacts are anticipated and could be mitigated through noise walls and/or façade treatments.
Visual amenity	Moderate – at grade the rail may be visible to residents in the current and future urban areas immediately to the north and south of Ningana Bushland.	High – the at grade rail will be positioned directly adjacent future residents in the urban development to the east.	Low – tunnel with limited visual impacts to the surface.	High – viaduct (bridges) are expected to be highly visible from a distance.
Revegetation opportunities	Low – due to large footprint of permanent infrastructure.	Low – due to large footprint of permanent infrastructure.	High – due to smaller footprint of permanent infrastructure, as predominantly built below ground.	High – due to smaller footprint of permanent infrastructure.
Dust	Standard construction dust emissions.	Standard construction dust emissions.	Standard construction dust emissions.	Standard construction dust emissions.
Length	Referred alignment – considered base case for comparison purposes. Total length is approximately 2.9 km through Ningana Bushland.	Longer than referred alignment. Total length is approximately 3.3 km through Ningana Bushland, 0.4 km longer.	Longer than referred alignment due to depth of tunnel required when using a tunnel boring machine (approximately 15 m below ground surface along entire length of tunnel).	Comparable to length of referred alignment.

Aspect	Option 1: Referred alignment, at-grade construction	Option 2: Alternative alignment, at-grade construction	Option 3: Referred alignment, tunnel boring construction	Option 4: Referred alignment, viaduct (bridges) construction
Speed	Referred alignment – considered base case for comparison purposes. Estimated to travel up to speeds of 130 km/hr.	Slower than referred alignment due to increased length and the increased curvature of track may require restricted speed in sections.	Comparable to speed of referred alignment.	Comparable to speed of referred alignment.
Travel time	Referred alignment – considered base case for comparison purposes.	Longer than referred alignment due to increased length and anticipated speed restrictions in sections.	Comparable to travel time of referred alignment.	Comparable to travel time of referred alignment.
Gradient	Construction works in undulating land in Ningana Bushland to build rail at grade.	Construction works in undulating land in Ningana Bushland to build rail at grade.	Greater gradient required than other options due to depth of tunnel required when using a tunnel boring machine (approximately 15 m below surface along entire length of tunnel).	Milder gradient likely to be required.
Cost	Referred alignment – considered base case for comparison purposes.	Slightly more expensive than Option 1.	10x more expensive than option 1.	5x more expensive than Option 1.

11.1.2 Engineering constraints in railway construction and operation

One of the primary considerations in railway design is the horizontal and vertical geometry of the railway. Trains must be able to reach speeds of up to 130 km/h if the full benefits of the railway are to be realised in terms of providing a competitive travel time compared with private modes of transport. To enable trains to operate at these high speeds, horizontal curve radii must be at least 5,000 m. In practical terms, this means tight curves and steep grades must be avoided. Compared to roads, railways have much less flexible geometries.

Given the undulating topography of the dune systems and the geometrical design constraints, much of the railway must be constructed in areas of cut and fill, i.e. in cuttings or on embankments.

The proposed railway is predominantly located in cut to reduce noise impacts to existing and future residential development. This also facilitates the construction of bridges over the railway linking adjoining communities and avoiding at-grade level crossings. Grade separated crossing points are desirable as they eliminate the risk of traffic and pedestrian collision with trains, level crossing audible warning device noise and the time impost on traffic waiting at boom gates as trains move through the crossing.

Where batters are used, cuttings and embankments require larger areas of ground disturbance to accommodate the batters (slopes) back to the surrounding natural surface level. Sheet pile/retaining walls do not require as large an area of ground disturbance. Potential alternative construction options include retaining walls to limit the width of batters or fill embankments, cut and cover tunnels or tunnelling using a tunnel boring machine. These generally come with significantly increased costs.

As stated earlier, tunnelling options are considered prohibitively expensive in comparison with the proposed cut and cover and at grade methods. This is due to the high per-kilometre costs associated with tunnelling, the costs of specialist equipment, spoil management, transport, storage and disposal, and the cost of operating and maintaining a tunnel. Tunnels do not eliminate all surface level impacts, as laydown areas are required for tunnel boring machine ingress/egress, emergency access/egress shafts, and cleared areas for emergency access tracks and assembly points.

As an example, the total footprint of an existing egress site constructed as part of the PTA's Forrestfield Airport Link project is approximately 90 m x 45 m (0.4 ha), which includes:

- Imported fill to raise the site which has increased the overall size.
- The actual egress shaft itself with a 1.5 m buffer around for fencing and scaffolding.
- Crib sheds and toilet facilities.
- Stockpiling area for the temporary storage of material coming out of the shaft.
- Leachate collection basin (as the material coming out is potential acid sulfate soils (PASS)), which also acts as a surface water collection point for the site.
- Crane pad.
- Laydown area.

'Cut and cover' construction, which is an alternative to tunnelling, has most of the same drawbacks as tunnelling and it requires the disturbance of a greater amount of native vegetation during construction, although much of this can be rehabilitated once construction is complete. Below ground, both tunnelling and cut and cover options could have a greater impact on karstic limestone features, subterranean fauna habitat and groundwater resources.

Construction of the railway entirely on aboveground structures such as bridges or viaducts would be prohibitively expensive and would also introduce additional impacts to amenity, including noise and visual impacts. The operational cost of rail bridges is also significantly higher.

Given that a substantial proportion of the adjoining land use is planned for residential development (including the land east of Ningana Bushland, zoned as 'urban') and the engineering and economic constraints described above, the PTA has elected to construct the Proposal generally within cuttings averaging 6 m below ground level. Lowering the railway has the additional benefit of significantly reducing noise to surrounding urban developments, which will include large numbers of residential dwellings. This excludes the portion of the alignment through Ningana Bushland.

Batters will be revegetated with native species providing some visual relief along the rail corridor. Exceptions will include batters that are too steep or not of suitable material (e.g. hard limestone ridges) or where infrastructure such as stairs or other operational requirements need to be provided. In these instances, alternative stabilisation measures will be used.

Three different batter/retaining options were considered for the construction of the alignment at grade through Ningana Bushland to compare and minimise environmental impacts and cost. A high-level assessment of the three options is summarised in Table 11-2. Final construction methods will be dictated in the detailed design phase, following completion of geotechnical investigation. It is likely that a combination of all three construction methods and potentially a bridged area over undulating landscape in place of fill will be used through the length of the alignment traversing Ningana Bushland.

Table 11-2: Batter options for the referred alignment through Ningana Bushland

Element	Option 1A Referred alignment, at-grade construction with 1:2 batters	Option 1B Referred alignment, at-grade construction with 1:3 batters	Option 1C Referred alignment, at-grade construction with retaining walls
Batter type	1:2	1:3	Retaining wall in place of batter.
Opportunity to landscape batters	More difficult to control erosion and establish plant cover on steeper batter gradient.	Best option for minimising erosion and establishing plant cover.	None.
Base width	30 m	30 m	40 m
Railway length	2.9 km	2.9 km	2.9 km
Total surface area of impact (assuming a hypothetical 50 m cross-section for comparison purposes)	14.3 ha	16.7 ha	12.9 ha
Estimated volume of surplus fill	68,193 m^3	90,138 m^3	32,405 m^3
Cost	Estimated to be cheaper than base case.	Considered base case for comparison purposes.	Approximately 16x more expensive than base case.

11.2 Air quality

Jacobs (2019a; Appendix S) undertook a qualitative air quality assessment of the net benefits associated with air quality expected due to the construction of YRE Part 2. Due to urban growth in the Yanchep area, an increase in demand for public transport is anticipated, without the expansion of the rail line to Yanchep the main roads in the area would see increased traffic and a rise in congestion (Jacobs 2019a).

The impact on air quality from increased traffic would cause an increase in vehicle-derived pollutant concentrations and would likely affect sensitive receptions such as residences close to Marmion Avenue between Eglinton and Yanchep. An increase in concentrations of particles less than 10 microns in diameter (PM_{10}) and less than 2.5 microns ($PM_{2.5}$) would be expected. When vehicle engines operate less efficiently (during congestion) the more emissions of pollutants are emitted per kilometre travelled. These particles are higher risk pollutants, due to the high background levels that occur occasionally (especially during smoky conditions) (Jacobs 2019a; Appendix S). YRE Part 2 is anticipated to reduce traffic congestion and the number of vehicles travelling between Eglinton and Yanchep, as it will mean fewer vehicles on the road, reduced air pollutant emissions (more efficient operating vehicle engines) and faster traffic movement that will reduce travel times (Jacobs 2019a; Appendix S).

11.2.1 Greenhouse gas emissions

Greenhouse gas emissions are Australia's third largest source of emissions, accounting for 18% of total greenhouse gas emissions in 2015 (Climate Council 2016). Almost half of Australia's transport emissions are attributed to cars, with road transport overall making up 85% of greenhouse gas emissions.

Table 11-3 shows the average emissions intensity of several modes of transport. Emissions from mass transit options – including urban passenger rail – vary substantially due to energy sources and the number of people using them. However, they are considerably less emissions intensive than cars, particularly in peak periods when passenger numbers on mass transit are higher and many private cars are carrying a single occupant.

Table 11-3: Emissions for different modes of transport

Transport mode	Average emissions per kilometre (g CO_2/km) Information source
Metro train systems	3–21 per person
Light rail	4–22 per person
Bus rapid transit systems	14–22 per person
Average car sold in 2017	182

Adapted from Climate Council (2016). Car emissions data from National Transport Commission (2019). Other data from IPCC (2014).

As part of assessing the business case for YRE Project, which includes this Proposal, the Department of Transport's Strategic Transport Evaluation Model (STEM) was used to assess how the YRE Project will impact the transport network and its use. Key future land use assumptions are incorporated into STEM to ensure forecast development is taken into account. The YRE Project was subsequently assessed against a 'base case' network to calculate changes in demand, which was then used as an input to an economic model that evaluates a range of benefits.

Rapid growth is forecast for the northwest corridor of Perth, which will be served by the YRE Project. From the modelling, annual fuel savings are predicted resulting from reduced amounts of road vehicle travel. Increased use of public transport has the effect of removing vehicles from the road network. This

results in a 'saving' in vehicle fuel usage and a corresponding reduction in greenhouse gas emissions from road user activity.

From these estimated fuel savings, energy content and emission factors from the Department of Environment and Energy (DoEE) National Greenhouse Account Factors July 2018 were applied to estimate the associated carbon dioxide (CO_2) emission savings. Based on STEM modelling, the YRE Project is estimated to provide an annual reduction of 14,140 t CO_2-equivalent (CO_2-e) in the year 2022 due to this removal of vehicles from the road network. With forecast urban growth, this will increase to an annual saving of 35,386 t CO_2-e in the year 2031. Cumulatively, a total saving of 287,966 t CO_2-e is estimated from opening in 2022 to the year 2050 associated with vehicles removed from the road network. Emissions savings are presented in Table 11-4**.**

Table 11-4: Estimated emissions savings

Year	Daily fuel consumption		Annual savings from YRE Project	
	Without YRE Project ('base case') (L/day)	With YRE Project (L/day)	Fuel (L/year)	Greenhouse gas emissions (t CO_2-e/year)
2021	5,660,000	5,623,000	10,643,000	28,133
2031	7,416,000	7,369,000	13,387,000	35,386
2035	8,528,000	8,463,000	18,684,000	49,388

Data from internal PTA and Department of Transport modelling.

This fuel saving from reduced road vehicle travel will also have resultant benefits for other greenhouse gases (i.e. methane (CH_4) and nitrous oxide (N_2O)) and particulates generated from road vehicle emissions.

A summary of the estimated greenhouse gas emissions associated with the construction and operation of the YRE Part 2 Proposal is presented in **Table 11-5** (Jacobs 2019b; Appendix T). Western Australia's annual greenhouse gas emissions for 2016 were approximately 88,355,000 t CO_2-e (Jacobs 2019b). The construction of the YRE Part 2 is approximately equal to 0.01% of Western Australia's (2016) annual greenhouse gas emissions. Annual operation of YRE Part 2 will represent 0.006% of state emissions (Jacobs 2019b). Note that these proportions are based on the project's Scope 1 and 2 inclusions only, as per Jacobs (2019b). The greenhouse gas emissions from construction and 50 years of operation are projected to be 258,198 t CO_2-e.

Table 11-5: Summary of estimated greenhouse gas emission associated with the Proposal

Emission Source	TP classification	Quantity	Unit	GHG Emissions (t CO2e)				% of Total Emissions
				1	**2**	**3**	**Total**	
Construction Emissions								
Liquid Fuel	Energy	2,040	kL	5,520			5,520	44%
Lost carbon sink	Vegetation removal	63	ha	6,903			6,903	56%
Total							**12,423**	**100%**
Annual Operational Emissions								

Emission Source	TP classification	Quantity	Unit	GHG Emissions (t CO2e)				% of Total Emissions
				1	**2**	**3**	**Total**	
Electricity - Traction	Energy	6,714	MWh		4,700		4,700	96%
Electricity - Stations	Energy	308	MWh		216		216	4%
Transport fuel	Energy	1,259	kL	3			1	1%
Total							**4,917**	**100%**

The greatest greenhouse gas emission mitigation delivered by YRE Part 2 will be the passenger mode shift associated with moving passengers from more greenhouse gas emission intensive modes of transport to a less intensive mode (Jacobs 2019b).

12 Offsets

This section represents a preliminary offsets strategy, summarising the Proposal's significant residual environmental impacts and proposed offsets. As this ERD considers impacts to values under both the EP Act and the EPBC Act, requirements for offsets for those impacts are considered under WA and Commonwealth offsets policies as applicable, specifically:

- WA Environmental Offsets Policy (Government of Western Australia 2011)
- EPBC Act Environmental Offsets Policy (Australian Government 2012)

The process of identifying significant residual impacts and determining appropriate offsets follows the framework provided by the WA Environmental Offsets Policy (Government of Western Australia 2011) and the WA Environmental Offsets Guidelines (Government of Western Australia 2014) while ensuring that the type and scale of the offsets proposed for MNES are appropriate and consistent with the EPBC Act Environmental Offsets Policy (Australian Government 2012) in addition to the State's requirements.

A final Offsets Strategy will be prepared as a standalone document following issue of conditions of approval for the Proposal. This section includes a preliminary discussion of the following elements in accordance with applicable policies and guidelines:

- The significant residual impacts of the Proposal and how they were determined.
- Appropriate offsets for the project and how they were determined
- Types of offsets considered
- The offset proposal for each significant residual impact.

12.1 Significant residual impacts

Environmental offsets will only be applied where the residual impacts of a project are determined to be significant after avoidance, minimisation and rehabilitation have been pursued (Australian Government 2012; Government of Western Australia 2014). These measures have been detailed in the relevant impact assessment chapters (Sections 5, 6 and 13) and are summarised in this chapter in Table 12-1**.**

The accreditation of the State assessment process for the Proposal presents an opportunity to avoid duplication of offsets where there is an overlap between State and Commonwealth environmental interests.

Significant residual impacts to environmental values recognised under WA policy are summarised in Table 12-1 and were determined in accordance with the Residual Impact Significant Model (RISM) (Table 12-1) and the WA Offsets template (Appendix U) in the WA Environmental Offsets Guidelines (Government of Western Australia 2014). Significant impacts for MNES have also been presented in Table 12-1 under their respective State environmental factor. The Commonwealth Offsets Calculator is provided in Appendix V.

The RISM defines four levels of impact in the context of determining whether offsets are required for State environmental values (Government of Western Australia (2014):

- Unacceptable impacts – those impacts which are environmentally unacceptable or where no offset can be applied to reduce the impact. Offsets are not appropriate in all circumstances, as some environmental values cannot be offset.

- Significant impacts requiring an offset – any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at a critical level.
- Potentially significant impact which may require an offset – the residual impact may be significant depending on the context and extent of the impact. These relate to impacts that are likely to result in a species or ecosystem requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision-maker based on information provided by the proponent or applicant and expert judgement; and
- Impacts which are not significant – impacts which do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset.

Significant residual impacts for environmental values recognised under Commonwealth policy have been determined in accordance with the Commonwealth Offsets Assessment Guide (DSWPAC 2012b) and the Commonwealth's significant impact guidelines 1.1 (Department of the Environment 2013).

As per the rationale and outcomes presented in Sections 5, 6 and 13, the following residual environmental impacts are considered significant impacts requiring an offset (see Table 12-1) and will be offset:

- Permanent loss of:
  - 0.05 ha of *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) SCP 26a.
  - 8.03 ha of Banksia dominated woodlands of the SCP TEC in good to excellent condition.
  - 18.07 ha of regionally significant bushland in Bush Forever site 289 (Ningana Bushland).
  - 56.31 ha of Carnaby's Cockatoo habitat.
  - 45 potential Black Cockatoo breeding trees.

Table 12-1: Residual Impact Significant Model

Environmental factor	Predicted impact	Mitigation		Unacceptable impacts or potential significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoid	Minimise			
Flora and vegetation	• Permanent loss of: ○ 49.17 ha of native vegetation in Excellent to Degraded condition. ○ Threatened and Priority ecological communities, including: ▪ 0.05 ha of *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) SCP 26a. ▪ 8.03 ha of Banksia dominated woodlands of the Swan Coastal Plain TEC in good to excellent condition. ▪ 8.76 ha of Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC. ▪ 13.68 ha of Northern Spearwood shrublands and woodlands (‘community type 24’) PEC. ▪ 2.13 ha of Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC. ○ 28.82 ha of Bush Forever site 289, including 18.07 ha of native vegetation in Degraded or better condition, considered regionally significant. ○ Vegetation associated with the east-west regional ecological linkage (Link No. 0).	• The development envelope was modified during the design phase to avoid additional direct impacts to Bush Forever Site No. 130 and Bush Forever Site No. 288. • Construction and access areas within the Development Envelope were 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 intentionally avoid direct impacts to vegetation which may have otherwise been able to be retained within future POS reservations.	Implementation of a CEMP that will include the following measures as a minimum: ○ Demarcate the development envelope to prevent clearing outside approved areas. ○ Measures to manage indirect impacts to surrounding vegetation. ○ Minimise clearing to as low as reasonably practicable. ○ Stabilise batters by planting locally endemic species where possible and/or using bioengineering controls should batters be of a suitable gradient and material and not required for operational infrastructure purposes. ○ Measures to prevent the distribution of declared pests and other weed species offsite and prevent introduction of *Phytophthora* dieback to the surrounding vegetation. ○ Inspect all vehicles and machinery at exit and entry locations to ensure they are free of weeds and soil prior to entering the development envelope. ○ Manage newly identified declared weeds within the development envelope in accordance with the BAM Act and subsidiary regulations. ○ Require all personnel to complete a site induction that will include hygiene training with regards to weed management requirements, the environmental implications of the introduction and spread of dieback. ○ Site inspections to identify the presence of weeds and implementation of weed control as necessary.	None.	Permanent loss of: • 0.05 ha of *Melaleuca huegelii – M. systena* shrublands on limestone ridges (Gibson et al. 1994 type 26a) SCP 26a. • 8.03 ha of Banksia dominated Woodlands of the Swan Coastal Plain TEC. • 28.82 ha of Bush Forever site 289, including 18.07 ha of native vegetation in Degraded or better condition, considered regionally significant.	Permanent loss of: • 49.17 ha of native vegetation in Excellent to Degraded condition. • 8.76 ha of Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC. • 13.68 ha of Northern Spearwood shrublands and woodlands (‘community type 24’) PEC. • 2.13 ha of Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC. • Vegetation associated with the east-west regional ecological linkage (Link No. 0).

Environmental factor	Predicted impact	Mitigation		Unacceptable impacts or potential significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoid	Minimise			
			○ If practicable, conduct ground disturbance activities in dry months to reduce the risk of spreading disease. ○ Avoid topsoil movement from uninterpretable areas to uninfested areas. ○ Measures to ensure materials brought into the development envelope are dieback free. ○ Install a temporary fence or appropriate buffer to prevent access to surrounding vegetation. ○ Incorporate best practice WSUD in the design to protect existing hydrological regimes. ○ Install drainage diversion around chemical storage areas. ○ Implement drainage controls to prevent offsite discharge of runoff. ○ Spill kits located in storage and refuelling areas. ○ Spill response procedures and training including implementation of the PTA's standard spill response framework for operational rail corridors. ○ Store fuels or chemicals in bunds capable of storing 110% of the capacity of the largest storage tank. ○ Secondary spill containment around tanks (with a perimeter bund) with sufficient freeboard capacity to contain all captured rainwater from a 20-year average return interval, 72-hour storm.			
Terrestrial fauna	• Permanent loss of: • 61.68 ha of terrestrial fauna habitat, consisting of 47.45 ha of high value and 14.23 ha of medium value habitat. • 56.31 ha of Carnaby's Black Cockatoo habitat, consisting of 22.56 ha of high value and 33.75 ha of medium value foraging habitat and		Implementation of a CEMP that will include the following measures as a minimum: ○ Restrict clearing to the approved development envelope to avoid over-clearing and to minimise indirect impacts to adjacent remnant vegetation and Carnaby's Cockatoo habitat.		• Permanent loss of: • 56.31 ha of Carnaby's Black Cockatoo habitat, consisting of 22.56 ha of high value and 33.75 ha of medium value	• Permanent loss of 61.68 ha of terrestrial fauna habitat, consisting of 47.45 ha of high value and 14.23 ha of medium value habitat. • Potential injury and/or mortality of fauna during clearing activities and construction and operation of the railway.

Environmental factor	Predicted impact	Mitigation		Unacceptable impacts or potential significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoid	Minimise			
	2.13 ha of breeding habitat (which is a subset of foraging habitat). • 45 potential Black Cockatoo breeding trees. • Potential injury and/or mortality of fauna during clearing activities and construction and operation of the railway.		○ Weed management measures. ○ Dieback management measures. ○ Revegetation using locally endemic species and replacement of topsoil which may allow eggs/larvae/dormant stages of some SRE's to recolonise previously cleared areas. ○ Dust control measures. ○ Chemical and hydrocarbon storage and management measures. ○ Managing changes to surface hydrology as far as practical and preventing additional water discharge into non-impact areas during construction. ○ Stabilise batters by planting locally endemic species where possible and/or using bioengineering controls should batters be of a suitable gradient and material and not required for operational infrastructure purposes. Species selection will be considerate of creating habitat for Carnaby's Cockatoo in areas further than 10 m from the railway. ○ Undertake progressive clearing to allow fauna to move away from clearing activities ○ Pre-clearing survey for potential black-cockatoos prior to construction works ○ Accurate delineation of the approved clearing boundary to provide transparent limits of permitted clearing lines. ○ Develop and implement further contingency measures in consultation with the DBCA to avoid or minimise impacts to significant fauna if identified during inspections. ○ Install two fauna crossings to maintain the local east-west habitat connectivity		foraging habitat and 2.13 ha of breeding habitat (which is a subset of foraging habitat). • 45 potential Black Cockatoo breeding trees.	

Environmental factor	Predicted impact	Mitigation		Unacceptable impacts or potential significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoid	Minimise			
			for the long-term movement of native fauna in Ningana Bushland. ○ Design stormwater and surface water management measures and controls with consideration of best practice WSUD principles, maximising infiltration at source. ○ Implement the NVMP (Lloyd George Acoustics 2018a; Appendix L) to address the potential noise and vibration social impacts during the operation of the railway line. ○ Manage construction noise through the *Environmental* Protection (*Noise) Regulations 1997 Regulation 13* – "Construction sites". ○ Consider feral animal management measures in parallel with the design and development of the fauna crossing option.			
Subterranean fauna	There is a low likelihood of overall impacts to subterranean fauna from all aspects of the development envelope. The predicted direct residual impact is the loss of 0.32 ha of low value subterranean fauna habitat. The vertical extent of potential troglofauna habitat will be retained below the proposed excavation level therefore surficial construction activities will have no impact to the continuity of potential subterranean habitat across and beneath the proposed rail alignment. In addition, the anticipated bulk earthworks will involve the disturbance/removal of Safety Bay Sand, which is not expected to provide habitat for subterranean fauna.	• Dewatering and abstraction is not proposed for this proposal. • Proposal avoids areas associated with high value subterranean fauna habitat such as high karst risk areas.	Implementation of a CEMP that will include the following measures as a minimum: • Measures to address the destruction of significant caves or large voids during construction if encountered. • Store fuel and other chemicals in correctly labelled containers and used only in designated areas. • Chemical and fuel storage measures such as bunds that can capture 110% of the volume of the container. • Dispose hazardous materials in accordance with regulatory requirements. • Provide spill kits at the designated storage and use areas. • Provide training where required, in the safe use, handling and disposal of hazardous materials. • Clearing/disturbance to remain within approved development envelope.		None	All residual impacts are considered insignificant

Environmental factor	Predicted impact	Mitigation		Unacceptable impacts or potential significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoid	Minimise			
			• Use of best practice WSUD principles in the detailed design phase and the stormwater management approach for the proposal will facilitate at-source infiltration to maintain the predevelopment hydrological regime and control the quality of stormwater recharged to the groundwater aquifers.			

Source: Government of Western Australian 2014

12.2 Determination of appropriate offsets

This section includes the rationale and outcome for determining appropriate type and scale/extent of offsets for each of the significant residual impacts. Each of the individual offset Proposals that arise from this determination are then presented in the subsequent sections.

The WA Environmental Offsets Guidelines (Government of Western Australia 2014) requires that environmental offsets are cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted. The EPA has indicated that, where appropriate, the Commonwealth Offsets Assessment Guide (DSEWPAC 2012b) ('the Guide') be applied in determining offsets appropriate and proportionate to the extent of impact. This approach aligns with State and Commonwealth requirements. The Guide is used to estimate the required area of any type of offset chosen to sufficiently mitigate the calculated quantum of impact based on assumptions of quality with and without offset, risk of loss with and without offset, and certainty in the outcome. The quantum of impact is an adjusted extent of residual impact moderated downwards for decreasing habitat quality. The quality score for area of habitat or area of community is a measure of how well a site supports a particular threatened species or ecological community and contributes to its ongoing viability (DSEWPAC 2012b). There are three components that contribute to the calculation of habitat quality: site condition, site context, and species stocking rates. Quality is indicated as a score between 1 and 10, where 0 is cleared land (i.e. habitat/TEC is lost) and 10 is pristine and of the highest possible quality.

For impacts to regionally significant bushland in Bush Forever areas, the framework provided in State Planning Policy 2.8 (Government of Western Australia 2010) (SPP 2.8) has been used to determine appropriate offsets. To secure long-term protection of biodiversity and associated environmental values, SPP 2.8 (Government of Western Australia 2010) provides a policy and implementation framework to ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed and integrated with broader land use planning and decision-making. This policy provides a framework for the consideration of offsets for significant residual impacts on Bush Forever areas.

For the purpose of offsets, the conservation significance of a Bush Forever site is assessed as ranging from Very High to Low. The level of conservation significance affects the type and composition of offset allowed. Under the offset criteria outlined in Appendix 4 of SPP 2.8, the following minimum offset ratios are required:

- 2:1 for sites of Very High conservation significance.
- 1.5:1 for sites of High conservation significance.
- 1:1 for sites of Medium or Low conservation significance.

In accordance with WA Environmental Offsets Guidelines (Government of Western Australia 2014), in identifying candidate sites/proposals that would meet the offset requirements listed above, the following values have been considered:

- It provides better condition / less disturbance compared with the impacted environmental value.
- It contains habitat structure as similar as possible to undisturbed examples of the vegetation type to be impacted.
- It has a better area to perimeter ratio than the impacted site.
- It contains additional numbers of rare or otherwise significant species and threatened species or community compared with the impact site.
- It is contiguous with an existing conservation area.

- It enhances biological corridors or ecological linkages between conservation areas.
- It includes actions to address threatening processes; and/or
- It allows for secure management arrangements in place that will provide for long term conservation.

The Commonwealth's requirements for offsets are similar, with the following aspects that have been considered (Australian Government 2012):

- They must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.
- They must be built around direct offsets but may include other compensatory measures.
- They must be in proportion to the level of statutory protection that applies to the protected matter.
- They must be of a size and scale proportionate to the residual impacts on the protected matter.
- They must effectively account for and manage the risks of the offset not succeeding.
- They must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs.
- They must be efficient, effective, timely, transparent, scientifically robust and reasonable.
- They must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

Environmental offsets are also to be based on sound environmental information and knowledge. In this case, the Guide has been used to demonstrate how the proposed offset will counterbalance the significant residual impact of its project. This will deliver long term environmental benefits.

12.3 Types of offsets

There are generally three types of environmental offsets under Government of Western Australia (2014), all of which have been considered in application of this offsets strategy:

1. Land acquisition – involves the protection of environmental values through improved security of tenure or restricting the use of the land. This can be achieved through ceding freehold land to the Crown for conservation purposes or perpetual covenants for conservation. The upfront costs of establishing the offset site and the ongoing management costs of maintaining the offset for the long term must be considered whether the land is to be managed by the proponent/applicant, a third party or the DBCA.
2. On ground management – involves tangible improvement to environmental values in the offset area through revegetation (re-establishment of native vegetation in degraded areas) and rehabilitation (repair of ecosystem processes and management of weeds, disease or feral animals).
3. Research – involves investigations that add significant value to the outcomes of on ground management and the understanding of the environmental value being impacted. The research must be designed to result in positive conservation outcomes, and may be targeted at improving the management and protection of existing conservation estate. Research that may include field surveys should be designed to address priority knowledge gaps with the outcomes publicly available to improve management of the environment generally, and provide information that will improve environmental assessment of future projects.

When also applying the Commonwealth Offsets Assessment Guide (2012), land acquisition and on ground management are considered direct offsets and must account for at least 90% of the offset

provisions. Direct offsets are those actions that provide a measurable conservation gain for the value being offset. Research is considered as other compensatory measure and cannot account for more than 10% of the offset provision and represent at least 10% of the financial value of the direct offsets.

When using SPP 2.8 to determine offset requirements, revegetation may account for no more than a certain proportion of the offset. The proportion is determined according to the conservation significance of the regionally significant bushland being impacted.

12.4 SCP 26a

12.4.1 Description

Melaleuca huegelii – M. systena shrublands on limestone ridges (Gibson et al. 1994 type 26a)' SCP 26a, or Floristic Community Type 26a, is subgroup of Type 26 as described by Gibson et al. (1994) found on shallow soils over limestone or massive limestone ridges of Tamala Limestone. It occurs on skeletal soil on ridge slopes and tops of ridges, and is dominated by *M. huegelii, M. systena* and *M*. aff. *systena* often over scattered limestone heath species such as *Dryandra sessilis* and *G. preissii* (Luu and English 2005).

SCP 26a is highly restricted and known from massive limestone ridges around Yanchep north of Perth, and south of Perth near Lake Clifton.

The '*Melaleuca huegelii – Melaleuca systena* shrublands of limestone ridges (Swan Coastal Plain Community type 26a - Gibson et al. 1994) Interim Recovery Plan 2004-2009' (Luu and English 2005) states that the most significant threat to SCP 26a is clearing for mining, housing and road building. Too frequent fire is another major threat to the community. With many of the occurrences surrounded by highly urbanised areas, the frequency of fires, impact of recreational uses and incidence of illegal rubbish dumping are generally increased. These factors can all lead to degradation of plant communities through increasing weed invasion and alteration of structure, species composition or loss of component taxa (Luu and English 2005).

The success criteria for the Recovery Plan are:

1. An increase in the area of this community under conservation management.
2. Maintenance in terms of diversity and basic composition of native species (as described in Gibson et al. 1994) as well as biological processes, taking account of natural change of the community over time, as identified through monitoring.
3. Improvement in terms of reduction of numbers of exotic species and of other threatening processes as identified through monitoring.

12.4.2 Required offset(s)

The clearing of 0.05 ha of SCP 26a will require a direct offset that involves the maintenance of or improvement in quality of an existing area of TEC and/or reduction in the risk of loss over time. The quantum impact to be offset is 0.04 ha adjusted for an existing quality score of 7 based on it being in Very Good condition, which in this exercise would typically be scored as quality score of 8 but moderated down in this case because of site context. This site context is that it has no connectivity to areas of the TEC outside of the development envelope. Its long-term viability in a local context is questionable given is the small 0.05 ha in area and adjacent to the site has some existing clearing. The proposed direct offset is the acquisition and/or securing of land that has no existing conservation tenure and transfer to the conservation estate. This would be supported by funding of conservation works to maintain or enhance the quality of the area of TEC. Section 12.8 provides the detail of the SCP 26a offset proposal.

12.5 Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community

12.5.1 Description

The Commonwealth listed Banksia Woodlands of the Swan Coastal Plain TEC (Banksia Woodlands TEC) is restricted to the SCP IBRA bioregion and immediately adjacent areas, including the Dandaragan Plateau, from Jurien Bay in the north, to Dunsborough in the south, and northwest on the Whicher and Darling escarpments. It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands.

The Banksia Woodlands TEC is described in the EPBC Act Approved Conservation Advice (incorporating listing advice) (TSSC 2016) as:

> *A woodland associated with the Swan Coastal Plain of southwest Western Australia. A key diagnostic feature is a prominent tree layer of Banksia, with scattered eucalypts 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.*

The conservation objective under the Conservation Advice (TSSC 2016) is to mitigate the risk of extinction of this ecological community, and help recover its biodiversity and function, through:

- Protecting it using the EPBC Act
- Implementing priority conservation actions.

The three key approaches to achieve the conservation objective under the Conservation Advice (TSSC 2016) are:

1. Protect the ecological community to prevent further loss of extent and condition;
2. Restore the ecological community within its original range by active abatement of threats, re-vegetation and other conservation initiatives; and
3. Communicate with and support researchers, land use planners, landholders, land managers, community members, including the Indigenous community, and others to increase understanding of the value and function of the ecological community and encourage their efforts in its protection and recovery.

The Conservation Advice (TSSC 2016) indicates high conservation value, unmodified and older growth areas are particularly important for retention and management and areas that form important landscape connections, such as wildlife corridors or other patches of particularly high quality or regional importance should be retained.

12.5.2 Required offset(s)

An environmental offset for the clearing of 8.03 ha of the Commonwealth listed Banksia Woodlands TEC is proposed as the impact exceeds the thresholds for referral under the Commonwealth guidance for the TEC in accordance with the significant impact guidelines (Department of the Environment 2013).

Direct offsets are proposed involving the maintenance of or improvement in quality of an existing area of TEC and/or reduction in the risk of loss over time. The quantum of impact to be offset is 6.42 ha adjusted for an existing quality score of 8. It was given this score based on it being in in Good to Excellent (mostly

in Very Good) condition and, in regard to site context, having good connectivity to areas of the TEC outside of the development envelope.

The proposed direct offset is the acquisition and/or securing of land that has no existing conservation tenure and transfer of the land to the conservation estate supported by funding of conservation works to maintain the quality (as a measure of quality) of the area of TEC. This will be provided through the application of a Class A rating to a site previously acquired by the WAPC and 'banked' for use by government as a future offsets site (discussed later in Section 12.12). In addition, it is likely that the Ningana Bushland on-ground conservation management offset (discussed later in Section 12.9), which involves undertaking of on-ground conservation management in degraded areas of the Bush Forever site that support the TEC, could also have benefits to TEC quality. The benefit of Ningana Bushland on-ground conservation management offset to the Banksia Woodlands TEC will be examined in the final Offsets Strategy and accounted for accordingly.

12.6 Bush Forever Site 289

12.6.1 Description

Bush Forever Site No. 289 (Ningana Bushland) is located in southern Yanchep, south of the Jindowie urban development and north of the existing Allara urban development (Figure 1-2). The site is connected to Bush Forever Site No. 397 (Coastal strip from Wilbinga to Mindarie) in the west and is in proximity to Bush Forever Site No. 288 (Yanchep National Park and Adjacent Bushland) to the east, which is separated from this site by vegetated land reserved for a future extension of the Mitchell Freeway. It is also intersected by Marmion Avenue in the west.

Bush Forever Site No. 289 is 640.83 ha in area and contains 551.5 ha of bushland comprised of woodland, heath, shrubland and grassland communities (Government of Western Australia 2000). More than 60% of the bushland is considered to be in Very Good or better condition as assessed in 'Ningana Bushland (Bush Forever Site 289) Candidate Offset Site Investigation - Yanchep Railway Extension' (ELA 2018; Appendix O). The site contains the Alkimos Dune Complex, a system of parabolic dunes of Holocene age containing a chronological sequence (Government of Western Australia 2000).

The development envelope will divide the eastern portion of the site into two parts separated by the railway. For this reason, the PTA is proposing to establish an underpass and an overpass fauna crossing across the railway within the Bush Forever site to mitigate terrestrial fauna impacts (see Section 6.6).

A total of 28.82 ha of Bush Forever Site No. 289 (Ningana Bushland) will be intersected by the development envelope, 27.71 ha of which is native vegetation in Degraded or better condition, and therefore considered regionally significant (Table 12-3). Of this, 9.64 ha is within the railways reservation. The remaining 18.07 ha is zoned Parks and Recreation and is not within the railways reservation.

12.6.2 Required offset(s)

The portion of the Bush Forever site 289 that will be impacted supports several conservation significant values (Table 12-2).

Table 12-2: Significant environmental values of area of Bush Forever Site 289 impacted by Proposal

Environmental factor	Significant value
Flora and vegetation	Large areas of vegetation in Good to Very Good condition.

Environmental factor	Significant value
	Four Priority flora species: *Hibbertia spicata* subsp. *leptotheca* (Priority 3), *Beyeria cinerea* subsp. *cinerea* (Priority 3), *Conostylis pauciflora* subsp. *euryrhipis* (Priority 4) and *Conostylis pauciflora* subsp. *pauciflora* (Priority 4) Occurrences of Banksia Woodlands of the Swan Coastal Plain TEC, *Melaleuca huegelii – M. systena* shrublands on limestone ridges SCP 26a, Banksia dominated woodlands of the Swan Coastal Plain IBRA Region PEC, Northern Spearwood shrublands and woodlands PEC and Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC
Terrestrial fauna	Connection to and inclusion of a regional ecological linkage. Fauna habitat, including Carnaby's Black Cockatoo, and several Priority fauna species including Quenda
Landform	Two Quindalup parabolic dunes

Table 12-3 specifies the vegetation condition and extent within the Ningana Bushland development envelope. Vegetation is ranked as having high conservation significance where the vegetation is in Good or better condition and Degraded to Good vegetation is given Medium conservation significance. The majority of vegetation is ranked as having High conservation significance.

In accordance with the WA Offsets Guidelines (Government of Western Australia (2010), an offset ratio of 1.5:1 will apply for that area of High conservation significance, which equates to an offset area of 16.23 ha (Table 12-3). An offset ratio of 1:1 is applied to Medium conservation significance area, which equates to 7.25 ha. The total area of Bush Forever habitat to be subject to offset based on offset ration is 23.48 ha (Table 12-3).

Table 12-3: Vegetation condition in the portion of Bush Forever Site 289 that is intersected by the development envelope and required area for offsetting regionally significant bushland

Vegetation condition		Extent in the development envelope within Ningana Bushland					Area to be subject to offset based on offset ratio (ha)
		Area (ha)	Conservation significance	Portion outside of rail reserve (ha)		Offset ratio required	
Excellent	Regionally significant bushland	0.44	High	0.44	10.82	1.5:1	16.23
Very Good		8.29		4.58			
Very Good – Good		0.10		0.10			
Good		7.73		5.70			
Good – Degraded		0.18	Medium	–	7.25	1:1	7.25
Degraded		10.97		7.25			
Total		**27.71**	**–**	**18.07**		**–**	**23.48**
Completely Degraded		0.81	Low	0.38		–	–

Vegetation condition	Extent in the development envelope within Ningana Bushland				Area to be subject to offset based on offset ratio (ha)
	Area (ha)	Conservation significance	Portion outside of rail reserve (ha)	Offset ratio required	
Cleared	0.28	None	0.23	–	–
Total	**28.82**	**–**	**18.68**	**–**	**23.48**

Based on the information provided in Table 12-3**,** to offset the impacts to clearing within Ningana Bushland, the PTA proposes to increase the conservation significance of an area of at least 23.48 ha within Ningana Bushland. This offset proposal takes into consideration the quantity and quality of the area impacted, in accordance with Table 12-3 and the impact to the unique environmental values of the Ningana Bushland through the conservation and management of the remaining portions of the Bush Forever site. Funding will be provided to the DBCA to fund on-ground conservation management works beyond that currently being undertaken. Management of Ningana Bush Forever is proposed as direct offsets within the area are scarce, management of Ningana will enhance fauna management measures proposed within the CEMP and the offset directly relates to the impact.

The offset objective is to improve the condition and quality of degraded vegetation within the un-impacted areas of the Bush Forever site raising its conservation significance from 'medium' to 'high'. This will be achieved through active management of threatening processes including weeds, feral animals and controlled access (Bamford 2019b). The area to be targeted by this program is 69.59 ha (Table 12-4), considerably more than the minimum 23.48 ha required. This is reflective of the extent of vegetation within the Bush Forever site that is in Degraded condition.

Table 12-4: Vegetation condition within Ningana Bushland

Vegetation Condition		Conservation significance	Area (ha)	Area impacted by YRE Part 2 (ha)	Remaining area	Post-offset vegetation condition	Post offset significance
Very Good	Regionally significant bushland	High	240.32	7.12	233.20	High	High
Good		High	112.18	13.90	98.28	High	High
Degraded		Medium	76.79	7.20	69.59	Moves from Degraded to Good	High
Completely Degraded		Low	1.34	–	1.34	–	Low
Cleared		None	6.65	0.45	6.2	–	None
Total		–	**437.27**	**28.68**	**198.61**	–	–

Broader benefits and relationship with other mitigation measures in Bush Forever Site 289

Additionally, as many of the conservation measures are not limited in their application to the Degraded areas they will have benefits to the remainder of the Bush Forever site. While weed management would be the focus on the degraded areas, fencing and feral animal control would likely be applied across the broader Bush Forever site (198.61 ha). These benefits will complement the fauna crossing proposed by the PTA connecting the two remaining portions of Bush Forever either side of the development envelope). As such, the PTA will seek to implement the offset and the fauna connection as an integrated conservation initiative for Ningana Bushland.

12.7 Carnaby's Cockatoo

12.7.1 Description

Carnaby's Cockatoo habitat occurs from the wheatbelt, in areas that receive between 300 and 750 mm of rainfall annually, across to wetter regions in the extreme south-west, including the Swan Coastal Plain and the southern coast (DoEE 2018a).

During the breeding season, Carnaby's Cockatoo forages in native vegetation that surrounds woodlands used for breeding. During the non-breeding season, Carnaby's Cockatoo forages extensively on:

- Banksia woodlands on the Swan Coastal Plain, including the Perth metropolitan area, as well as in banksia heath on the southern coast.
- Seeding marri and jarrah. Pine plantations, seasonally, in areas that receive high rainfall, such as that on the Swan Coastal Plain.
- Native and non-native plants around the Perth metropolitan area, such as liquid amber (DoEE 2018a).

Breeding habitat (or sites) encompasses those areas that contain suitable nest trees within the range of the species, and associated foraging habitat. Carnaby's Cockatoo nests in large hollows in tall, living or dead eucalypts. Breeding activity was typically restricted to eucalypt woodlands mainly in the semiarid and subhumid interior known as the Wheatbelt, but records indicate the species has expanded its breeding range westward and south into the jarrah-marri forests of the Darling Scarp and into the tuart forests of the Swan Coastal Plain, including the Yanchep area, Lake Clifton and near Bunbury (DoEE 2018a).

12.7.2 Interactions with and consideration of previous offsets

To facilitate preliminary geotechnical investigations for the YRE Project, the PTA applied for a clearing permit under Part V of the EP Act. Clearing permit CPS 7843/1 was issued by the DWER on 31 August 2018 for the clearing of 6.56 ha of native vegetation for the purposes of geotechnical and UXO investigations only. The clearing permit is valid until 2029. The 6.56 ha of clearing authorised by this clearing permit is for the entire YRE Project (Part 1 and 2) and has not been resolved into components for each of YRE Parts 1 and 2. The clearing approved included Carnaby's Cockatoo habitat, required to be offset as a condition of the permit. Accordingly, the calculation of impacts to Carnaby's Cockatoo habitat as part of this Proposal is likely to include at least a portion of clearing that has already been authorised under CPS 7843/1 and has already been offset. In the final Offsets Strategy, the PTA will have determined the portion of the area cleared under CPS 7843/1 that falls within the YRE Part 2 development envelope and to avoid double counting, adjust the significant residual impact and the area of offset required accordingly.

In addition, approximately 3.93 ha of the Carnaby's Cockatoo foraging habitat recorded within the development envelope was approved to be cleared under the EPBC Act via the approval for the LandCorp - Eglinton / South Yanchep Residential Development, which was assessed on Preliminary Documentation and approved on 16 June 2013 (EPBC 2011/6021). 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 Cockatoo habitat to offset the significant residual impact of this action on Carnaby's Cockatoo. The WA Environmental Offsets Guidelines (Government of Western Australia 2014) identifies 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. In the final Offsets Strategy, the PTA will demonstrate the extent to which 3.93 ha of impacts to foraging habitat has already been mitigated and take this into account in the final new offsets proposed for Carnaby's Cockatoo. The offset calculations in later subsections do not currently take this area already provided into account and assume 100% of the Proposal's significant residual impact has already been offset.

Of further relevance to this Proposal, 0.14 ha of the 197.42 ha offset provided under EPBC 2011/6021 is located within the YRE Part 2 development envelope. As such, the Proposal will impact 0.14 ha of an offset provided under another approval. The ESD indicates that the PTA is to compensate for the impact of the original action for which the offset was a condition of approval as well as the impact of the Proposal on this area. As such an additional 0.14 ha of impact to foraging habitat has been added to the significant residual impact to be offset.

12.7.3 Offset requirements

Foraging habitat

The clearing of 56.31 ha of Carnaby's Cockatoo habitat (consisting of 22.56 ha of high value and 33.75 ha of medium value foraging habitat and 2.13 ha of breeding habitat) requires one or more direct offsets that involve the maintenance of or improvement in quality of an existing area of Carnaby's Cockatoo habitat and/or reduction in the risk of loss over time.

Using the Commonwealth Offsets Calculator, the quantum of impact to Carnaby's Cockatoo habitat to be offset is 45.05 ha adjusted for an existing quality of 8. This quality is based on a starting value of 9 to 10 for the occurrence of high value habitat downgraded to an overall quality score of 8, as 45% of impact area is medium foraging value or lower.

Potential breeding habitat trees

To offset the impact on 45 potential breeding trees, a sufficient number of potential breeding trees will be provided as part of the proposed Gingin land acquisition offset (Section 12.12). The Gingin land acquisition shall provide a notional 135 potential breeding trees, calculated on a 3:1 ratio. The offset calculations for potential breeding trees does not consider risk of loss, however risk of loss; can be calculated into other parameters. The future value without offset parameter has been set at 114.75 potential breeding trees, which is based on assumption of 15% risk of loss (equivalent to losing 15% of the 135 potential breeding trees). The future value with offset parameter has been set at 128.25 potential breeding trees, which makes a similar assumption using a 5% risk of loss (equivalent to losing 5% of the 135 potential breeding trees).

12.8 SCP 26a offset proposal 1 –Nowergup/Neerabup land acquisition

12.8.1 Overview of proposed offset

The PTA is currently consulting with the DBCA to identify suitable potential offset options for SCP 26a. Through this process it has been identified that a large proportion of the occurrences of SCP 26a are already within DBCA managed estate. There are only a small number of occurrences outside DBCA managed estate considered suitable for acquisition and protection due to proposed or existing development approvals (basic raw material extraction and infrastructure) and the ability to retain the communities in perpetuity.

Therefore, identifying a suitable site as a proposed offset is challenging. Nevertheless, three suitable offset sites have been identified by the DBCA, with the preferred acquisition site located in the Nowergup/Neerabup locality. The Nowergup/Neerabup site will be the target for acquisition and is offset proposal 1, summarised within this chapter. The address has been withheld due to commercial sensitivity with regard to reaching a sales agreement. Acquisition of land containing SCP 26a for transfer to conservation estate with a corresponding monetary contribution for rehabilitation to improve condition (quality) and avert the risk of loss over time will address threatening processes and provide secure management arrangements for long-term conservation. The area to be acquired and rehabilitated shall be appropriate and proportionate to the quantum of impact (0.04 ha) such that there is a net environmental gain for SCP 26a arising from the offset in the long-term. The PTA confirms that this acquisition site has adequate area available to provide for offsets for the Yanchep Part 1 and Part 2 proposals.

The DBCA has undertaken site assessments of the vegetation within this site which have confirmed the presence of SCP 26a. It has advised this site contains very high conservation value and is a high priority for acquisition and protection through conservation reservation.

Acquisition of the identified site in the Nowergup/Neerabup locality will sufficiently offset the residual impact to SCP 26a from the Proposal. The PTA proposes to provide funds to the DBCA for the acquisition of the property, and funds to manage the site for a period of seven years.

In the event that this identified site is not able to be acquired because purchase of the site does not represent value for money to WA (and therefore does not meet the requirement of the WA Offsets Policy in providing a cost-effective solution) or the prospect of reaching a purchase agreement for the site cannot be conducted in a timely manner, other options will be considered in consultation with the DBCA. These alternative options also propose land acquisition are described further in Sections 12.9 and 12.10

It is considered that either of these alternative options will offset the residual impact to SCP 26a. The PTA will notify EPA Services should acquisition of the identified site in Nowergup/Neerabup not be possible.

The DBCA undertook a brief vegetation survey of the proposed offset site in Nowergup/Neerabup to assess the values and condition of the site. The site is zoned ‘Rural’ under the Metropolitan Region Scheme (MRS) and is owned by a private landholder.

The DBCA determined that the lot consists of approximately 18 ha of native vegetation, in Excellent to Very Good condition. The site is entirely covered by vegetation, with some access tracks through it.

The site has been found to support 7.3 ha of *Melaleuca huegelii – Melaleuca systena* shrublands of limestone ridges (Swan Coastal Plain Community type 26a (SCP 26a)). It also supports the following values:

- Banksia woodlands of the Swan Coastal Plain EPBC Act listed TEC (approx. 0.9 ha).
- Proposed EPBC Act TEC Tuart Woodlands of the Swan Coastal Plain (approx. 1.6 ha).
- Tuart-Banksia woodlands (approx. 3.6 ha).
- *Banksia sessilis* shrublands (approx. 4.6 ha).
- Carnaby's Cockatoo foraging habitat (approx.10.7 ha).
- Priority 4 *Jacksonia sericea* and Priority 3 *Sarcozona bicarinata.*

The site has been impacted, particularly along firebreaks, by soil disturbance, weed invasion and rubbish dumping. Some disturbance appears to be related to market gardening activities on the adjacent lands to the east and south east. Other disturbances include rabbits, frequent fire (evident during historical inspection in 2004 and from review of aerial photography) and minor tracks. The most common weeds noted at the site include: *Eragrostis curvula* (love grass), *Euphorbia terracina* (Geraldton carnation weed) and *Asparagus asparagoides* (asparagus). The site is partly fenced with intact fencing along the northern boundary and the majority of the western boundary. There are firebreaks established around the majority of the site, with some overgrown areas.

12.8.2 Desirable characteristics

The offset site must support approximately 0.21 ha of SCP 26a habitat based on a minimum of requirement to offset 90% of the impact.

Table 12-5 summarises the desirable characteristics of the site in accordance with the WA Environmental Offsets Guidelines (Government of WA, 2014) and environmental values of the site based on Commonwealth Assessment Guide (DSEWPAC, 2012b) inputs.

Table 12-5: Evaluation against desirable characteristics in accordance with Government of Western Australia (2014) of Nowergup/Neerabup site

Value	Nowergup/Neerabup site
Ownership	Private
Tenure	Rural (MRS)
Zoning	Rural Resource
Area (ha)	Approximately 20 ha
In proximity to the area of impact	The site is situated within the City of Wanneroo, and is approximately 5 km to the south-east of the southern extent of the proposal.
Similar or better vegetation condition than area impacted.	The site comprises vegetation in Very Good to Excellent condition, which is similar to or better than the condition of SCP 26a impacted by the proposal.
Supports additional rare or otherwise significant species and threatened species or community compared other than SCP 26a.	The site contains two other TECs - Banksia woodlands of the Swan Coastal Plain EPBC Act listed TEC and the proposed EPBC Act TEC Tuart Woodlands of the Swan Coastal Plain. The site also contains Carnaby's Cockatoo foraging habitat and two DBCA Priority flora species – *Jacksonia sericea* (Priority 4) and *Sarcozona bicarinata* (Priority 3).

Value	Nowergup/Neerabup site
Close to or contiguous with an existing conservation area (e.g. Bush Forever).	The site is located immediately north of a Bush Forever site and Class A Reserve.
Likely to enhance ecological linkages.	The site is adjoining and likely to enhance a regional ecological linkage that runs south-west of the site into Neerabup National Park from the north and east through the Nowergup/Neerabup area.

The environmental values of the site have been used to assess the total contribution to meeting the offset requirement for SCP 26a. Using the Commonwealth Offsets Assessment Guide ("offsets calculator") (DSEWPAC 2012b), the purchase of the Nowergup/Neerabup site meets substantially more than 100% of the total offset requirement of SCP 26a (**Table 12-6**).

Table 12-6:Environmental values of proposed Nowergup/Neerabup site

Criteria	Quantity/ Rating	Explanation
Clearing area		
Area (ha)	0.05	Vegetation surveys recorded a total of 0.05 ha of SCP 26a within the development envelope.
Quality	8	Vegetation surveys recorded a total of 0.05 ha of SCP 26a within the development envelope in Very Good condition.
Quantum of impact	0.04	Calculated using the DoEE calculator.
Offset site		
Area (ha)	0.23	Brief survey undertaken by DBCA identified approximately 7.3 ha of SCP 26a within the site, of which 0.23 ha will be attributed to YRE Part 2 offsets.
Start quality	8	A formal vegetation condition assessment has not been undertaken at the site; however, a brief survey by DBCA noted the areas of SCP 26a were in Very Good to Excellent condition.
Risk of loss (%) without offset	25	No formal protection mechanisms are currently in place on the proposed offset site. The site is privately owned and is at risk of being developed due to changes in zoning as well as excavated as a potential source of raw limestone (designated as a basic raw material extraction activities area). The 25% acknowledges that that risk is moderated by the known high conservation value of the site limiting the potential for development.
Future quality without offset*	7	It is assumed that without active conservation management measures there will be a small reduction in quality due to weed incursion.
Risk of loss (%) with offset	5	Formal protection of the offset site will ensure that the risk of future loss is substantially reduced.

Criteria	Quantity/ Rating	Explanation
Future quality with offset*	8	Formal protection of the offset and provision of capped funds to the DBCA to engage in active management of the site will enhance the quality of the offset. Projected maintenance of quality due to active management measures not currently being implemented by the land owner such as ongoing weed control and fire management.
Confidence in result (averted loss) (%)	90	The formal protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	70	There is a moderate degree of confidence in this prediction based on DBCA involvement in conservation management.
Time over which loss is averted (years)	20	Provision of offset for protection in perpetuity.
Time until ecological benefit (years)	1	The protected effect of the acquisition is immediate on transfer of land.
Total offset %	**101.45%**	**The impact will be over mitigated by the offset exceeding 100% threshold by 1.45%**

12.8.3 Objectives, targets and completion criteria

The overarching objective of the offset is to conserve and enhance the SCP 26a within the Nowergup/Neerabup site. Objectives, targets and completion criteria to be achieved by the PTA are outlined in Table 12-7.

Table 12-7:Objectives, targets and completion criteria for Nowergup/Neerabup site

Objective	Target	Completion Criteria
Protect 0.23 ha of SCP 26a	Purchase, Nowergup/Neerabup site and transfer ownership to the Crown for the purpose of conservation.	Site ceded to the Crown for the purpose of conservation.
	Restrict access to Nowergup/Neerabup site to ensure ongoing protection.	Site fenced.
Manage 0.23 ha of SCP 26a to avoid degradation from threatening processes.	Provide adequate funding to the DBCA to allow ongoing management of Nowergup/Neerabup site for seven years.	Provision of funding to the DBCA. Completion of management actions as outlined in **Table 12-8**:

The intended outcome is to increase the area of this community under conservation management and maintain the diversity and basic composition of native species and address threatening processes consistent with the SCP 26a Interim Recovery Plan (Luu and English 2005).

12.8.4 Actions to be undertaken

The following actions are to be undertaken for implementation of this offset:

- Liaise with the DBCA to discuss the proposed offset site and obtain all existing information on the site.
- Conduct a desktop review of available information to understand site environmental values.
- Conduct a survey of the site to:
    - Assess and map the extent and condition of SCP 26a.
    - Assess and map the extent and condition of Banksia Woodlands of the Swan Coastal Plain TEC.
    - Identify existing threatening processes relevant to and SCP 26a and Banksia Woodlands of the Swan Coastal Plain TEC e.g. weed infestation (map weeds), feral animal damage, likely frequency of fires, and uncontrolled access.
    - Assess terrestrial fauna values including Black Cockatoo habitat, values and extent.
    - Map the area of Carnaby's Black Cockatoo foraging habitat, breeding habitat, roosting habitat and potential breeding trees.
- Update Offset Strategy in consultation with DBCA and DWER.
- Prepare and execute a MOU between the PTA and DBCA with regard to the funding and delivery of this offset. This would include, but not be limited to funding, maintenance works, reporting schedule, and responsibilities of PTA in the case of certain events.
- Provide funding to DBCA to manage site.
- DBCA to maintain offset site in perpetuity and provide PTA with annual reports for the pre-arranged time period (minimum seven years).

The PTA will provide management funding to the DBCA to undertake management actions. Proposed management actions are outlined in Table 12-8. The associated costs will be determined in further consultation with the DBCA, and the details of the actions will be specified in an agreement to be established between the PTA and the DBCA within 12 months of approval of this Offsets Strategy.

The provision of management funding has been adjusted to account for the PTA providing over 100% of the SCP 26a offset requirement (**Table 12-6**).

Table 12-8: Proposed management actions for Nowergup/Neerabup site

Year	Action	Timing
1	Install conservation style fencing around perimeter of site to restrict access.	Prior to any works being undertaken within the site.
	Install lockable vehicle access gate.	Prior to any works being undertaken within the site.
	Undertake targeted control programme for priority weeds.	Autumn and spring.
	Install firebreaks around perimeter of site as required in consultation with the DBCA.	Prior to onset of bushfire season if required.

Year	Action	Timing
2 to 10	Undertake targeted control program for priority weeds.	Autumn and spring.
	Undertake fire break maintenance if required.	Annually prior to onset of bushfire season.
	Monitor condition of fencing.	Autumn and spring.
	Fence maintenance.	Autumn and spring as required.
	Undertake periodic conservation measures for maintenance of TEC quality over seven years including weed control and vegetation condition inspections.	Spring.

12.8.5 Success criteria

Table 12-9 indicates the success criteria for this offset proposal.

Table 12-9: SCP 26a offset proposal 1 success rating

Objective	Success criteria
Acquire or secure area of SCP 26a appropriately proportionate to the area of impact and transfer to conservation tenure.	Site meeting essential criteria (as per Table 12-6) transferred to conservation estate.
Provide rehabilitation and conservation management of the area of SCP 26a to increase and then maintain its condition/quality.	Condition/quality of area of SCP 26a is increased and maintained at this level by seven years.

12.8.6 Risks and contingency measures

Key risks and contingency measures for this offset Proposal are summarised in Table 12-10.

Table 12-10: Key risks and contingency measures for proposed Nowergup/Neerabup site

Risk/Trigger	Potential contingency measures
Proposed site not able to be acquired due to funding limitations/purchased by another buyer/does not present value for money.	• Seek advice from the DBCA regarding potential acquisition of alternative SCP 26a offset sites, SCP 26a offset proposals 2 and 3 in accordance with the information provided in Sections 12.9 and 12.10.
Condition/quality of area of SPC 26a degrades over time despite conservation measures to maintain or improve.	• Investigate cause. • Restrict access to affected areas. • Investigate cause and extent of vegetation decline (disturbance, pest, weed, pathogen, climate). • Review vegetation management measures. • Implement control and remedial measures in consultation with regulators, including weed spraying, pest control, access management as required. • Monitor success of control and remedial measures.

12.9 SCP 26a offset proposal 2 – north Lake Clifton land acquisition

12.9.1 Overview of proposed offset

An alternative option to offset SCP 26a impacts should the Nowergup/Neerabup site not proceed, is the acquisition of two sites, located side-by-side, north of Lake Clifton. The addresses have been withheld due to commercial sensitivity and private ownership. Acquisition of land containing SCP 26a for transfer to conservation estate with a corresponding monetary contribution for rehabilitation to improve condition (quality) and avert the risk of loss over time will address threatening processes and provide secure management arrangements for long-term conservation. The area to be acquired and rehabilitated shall be appropriate and proportionate to the quantum of impact (0.04 ha) such that there is a net environmental gain for SCP 26a arising from the offset in the long-term.

The DBCA has undertaken a site inspection to assess environmental values of the sites and confirmed the presence of SCP 26a. The extent and condition of SCP 26a were not recorded during the survey as it was not within the original scope of the inspection. The DBCA has identified that the sites are a high priority for acquisition due to their proximity to Yalgorup National Park and are intended to be protected through future conservation reservation.

It is anticipated that acquisition of the identified sites will sufficiently offset the residual impact to SCP 26a. The PTA proposes to provide funds to the DBCA to acquire the properties, and funds to manage the sites for a period of seven years.

In the event that the identified sites are not able to be acquired because purchase of the sites do not represent value for money to WA (and therefore does not meet the requirement of the WA Offsets Policy in providing a cost-effective solution) or the prospect of reaching a purchase agreement for the sites cannot be conducted in a timely manner, other options will be considered in consultation with the DBCA. A third alternative option proposes land acquisition of a site east of Lake Clifton, described further in Section 12.10. It is considered that either of these alternative options will offset the proposal's residual impact on SCP 26a. The PTA will notify EPA Services should offset proposal 1 or 2 not proceed.

12.9.2 Desirable characterises

The offset site must support approximately 0.33 to 0.38 ha of SCP 26a habitat based on a minimum of requirement to offset 90% of the impact.

Table 12-11 summarises the desirable characteristics of the sites in accordance with the WA Environmental Offsets Guidelines (Government of WA, 2014) and environmental values of the site based on Commonwealth Assessment Guide (DSEWPAC, 2012b) inputs.

Table 12-11: Evaluation of the sites north of Lake Clifton against desirable characteristics

Value	Nowergup/Neerabup site
Ownership	Private
Tenure	Rural (MRS)
Zoning	Rural Resource
Area (ha)	Eastern site: approximately 38 ha Western site: approximately 39 ha Total area: approximately 77 ha.

Value	Nowergup/Neerabup site
In proximity to the area of impact	The sites are situated within the Shire of Waroona, and are located approximately 160 km south of Yanchep.
Similar or better vegetation condition than area impacted.	Site vegetation condition is unknown, however, due to the site's proximity to A Class Reserve, it is anticipated vegetation is in similar or better than the condition of SCP 26a impacted by the proposal.
Supports additional rare or otherwise significant species and threatened species or community compared other than SCP 26a.	Due to the DBCA's interest in the site, it is anticipated that the sites contain additional rare or otherwise significant species and/or TECs/PECs, including Banksia Woodlands of the SCP TEC and Carnaby's Black Cockatoo habitat; however, further information will be provided by the DBCA and sought should this proposal be pursued. The site is part of the Ramsar Peel-Yalgorup Wetland system.
Close to or contiguous with an existing conservation area (e.g. Bush Forever).	Both sites are surrounded by Class A Reserve, Yalgorup National Park on the northern, western and southern sides.
Likely to enhance ecological linkages.	Due to the site's location adjacent Yalgorup National Park, the site will enhance the regional ecological linkage associated with the National Park.

Source: In accordance with Government of Western Australia 2014

The environmental values of the site have been used to assess the total contribution to meeting the offset requirement for SCP 26a. Using the Commonwealth Offsets Assessment Guide ("offsets calculator") (DSEWPAC 2012b), the purchase of the Nowergup/Neerabup site meets substantially more than 100% of the total offset requirement of SCP 26a (Table 12-2).

Table 12-12: Environmental values of sites north of Lake Clifton

Criteria	Quantity/ Rating	Explanation
Clearing area		
Area (ha)	0.05	Vegetation surveys recorded a total of 0.05 ha of SCP 26a within the development envelope.
Quality	8	Vegetation surveys recorded a total of 0.05 ha of SCP 26a within the development envelope in Very Good condition.
Quantum of impact	0.04	Calculated using the DoEE calculator.
Offset site		
Area (ha)	0.42	Total area of SCP 26a within the site is unknown, however, up to 0.42 ha will be attributed to YRE Part 2 offsets.
Start quality	7	A formal vegetation condition assessment has not been undertaken at the site; however, due to the condition of surrounding vegetation, it is

Criteria	Quantity/ Rating	Explanation
		anticipated the areas of SCP 26a are in Very Good to Excellent condition.
Risk of loss (%) without offset	15	No formal protection mechanisms are currently in place on the proposed offset site. The site is privately owned and the 15% acknowledges the risk of being impacted or developed.
Future quality without offset*	6	It is assumed that without active conservation management measures there will be a small reduction in quality due to weed incursion.
Risk of loss (%) with offset	5	Risk of loss is 5% due to risk of fire/other potential impacts such as weeds.
Future quality with offset*	7	Formal protection of the offset and provision of capped funds to the DBCA to engage in active management of the site will enhance the quality of the offset. Projected maintenance of quality due to active management measures not currently being implemented by the land owner such as ongoing weed control and fire management.
Confidence in result (averted loss) (%)	90	The formal protection mechanisms and proposed management provide a high level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	70	There is a moderate degree of confidence in this prediction based on DBCA involvement in conservation management.
Time over which loss is averted (years)	20	Provision of offset for protection in perpetuity.
Time until ecological benefit (years)	1	The protected effect of the acquisition is immediate on transfer of land.
Total offset %	102.44%	Assuming site contains minimum requirement of 0.40 ha of SCP 26a habitat.

12.9.3 Objectives, targets and completion criteria

The overarching objective of the offset is to conserve and enhance the SCP 26a within the acquired sites. Objectives, targets and completion criteria to be achieved by the PTA are outlined in Table 12-13**.**

Table 12-13: Objectives, targets and completion criteria for sites north of Lake Clifton

Objective	Target	Completion Criteria
Protect up to 0.42 ha of SCP 26a	Purchase, sites north of Lake Clifton and transfer ownership to the Crown for the purpose of conservation.	Sites ceded to the Crown for the purpose of conservation.

	Restrict access to sites north of Lake Clifton to ensure ongoing protection.	Site fenced.
Manage up to 0.42 ha of SCP 26a to avoid degradation from threatening processes.	Provide adequate funding to the DBCA to allow ongoing management of Nowergup/Neerabup site for seven years.	Provision of funding to the DBCA. Completion of management actions as outlined in **Table 12-8:**.

The intended outcome is to increase the area of this community under conservation management and maintain the diversity and basic composition of native species and address threatening processes consistent with the SCP 26a Interim Recovery Plan (Luu and English 2005).

12.9.4 Actions to be undertaken

The following actions are to be undertaken for implementation of this offset:

- Liaise with the DBCA to discuss the proposed offset site and obtain all existing information on the site.
- Conduct a desktop review of available information to understand site environmental values.
- Conduct a survey of the site to:
  - Assess and map the extent and condition of SCP 26a.
  - Assess and map the extent and condition of Banksia Woodlands of the Swan Coastal Plain TEC.
  - Identify existing threatening processes relevant to and SCP 26a and Banksia Woodlands of the Swan Coastal Plain TEC e.g. weed infestation (map weeds), feral animal damage, likely frequency of fires, and uncontrolled access.
  - Assess terrestrial fauna values including Black Cockatoo habitat, values and extent.
  - Map the area of Carnaby's Black Cockatoo foraging habitat, breeding habitat, roosting habitat and potential breeding trees.
- Update Offset Strategy in consultation with DBCA and DWER.
- Prepare and execute a MOU between the PTA and DBCA with regard to the funding and delivery of this offset. This would include, but not be limited to funding, maintenance works, reporting schedule, and responsibilities of PTA in the case of certain events.
- Provide funding to DBCA to acquire and manage site.
- DBCA to acquire or secure site.
- Prepare rehabilitation plan for site.
- Undertake upfront on ground conservation works, including:
  - rubbish removal
  - fencing
  - weed control
  - signage
  - fire control measures.

- Make arrangements for transfer to conservation estate.
- Undertake rehabilitation works to improve TEC quality including:
  - targeted weed removal
  - feral animal control
  - selective seedling planting to restore structure, cover, composition and species diversity characteristic of SCP 26a
  - monitor annually up to five years (extending only if desired quality not achieved).
- Beyond five years undertake conservation works to maintain quality at desired level by seven years including:
  - weed control
  - vegetation condition inspections.
- DBCA to maintain offset site in perpetuity and provide PTA with annual reports for the pre-arranged time period (minimum seven years).

The PTA will provide management funding to the DBCA to undertake management actions. Proposed management actions are outlined in Table 12-12. The associated costs will be determined in further consultation with the DBCA, and the details of the actions will be specified in an agreement to be established between the PTA and the DBCA within 12 months of approval of this Offsets Strategy.

The provision of management funding has been adjusted to account for the PTA providing over 100% of the SCP 26a offset requirement (Table 12-12).

Table 12-14: Proposed management actions for sites north of Lake Clifton

Year	Action	Timing
1	Install conservation style fencing around perimeter of site to restrict access.	Prior to any works being undertaken within the site.
	Install lockable vehicle access gate.	Prior to any works being undertaken within the site.
	Undertake targeted control programme for priority weeds.	Autumn and spring.
	Install firebreaks around perimeter of site as required in consultation with the DBCA.	Prior to onset of bushfire season if required.
2 to 10	Undertake targeted control program for priority weeds.	Autumn and spring.
	Undertake fire break maintenance if required.	Annually prior to onset of bushfire season.
	Monitor condition of fencing.	Autumn and spring.
	Fence maintenance.	Autumn and spring as required.
	Undertake periodic conservation measures for maintenance of TEC quality over seven years including weed control and vegetation condition inspections.	Spring.

12.9.5 Success criteria

Table 12-15 indicates the success criteria for this offset proposal.

Table 12-15: SCP 26a offset 2 success criteria

Objective	Success criteria
Acquire or secure area of SCP 26a appropriately proportionate to the area of impact and transfer to conservation tenure.	Site meeting essential criteria transferred to conservation estate.
Provide rehabilitation and conservation management of the area of SPC 26a to increase and then maintain its condition/quality.	Condition/quality of area of SPC 26a is increased and maintained at this level by seven years.

12.9.6 Risks and contingency measures

Key risks and contingency measures for this offset Proposal are summarised in **Table 12-16**.

Table 12-16: Key risks and contingency measures for proposed sites north of Lake Clifton

Risk/Trigger	Potential contingency measures
Proposed site not able to be acquired due to funding limitations/purchased by another buyer/does not present value for money.	• Seek advice from the DBCA regarding potential acquisition of alternative SCP 26a offset sites, SCP 26a offset proposal 3 in accordance with the information provided in Sections 12.10.
Condition/quality of area of SCP 26a degrades over time despite conservation measures to maintain or improve.	• Investigate cause. • Restrict access to affected areas. • Investigate cause and extent of vegetation decline (disturbance, pest, weed, pathogen, climate). • Review vegetation management measures. • Implement control and remedial measures in consultation with regulators, including weed spraying, pest control, access management as required. • Monitor success of control and remedial measures.

12.10 SCP 26a offset proposal 3 – east Lake Clifton land acquisition

12.10.1 Overview of offset

An alternative option to offset SCP 26a should SCP 26a offset proposal 1 or 2 not proceed, is the acquisition of two potential sites, located east of Lake Clifton. The addresses have been withheld due to commercial sensitivity and private ownership. Acquisition of land containing SCP 26a for transfer to conservation estate with a corresponding monetary contribution for rehabilitation to improve condition (quality) and avert the risk of loss over time will address threatening processes and provide secure management arrangements for long-term conservation. The area to be acquired and rehabilitated shall

be appropriate and proportionate to the quantum of impact (0.04 ha) such that there is a net environmental gain for SCP 26a arising from the offset in the long-term.

The DBCA has undertaken a site inspection to assess environmental values of the sites and mapped the extent of SCP 26a. SCP 26a vegetation was not formally recorded, however, it was noted that the SCP 26a patches were Degraded and fragmented. The DBCA has identified that the sites are a low priority for acquisition due to the condition of SCP 26a habitat, the fragmented nature of habitat and uncertainty surrounding patch viability.

It is anticipated that acquisition of the identified sites will sufficiently offset the residual impact to SCP 26a. The PTA proposes to provide funds to the DBCA to acquire the properties, and funds to manage the sites for a period of seven years.

In the event that the identified sites are not able to be acquired because purchase of the sites do not represent value for money to WA (and therefore does not meet the requirement of the WA Offsets Policy in providing a cost-effective solution) or the prospect of reaching a purchase agreement for the sites cannot be conducted in a timely manner, other options will be considered in consultation with the DBCA. The PTA will notify EPA Services should offset proposal 1, 2 or 3 not proceed.

12.10.2 Desirable characteristics

The offset site must support approximately 0.53 ha of SCP 26a habitat based on a minimum of requirement to offset 90% of the impact.

Table 12-17 summarises the desirable characteristics of the sites in accordance with the WA Environmental Offsets Guidelines (Government of WA, 2014) and environmental values of the site based on Commonwealth Assessment Guide (DSEWPAC, 2012b) inputs.

Table 12-17: Evaluation of sites east of Lake Clifton against desirable characteristics in accordance with Government of Western Australia (2014)

Value	Site east of Lake Clifton
Ownership	Private
Tenure	Rural (MRS)
Zoning	Rural Resource
Area (ha)	Northern site: approximately 79 ha – containing 1.65 ha of SCP 26a. Southern site: approximately 74 ha – containing 4.90 ha of SCP 26a.
In proximity to the area of impact	The sites are situated within the Shire of Waroona, and are located approximately 160 km south of Yanchep.
Similar or better vegetation condition than area impacted.	Site vegetation condition is unknown, however, previous inspections have suggested that SCP 26a patches are fragmented and Degraded and surrounded by Degraded paddock.

Value	Site east of Lake Clifton
Supports additional rare or otherwise significant species and threatened species or community compared other than SCP 26a.	It is unknown whether the sites contain environmental values additional to SCP 26a, however, it is unlikely due to the surrounding vegetation predominantly consisting of Degraded paddock habitat.
Close to or contiguous with an existing conservation area (e.g. Bush Forever).	Both sites are located adjacent Class A Reserve, Yalgorup National Park.
Likely to enhance ecological linkages.	Due to the site's location adjacent Yalgorup National Park, the site may enhance the regional ecological linkage associated with the National Park.

The environmental values of the site have been used to assess the total contribution to meeting the offset requirement for SCP 26a. Using the Commonwealth Offsets Assessment Guide ("offsets calculator") (DSEWPAC 2012b), the purchase of the Nowergup/Neerabup site meets substantially more than 100% of the total offset requirement of SCP 26a (Table 12-18).

Table 12-18: Environmental values of proposed sites east of Lake Clifton

Criteria	Quantity/ Rating	Explanation
Clearing area		
Area (ha)	0.05	Vegetation surveys recorded a total of 0.05 ha of SCP 26a within the development envelope.
Quality	8	Vegetation surveys recorded a total of 0.05 ha of SCP 26a within the development envelope in Very Good condition.
Quantum of impact	0.04	Calculated using the DoEE calculator.
Offset site		
Area (ha)	0.59	Total area of SCP 26a within the site is unknown; however, up to 0.52 ha will be attributed to YRE Part 2 offsets (calculated using Offsets calculator).
Start quality	5	A formal vegetation condition assessment has not been undertaken at the site; however, due to the condition of surrounding vegetation, and the fragmented and Degraded condition of the SCP 26a habitat, it is anticipated the areas of SCP 26a are in Degraded condition.
Risk of loss (%) without offset	15	No formal protection mechanisms are currently in place on the proposed offset site. The site is privately owned and the 15% acknowledges the risk of being impacted or developed.
Future quality without offset*	4	It is assumed that without active conservation management measures there will be a small reduction in quality due to weed incursion, increased degradation due to small patch size and lack of management.

Criteria	Quantity/ Rating	Explanation
Risk of loss (%) with offset	10	Risk of loss is 10% due to risk of fire/other potential impacts such as weeds and the small patch size and unknown vibaility.
Future quality with offset*	5	Formal protection of the offset and provision of capped funds to the DBCA to engage in active management of the site will enhance the quality of the offset. Projected maintenance of quality due to active management measures not currently being implemented by the land owner such as ongoing weed control and fire management.
Confidence in result (averted loss) (%)	80	The formal protection mechanisms and proposed management provide a moderate level of certainty that the offset will be conserved, averting the level of loss that would likely occur should no formal protection measures be implemented.
Confidence in result (habitat quality) (%)	70	There is a moderate degree of confidence in this prediction based on DBCA involvement in conservation management.
Time over which loss is averted (years)	20	Provision of offset for protection in perpetuity.
Time until ecological benefit (years)	1	The protected effect of the acquisition is immediate on transfer of land.
Total offset %	101.13%	Assuming site contains minimum requirement of 0.59 ha of SCP 26a habitat.

12.10.3 Objectives, targets and completion criteria

The overarching objective of the offset is to conserve and enhance the SCP 26a within the acquired sites. Objectives, targets and completion criteria to be achieved by the PTA are outlined in Table 12-19.

Table 12-19: Objectives, targets and completion criteria for sites east of Lake Clifton

Objective	Target	Completion Criteria
Protect up to 0.59 ha of SCP 26a	Purchase, sites east of Lake Clifton and transfer ownership to the Crown for the purpose of conservation.	Sites ceded to the Crown for the purpose of conservation.
	Restrict access to sites north of Lake Clifton to ensure ongoing protection.	Site fenced.
Manage up to 0.42 ha of SCP 26a to avoid degradation from threatening processes.	Provide adequate funding to the DBCA to allow ongoing management of Nowergup/Neerabup site for seven years.	Provision of funding to the DBCA. Completion of management actions as outlined in **Table 12-8.**

The intended outcome is to increase the area of this community under conservation management and maintain the diversity and basic composition of native species and address threatening processes consistent with the SCP 26a Interim Recovery Plan (Luu and English 2005).

12.10.4 Actions to be undertaken

The following actions are to be undertaken for implementation of this offset:

- Liaise with the DBCA to discuss the proposed offset site and obtain all existing information on the site.
- Conduct a desktop review of available information to understand site environmental values.
- Conduct a survey of the site to:
    - Assess and map the extent and condition of SCP 26a.
    - Assess and map the extent and condition of Banksia Woodlands of the Swan Coastal Plain TEC.
    - Identify existing threatening processes relevant to and SCP 26a e.g. weed infestation (map weeds), feral animal damage, likely frequency of fires, and uncontrolled access.
    - Assess terrestrial fauna values including Black Cockatoo habitat, values and extent.
    - Map the area of Carnaby's Black Cockatoo foraging habitat, breeding habitat, roosting habitat and potential breeding trees.
- Update Offset Strategy in consultation with DBCA and DWER.
- Prepare and execute a MOU between the PTA and DBCA with regard to the funding and delivery of this offset. This would include, but not be limited to funding, maintenance works, reporting schedule, and responsibilities of PTA in the case of certain events.
- Provide funding to DBCA to acquire and manage site.
- DBCA to acquire or secure site.
- Prepare rehabilitation plan for site.
- Undertake upfront on ground conservation works, including:
    - rubbish removal
    - fencing
    - weed control
    - signage
    - fire control measures.
- Make arrangements for transfer to conservation estate.
- Undertake rehabilitation works to improve TEC quality including:
    - targeted weed removal
    - feral animal control
    - selective seedling planting to restore structure, cover, composition and species diversity characteristic of SCP 26a
    - monitor annually up to five years (extending only if desired quality not achieved).
- Beyond five years undertake conservation works to maintain quality at desired level by seven years including:
    - weed control

- vegetation condition inspections.

- DBCA to maintain offset site in perpetuity and provide PTA with annual reports for the pre-arranged time period (minimum seven years).

Proposed management actions are outlined in Table 12-20**.** The associated costs will be determined in further consultation with the DBCA, and the details of the actions will be specified in an agreement to be established between the PTA and the DBCA within 12 months of approval of this Offsets Strategy.

The provision of management funding has been adjusted to account for the PTA providing over 100% of the SCP 26a offset requirement (Table 12-20).

Table 12-20: Proposed management actions for sites east of Lake Clifton

Year	Action	Timing
1	Install conservation style fencing around perimeter of site to restrict access.	Prior to any works being undertaken within the site.
	Install lockable vehicle access gate.	Prior to any works being undertaken within the site.
	Undertake targeted control programme for priority weeds.	Autumn and spring.
	Install firebreaks around perimeter of site as required in consultation with the DBCA.	Prior to onset of bushfire season if required.
2 to 10	Undertake targeted control program for priority weeds.	Autumn and spring.
	Undertake fire break maintenance if required.	Annually prior to onset of bushfire season.
	Monitor condition of fencing.	Autumn and spring.
	Fence maintenance.	Autumn and spring as required.
	Undertake periodic conservation measures for maintenance of TEC quality over seven years including weed control and vegetation condition inspections.	Spring.

12.10.5 Success criteria

Table 12-21 indicates the success criteria for this offset proposal.

Table 12-21: SCP 26a offset proposal 3 success criteria

Objective	Success criteria
Acquire or secure area of SCP 26a appropriately proportionate to the area of impact and transfer to conservation tenure.	Site meeting essential criteria (as per Table 12-18) transferred to conservation estate.
Provide rehabilitation and conservation management of the area of SCP 26a to increase and then maintain its condition/quality.	Condition/quality of area of SCP 26a is increased and maintained at this level by seven years.

12.10.6 Risks and contingency measures

Key risks and contingency measures for this offset proposal are summarised in **Table 12-22**.

Table 12-22: Key risks and contingency measures for sites east of Lake Clifton

Risk/Trigger	Potential contingency measures
Proposed site not able to be acquired due to funding limitations/purchased by another buyer/does not present value for money.	• Seek advice from the DBCA regarding potential acquisition of alternative SCP 26a offset sites,
Condition/quality of area of SCP 26a degrades over time despite conservation measures to maintain or improve.	• Investigate cause. • Restrict access to affected areas. • Investigate cause and extent of vegetation decline (disturbance, pest, weed, pathogen, climate). • Review vegetation management measures. • Implement control and remedial measures in consultation with regulators, including weed spraying, pest control, access management as required. • Monitor success of control and remedial measures.

12.11 Banksia TEC/Black Cockatoo Offset Proposal 1 – Mardella Land acquisition

12.11.1 Overview of proposed offset

It is proposed that an existing Bush Forever site in Mardella is utilised as the land acquisition offset. The site was purchased by the WAPC in 2014 and transferred to a Class A nature reserve (owned and managed by DBCA) in 2015. Part of the condition of purchase was the Commonwealth's in principle agreement that the site could be 'banked' to provide offsets for future government Strategic Development projects due to its known environmental values. The Mardella site would be allocated to this proposal and would no longer be able to be utilised as offsets for other government projects.

As a Class A nature reserve, the DBCA are responsible for site management and maintenance works. A number of vegetation surveys have been conducted on the site and the known environmental values include:

- Black Cockatoo foraging habitat (likely to include Carnaby's, Forest Red-tailed and Baudin's Black Cockatoo foraging habitat).
- Black Cockatoo potential breeding habitat.
- Banksia Woodlands of the Swan Coastal Plain TEC.
- Wetlands.
- Threatened flora.
- Other TECs or PECs.

The Mardella site is proposed to offset the following impacts resulting from the Proposal:

- Clearing of Carnaby's Black Cockatoo foraging habitat (residual impact of 56.31 ha of habitat suitable for Carnaby's Black Cockatoos).
- Clearing of 45 potential Black Cockatoo breeding trees.

- Clearing of Banksia Woodlands of the Swan Coastal Plain TEC (residual impact 8.03 ha);
- Clearing of Bush Forever Sites (residual impact of 18.07 ha).

In addition, the PTA will provide funding to the DBCA to conduct seven years of onsite management of the site. It is intended that funding will be directed to management and maintenance works specific to the environmental values being offset under this strategy. This ensures management works are over and above the current site management works and long-term conservation is applied to those environmental values being offset.

The total area of the site is appropriate and proportionate to the quantum of impact such that there is a net environmental gain for the values arising from the offset in the long term. Due to the size of the site, only a portion of the site will be applied to offset the impacts associated with the YRE Part 2 project, which has been calculated using the Commonwealth Offsets Assessment Guide (DSWEPAC 2012b).

It is intended that this offset comprises 90% of the Carnaby's Black Cockatoo offset requirement, when delivered in addition to Black Cockatoo Research Funding (see Section 12.16).

In the event that this identified site is not able to be used as an offset, other site options will be considered in consultation with the DBCA. An alternative acquisition option is described in Section 12.12. It is considered that either of these options will adequately compensate the residual impacts from the TCL Proposal.

12.11.2 Desirable characteristics

The offset site must support the following approximate habitat extents based on a minimum of 90% of the impact to each value offset being addressed:

- 300 ha to 335 ha of Carnaby's Black Cockatoo foraging habitat depending on starting quality of offset (based on meeting minimum 90% of offset requirement).
- 135 potential Black Cockatoo breeding trees.
- 43 to 47 ha of Banksia Woodlands of the Swan Coastal Plain TEC depending on starting quality of offset minus any area provided in the Bush Forever on-ground management offset (Section 12.12).
- 23.48 ha of Bush Forever offsets (100% of offset requirement).

Table 12-23 summarises the desirable characteristics of the site in accordance with the WA Environmental Offsets Guidelines (Government of WA, 2014) and environmental values of the site based on Commonwealth Assessment Guide (DSEWPAC, 2012b) inputs.

Table 12-23: Mardella offset site desirable characteristics and environmental values (area, quality and % risk of loss)

Criteria	Summary
Ownership	Crown land
Tenure	State
Zoning	Class A
Area (ha)	1138
In proximity to the area of impact	The site is located in the Shire of the Serpentine-Jarrahdale, which is located approximately 100 km south of Yanchep.
Similar or better vegetation condition than area impacted.	The DBCA reports that vegetation condition within the site is Very Good to Excellent. This is supported by the Class A

Criteria	Summary
	reserve conservation rating and the extent of management works conducted onsite by the DBCA.
Supports additional rare or otherwise significant species and threatened species or community other than that proposed to be offset.	The site contains known TEC habitat including *Caladenia huegelii* and *Drakea elastica*.
Close to or contiguous with an existing conservation area (e.g. Bush Forever).	The site is predominantly surrounded by rural properties however; the Serpentine River passes through the site. Other Bush Forever sites are located in proximity to the site.
Likely to enhance ecological linkages.	Due to the site's unique environmental values among predominantly rural/farming land, it is unlikely to enhance ecological linkages other than those already created by the Serpentine River.

Black Cockatoo Habitat and Banksia Woodlands TEC				
Values being offset to be supported	**Carnaby's Black Cockatoo habitat**		**Banksia Woodlands TEC**	
Impact (ha)	56.31		8.03	
Quantum of impact (ha)	45.05		6.42	
Habitat quality of value	9	8	9	8
Area/number of each value required (ha)	300	317	47.8	50.5
Current % risk of loss* / % decrease in trees over 20 years	15%			
Future % risk of loss* / % decrease in trees over 20 years	5%			
Current quality* / number	9	8	9	8
Future quality without offset*	8	7	8	7
Future quality with offset*	9	8	9	8

Black Cockatoo potential breeding trees		
Time horizon	5 years	
Start value	135 potential breeding trees	
Future value without offset	114.75 potential breeding trees	(represents a 15% risk of loss)
Future value with offset	128.25 potential breeding trees	(represents a 5% risk of loss)

Source: Derived from DSEWPAC 2012b

* These criteria have been derived using the Commonwealth Offset Assessment Guide (DSEWPAC, 2012b) with the 'time until ecological benefit' set at 10 years with confidence in predictions for change in quality and % risk of loss both set at 90% and 85%.

There is a high degree of confidence in the predictions for % loss and change in quality given the known security of conservation tenure being placed on currently developable land and current threats likely to unmanaged rural land.

12.11.3 Objectives and intended outcome

The objective of this offset was to prevent the future loss of and provide continual management and maintenance of an area of high quality habitat for Carnaby's Black Cockatoos, vegetation meeting the criteria for Banksia Woodlands of the Swan Coastal Plain TEC and Bush Forever.

The offset will also address threatening processes consistent with the Carnaby's Black Cockatoos recovery plans (DPaW 2013) and the approved conservation advice for the TEC (TSSC 2016).

12.11.4 Actions to be undertaken

The following actions are to be undertaken for implementation of this offset:

- Liaise with WAPC, DBCA, EPA Services and the Commonwealth regarding agreed use of the site for retrospective offsets.
- Liaise with the DBCA to discuss the proposed offset site and obtain all existing information on the site.
- Conduct a desktop review of available information to understand site environmental values.
- Conduct a fauna and targeted Black Cockatoo survey of the site to:
    - Assess terrestrial fauna values.
    - Assess the extent of Black Cockatoo habitat and values.
    - Map the area of Carnaby's, Forest Red-tailed and Baudin's Black Cockatoo foraging habitat, breeding habitat, roosting habitat and potential breeding trees.
    - Identify existing threatening processes relevant to Black Cockatoos.
- Conduct a vegetation survey to:
    - map the extent and condition of Banksia Woodlands of the Swan Coastal Plain TEC and the extent and condition of wetlands habitat.
    - identify existing threatening processes relevant to and Banksia Woodlands of the Swan Coastal Plain TEC and wetlands.
- Update Offset Strategy in consultation with DBCA and DWER.
- Prepare and execute a MOU between the PTA and DBCA with regard to the funding and delivery of this offset. This would include, but not be limited to funding, maintenance works, reporting schedule, and responsibilities of PTA in the case of certain events.
- Provide funding to DBCA to manage site.
- DBCA to maintain offset site in perpetuity and provide PTA with annual reports for the pre-arranged time period (minimum seven years).

12.11.5 Success criteria

The objective of this offset proposal is to manage the offset site to maintain or increase its habitat quality and/or condition. Success will be measured based on the condition/quality of area maintained or increased over seven years.

12.11.6 Risks and contingency measures

The key risks and contingency measures for this offset proposal are summarised in **Table 12-24**.

Table 12-24:Key risks and contingency measures for the Mardella Site

Risk/Trigger	Potential contingency measures
Proposed site not able to be used as an offset site for all or some of the environmental values proposed	Seek advice from the DBCA regarding: • Potential alternative acquisition sites. • Potential alternative offset options such as rehabilitation of existing Black Cockatoo habitat already in conservation estate.
Insufficient area of Black Cockatoo and Banksia TEC habitat meeting essential criteria able to be practicably acquired within required timeframe.	Seek advice from the DBCA regarding: • Potential alternative acquisition sites. • Potential alternative offset options such as rehabilitation of existing Black Cockatoo habitat already in conservation estate. • An extension/non-compliance implications/next steps.
Quality/condition of Black Cockatoo habitat/Banksia Woodlands of the Swan Coastal Plain TEC habitat/Bush Forever not maintained or improved or degrades over time despite rehabilitation and conservation measures.	• Investigate cause. • Restrict access to affected areas. • Investigate cause and extent of decline (fire disturbance, pest, weed, pathogen, climate). • Review vegetation management measures. • Implement control and remedial measures in consultation with regulators, including supplementary planting, weed spraying, feral animal control, access management as required. • Monitor success of control and remedial measures.
Site does not contain 144 potential breeding trees for ongoing management and conservation to offset impacts to potential breeding trees from the proposal.	Should an insufficient number of potential breeding trees be located on the acquired site, an alternative acquisition site with 144 potential breeding trees will be sought.

12.12 Banksia TEC/Black Cockatoo offset proposal 2 – Keysbrook land acquisition

12.12.1 Overview of proposed offset

An alternative option to offset Carnaby's Black Cockatoo habitat and Banksia Woodlands of the Swan Coastal Plain TEC impacts should the Mardella site not proceed, is the acquisition of a Bush Forever site in Keysbrook. WAPC recently purchased a privately owned portion of the Bush Forever site with the intention to transfer it from 'Rural Complementary' zoning to 'Parks and Recreation' to increase conservation status and utilise it as a future offset site for government strategic projects.

The site is estimated to be 257 ha and contains:

- Wetland habitat including conservation category wetlands.
- Potential Carnaby's, Forest Red-tailed and Baudin's Black Cockatoo foraging habitat and potential breeding trees.
- Potential Banksia Woodlands of the Swan Coastal Plain TEC.
- Other known TEC habitat.

It is intended that this site is used to offset the impacts to Carnaby's Black Cockatoo habitat (residual impact of 56.31 ha) and Banksia Woodland of the SCP TEC (residual impact of 8.03 ha) as a minimum, with potential leftover area, should it occur, banked for other METRONET projects.

At this stage, site environmental values have been unconfirmed; however, a site survey will be conducted to assess environmental values and their extent to assess offset applicability.

In addition, the PTA will provide funding for initial onsite management and maintenance works, and ongoing management works in negotiation with the DBCA/WAPC for a period of up to seven years. It is intended that management works are over and above current site management works and long-term conservation is applied to those environmental values being offset.

The total area of the site is appropriate and proportionate to the quantum of impact such that there is a net environmental gain for the values arising from the offset in the long term.

In the event that this identified site is not able to be used as an offset, other land acquisition options will be considered in consultation with the DBCA and WAPC. An alternative Bush Forever offset option is described in Section 12.13.

12.12.2 Desirable characteristics

The offset site must support the following approximate habitat extents based on a minimum of 90% of the impact to each value offset being addressed:

- 300 ha to 335 ha of Carnaby's Black Cockatoo foraging habitat depending on starting quality of offset (based on meeting minimum 90% of offset requirement).
- 135 potential Black Cockatoo breeding trees.
- 43 to 47 ha of Banksia Woodlands of the Swan Coastal Plain TEC depending on starting quality of offset minus any area provided in the Bush Forever on-ground management offset (Section 12.12).
- 23.48 ha of Bush Forever offsets (100% of offset requirement).

Table 12-25 summarises the desirable characteristics of the site in accordance with the Western Australian Environmental Offsets Guidelines (Government of Western Australia, 2014) and environmental values of the site based on Commonwealth Offset Assessment Guide (DSEWPAC, 2012b) inputs. It is recognised, due to the size of the site, there will be an insufficient amount of Carnaby's Black Cockatoo habitat to meet the total offset requirement for this environmental value. As such, if Keysbrook were used, the shortfall of Carnaby's Black Cockatoo habitat will be taken from another offset site, such as Cataby.

Table 12-25: Keysbrook offset site description (are, quality and % risk of loss values

Criteria	Summary
Ownership	Crown land
Tenure	State
Zoning	Rural Complementary
Area (ha)	257
In proximity to the area of impact	The site is located in the Shire of the Serpentine-Jarrahdale, which is located approximately 120 km south of Yanchep.
Similar or better vegetation condition than area impacted.	Vegetation condition is unknown at the time of writing, but due to the Bush Forever conservation status and location, it is likely

Criteria	Summary
	vegetation condition will be similar or better than the area impacted.
Supports additional rare or otherwise significant species and threatened species or community other than that proposed to be offset.	The site contains known TEC habitat.
Close to or contiguous with an existing conservation area (e.g. Bush Forever).	The acquired site is the northern portion of Bush Forever Site 77, and it is also located west of the Serpentine National Park.
Likely to enhance ecological linkages.	Acquisition of the site will improve the conservation status of Bush Forever Site 77 through rezoning the Rural complimentary lot to Parks and Recreation.

Black Cockatoo Habitat and Banksia Woodlands TEC				
Values being offset to be supported	**Carnaby's Black Cockatoo habitat**		**Banksia Woodlands TEC**	
Impact (ha)	56.31		8.03	
Quantum of impact (ha)	45.05		6.42	
Habitat quality of value	9	8	9	8
Area/number of each value required (ha)	300	317	47.52	50.15
Current % risk of loss* / % decrease in trees over 20 years	15%			
Future % risk of loss* / % decrease in trees over 20 years	5%			
Current quality* / number	9	8	9	8
Future quality without offset*	8	7	8	7
Future quality with offset*	9	8	9	8

Source: Derived from DSEWPAC (2012b)

* These criteria have been derived using the Commonwealth Offset Assessment Guide (SEWPAC, 2012b) with the 'time until ecological benefit' set at 10 years with confidence in predictions for change in quality and % risk of loss both set at 90% and 85%.

There is a high degree of confidence in the predictions for % loss and change in quality given the known security of conservation tenure being placed on currently developable land and current threats likely to unmanaged rural land.

12.12.3 Objectives and intended outcome

The objective of this offset is to prevent future loss and degradation of and the provision of funding to manage and maintain an area of high quality Black Cockatoo, Banksia Woodlands of the Swan Coastal Plain TEC and Bush Forever habitat.

12.12.4 Actions to be undertaken

The following actions are to be undertaken for implementation of this offset:

- Liaise with WAPC, DBCA, EPA Services and the Commonwealth regarding agreed use of the site.
- Liaise with the DBCA/WAPC to discuss the proposed offset site and obtain all existing information on the site including an average cost to maintain the site per annum.
- Conduct a desktop review of available information to understand site environmental values.
- Conduct a fauna and targeted Black Cockatoo survey of the site to:
  - Assess terrestrial fauna values.
  - Assess the extent of Black Cockatoo habitat and values.
  - Map the area of Carnaby's, Forest Red-tailed and Baudin's Black Cockatoo foraging habitat, breeding habitat, roosting habitat and potential breeding trees.
  - Identify existing threatening processes relevant to Black Cockatoos.
- Conduct a vegetation survey to:
  - Map the extent and condition of Banksia Woodlands of the Swan Coastal Plain TEC and the extent and condition of wetlands habitat.
  - Identify existing threatening processes relevant to and Banksia Woodlands of the Swan Coastal Plain TEC and wetlands.
- Update Offset Strategy in consultation with DBCA and DWER.
- Prepare and execute a MOU between the PTA and DBCA with regard to the funding and delivery of this offset. This would include, but not be limited to funding, maintenance works, reporting schedule, and responsibilities of PTA in the case of certain events.
- Provide funding to DBCA to manage site.
- DBCA to maintain offset site in perpetuity and provide PTA with annual reports for the pre-arranged time period (minimum seven years).

12.12.5 Success criteria

The objective of this offset proposal is to manage the offset site to maintain or increase its habitat quality and/or condition. Success will be measured based on the condition/quality of area maintained or increased over seven years.

12.12.6 Risks and contingency measures

The key risks and contingency measures for this offset proposal are summarised in **Table 12-26**.

Table 12-26: Key risks and contingency measures for Keysbrook site

Risk/Trigger	Potential contingency measures
Proposed site not able to be used as an offset site for all or some of the environmental values proposed.	Seek advice from the DBCA regarding: • Potential alternative acquisition sites. • Potential alternative offset options such as rehabilitation of existing Black Cockatoo/Banksia Woodlands TEC habitat already in conservation estate.
Insufficient area of environmental values meeting essential criteria able to be practicably acquired within required timeframe.	Seek advice from the DBCA regarding: • Potential alternative acquisition sites. • Potential alternative offset options such as rehabilitation of existing Black Cockatoo/Banksia Woodlands TEC habitat already in conservation estate. • An extension / non-compliance implications/next steps.

Risk/Trigger	Potential contingency measures
Quality / condition of Black Cockatoo / Banksia Woodlands of the Swan Coastal Plain TEC not maintained or improved or degrades over time despite rehabilitation and conservation measures.	• Investigate cause. • Restrict access to affected areas. • Investigate cause and extent of decline (fire disturbance, pest, weed, pathogen, climate). • Review vegetation management measures. • Implement control and remedial measures in consultation with regulators, including supplementary planting, weed spraying, feral animal control, access management as required. Monitor success of control and remedial measures.
Site contains less than 90% of the total offset required for the impact to Black Cockatoo/Banksia Woodlands TEC habitat.	• Assess the extent of Black Cockatoo/Banksia Woodlands TEC habitat offset onsite and whether it meets required offset extent. • Where a shortfall is identified, discuss applicability of alternative offset sites with DBCA.

12.13 Banksia TEC/Black Cockatoo offset proposal 3 – Cataby site land acquisition

12.13.1 Overview of proposed offset

An alternative option to offset Carnaby's Black Cockatoo habitat and Banksia Woodlands of the Swan Coastal Plain TEC impacts should the Mardella site and/or Keysbrook sites not proceed, is the acquisition of a site in Cataby. The DBCA recently purchased a privately owned site in Cataby with the intention to transfer it from 'Rural Complementary' zoning to 'Parks and Recreation' to increase conservation status and allocate portions of the site to proponents to offset significant residual environmental impacts.

It is estimated that 200 ha of the Cataby site may be available for allocation to METRONET and contains:

- Low, moderate and high Black Cockatoo foraging habitat and potential Black Cockatoo breeding trees.
- Banksia Woodlands of the Swan Coastal Plain TEC.

It is intended that this site is used to offset the impacts to Carnaby's Black Cockatoo habitat (residual impact of 56.31 ha) and Banksia Woodland of the SCP TEC (residual impact of 8.03 ha) as a minimum.

A site survey will be conducted to assess the extent and quality of environmental values in the allocated portion of the site and total offset applicability.

In addition, the PTA will provide funding for initial onsite management and maintenance works, and ongoing management works in negotiation with the DBCA for a period of up to seven years. It is intended that management works are over and above current site management works and long-term conservation is applied to those environmental values being offset.

The total area of the site is appropriate and proportionate to the quantum of impact such that there is a net environmental gain for the values arising from the offset in the long-term.

In the event that this identified site is not able to be used as an offset, other land acquisition options will be considered in consultation with the DBCA and WAPC or a combination of the three Black Cockatoo/Banksia Woodlands of the SCP TEC offset proposals will be sought.

12.13.2 Desirable characteristics

The offset site must support the following approximate habitat extents based on a minimum of 90% of the impact to each value offset being addressed:

- 300 ha to 335 ha of Carnaby's Black Cockatoo foraging habitat depending on starting quality of offset (based on meeting minimum 90% of offset requirement).
- 135 potential Black Cockatoo breeding trees.
- 43 to 47 ha of Banksia Woodlands of the Swan Coastal Plain TEC depending on starting quality of offset minus any area provided in the Bush Forever on-ground management offset (Section 12.12).
- 23.48 ha of Bush Forever offsets (100% of offset requirement).

Table 12-27 summarises the desirable characteristics of the site in accordance with the Western Australian Environmental Offsets Guidelines (Government of Western Australia, 2014) and environmental values of the site based on Commonwealth Offset Assessment Guide (DSEWPAC, 2012b) inputs. It is recognised, due to the size of the site, there will be an insufficient amount of Carnaby's Black Cockatoo habitat to meet the total offset requirement for this environmental value. As such, if the Cataby site were used, the shortfall of Carnaby's Black Cockatoo habitat will be taken from another offset site, such as the Keysbrook site.

Table 12-27: Cataby offset site description (Area, quality and % risk of loss values derived from DSEWPAC(2012b))

Criteria	Summary
Ownership	Crown land
Tenure	State
Zoning	Rural Complementary
Area (ha)	600 in total, approximately 200 ha available for use.
In proximity to the area of impact	The site is located in the Shire of Dandaragan and is located approximately 100 km north of Yanchep.
Similar or better vegetation condition than area impacted.	Vegetation condition is unknown at the time of writing, but it is likely vegetation condition will be similar or better than the area impacted.
Supports additional rare or otherwise significant species and threatened species or community other than that proposed to be offset.	Existing vegetation mapping has not indicated whether the site contains TECs/PECs other than Banksia Woodlands of the SCP TEC.
Close to or contiguous with an existing conservation area (e.g. Bush Forever).	The acquired site is located on the eastern side of the Namming Nature Reserve and the Eneminga Nature Reserve.
Likely to enhance ecological linkages.	Due to the acquired site's location in the DBCA identified Banksia Woodlands of the SCP community ecological corridor in accordance with ENV (2009), it will contribute to the ecological linkage of that community in the northern corridor.
Black Cockatoo Habitat and Banksia Woodlands TEC	

Values being offset to be supported	Carnaby's Black Cockatoo habitat		Banksia Woodlands TEC	
Impact (ha)	56.31		8.03	
Quantum of impact (ha)	45.05		6.42	
Habitat quality of value	9	8	9	8
Area/number of each value required (ha)	300	317	47.52	50.15
Current % risk of loss* / % decrease in trees over 20 years	15%			
Future % risk of loss* / % decrease in trees over 20 years	5%			
Current quality* / number	9	8	9	8
Future quality without offset*	8	7	8	7
Future quality with offset*	9	8	9	8

Source: Derived from DSEWPAC (2012b)

* These criteria have been derived using the Commonwealth Offset Assessment Guide (SEWPAC, 2012b) with the 'time until ecological benefit' set at 10 years with confidence in predictions for change in quality and % risk of loss both set at 90% and 85%.

There is a high degree of confidence in the predictions for % loss and change in quality given the known security of conservation tenure being placed on currently developable land and current threats likely to unmanaged rural land.

12.13.3 Objectives and intended outcome

The objective of this offset is to prevent future loss and degradation of and the provision of funding to manage and maintain an area of high quality Black Cockatoo and Banksia Woodlands of the Swan Coastal Plain TEC habitat.

12.13.4 Actions to be undertaken

The following actions are to be undertaken for implementation of this offset:

- Liaise with WAPC, DBCA, EPA Services and the Commonwealth regarding agreed use of the site.
- Liaise with the DBCA/WAPC to discuss the proposed offset site and obtain all existing information on the site including an average cost to maintain the site per annum.
- Conduct a desktop review of available information to understand site environmental values.
- Conduct a fauna and targeted Black Cockatoo survey of the site to:
  - Assess terrestrial fauna values.
  - Assess the extent of Black Cockatoo habitat and values.
  - Map the area of Carnaby's Black Cockatoo foraging habitat, breeding habitat, roosting habitat and potential breeding trees.
  - Identify existing threatening processes relevant to Black Cockatoos.
- Conduct a vegetation survey to:
  - Map the extent and condition of Banksia Woodlands of the Swan Coastal Plain TEC and the extent and condition of wetlands habitat; and

  - Identify existing threatening processes relevant to and Banksia Woodlands of the Swan Coastal Plain TEC and wetlands.
- Update Offset Strategy in consultation with DBCA and DWER.
- Prepare and execute a MOU between the PTA and DBCA with regard to the funding and delivery of this offset. This would include, but not be limited to funding, maintenance works, reporting schedule, and responsibilities of PTA in the case of certain events.
- Provide funding to DBCA to manage site.
- DBCA to maintain offset site in perpetuity and provide PTA with annual reports for the pre-arranged time period (minimum seven years).

12.13.5 Success criteria

The objective of this offset proposal is to manage the offset site to maintain or increase its habitat quality and/or condition. Success will be measured based on the condition/quality of area maintained or increased over seven years.

12.13.6 Risks and contingency measures

The key risks and contingency measures for this offset proposal are summarised in **Table 12-28.**

Table 12-28: Key risks and contingency measures for the Cataby site

Risk/trigger	Potential contingency measures
Proposed site not able to be used as an offset site for all or some of the environmental values proposed.	Seek advice from the DBCA regarding: • Potential alternative acquisition sites. • Potential alternative offset options such as rehabilitation of existing Black Cockatoo/Banksia Woodlands TEC habitat already in conservation estate.
Insufficient area of environmental values meeting essential criteria able to be practicably acquired within required timeframe.	Seek advice from the DBCA regarding: • Potential alternative acquisition sites. • Potential alternative offset options such as rehabilitation of existing Black Cockatoo/Banksia Woodlands TEC habitat already in conservation estate. • An extension / non-compliance implications/next steps.
Quality / condition of Black Cockatoo / Banksia Woodlands of the Swan Coastal Plain TEC not maintained or improved or degrades over time despite rehabilitation and conservation measures.	• Investigate cause. • Restrict access to affected areas. • Investigate cause and extent of decline (fire disturbance, pest, weed, pathogen, climate). • Review vegetation management measures. • Implement control and remedial measures in consultation with regulators, including supplementary planting, weed spraying, feral animal control, access management as required. • Monitor success of control and remedial measures.
Site contains less than 90% of the total offset required for the impact to Black Cockatoo/Banksia Woodlands TEC habitat.	• Assess the extent of Black Cockatoo/Banksia Woodlands TEC habitat offset onsite and whether it meets required offset extent. • Where a shortfall is identified, discuss applicability of alternative offset sites with DBCA.

12.14 Bush Forever offset proposal 1 – Ningana Bushland on ground conservation and management

12.14.1 Overview of offset

To counterbalance significant residual impacts to clearing vegetation within Ningana Bushland (Bush Forever Site 289), on-ground conservation management in Ningana Bushland (Bush Forever Site 289) to improve the condition and quality of Degraded vegetation within the un-impacted areas is proposed. The PTA proposes to increase the conservation significance of an area of at least 23.48 ha within Ningana Bushland through site management measures. This option has been proposed by the PTA as the existing condition of Ningana Bushland is such that significant benefits can be obtained for the existing bushland if on-ground conservation management is undertaken. A minimum of 23.48 ha of vegetation in Degraded condition within the un-impacted areas of the Bush Forever site will be targeted to increase conservation significance from 'medium' to 'high'. On-ground management measures will represent works beyond that currently conducted by the WAPC in the bushland. This will be achieved through active management of threatening processes including weeds, feral animals, uncontrolled access, and fire. It is intended that a total of 69.59 ha **(**Table 12-4) is targeted by this program, considerably more than the minimum 23.48 ha required. This figure represents the extent of Degraded vegetation within Ningana Bushland.

The offset will complement and integrate existing mitigation measures within Ningana Bushland. particularly the provision of fencing and a fauna connection across the development envelope between separated areas of the Bush Forever site.

12.14.2 Objectives and intended outcomes

The objectives of this offset proposal are to:

- Improve the condition of currently Degraded areas of vegetation within Bush Forever site 289.
- Reduce risk of loss of vegetation and habitat from threatening processes in Bush Forever site 289.
- Implement conservation measures that improve the likelihood of success of the proposed fauna crossings, as recommended by Bamford (2019b).

The intended outcome is the Bush Forever site 289 to have a net increase in high conservation significant vegetation, an overall improvement in conservation management, and for an increase in the extent of breeding habitat in the long-term.

12.14.3 Actions undertaken to date

An evaluation of the presence and extent of environmental values in Ningana Bushland has been undertaken by ELA on behalf of the PTA. This is documented in 'Ningana Bushland (Bush Forever Site 289) Candidate Offset Site Investigation - Yanchep Railway Extension' (ELA 2018; Appendix O). Other flora and vegetation and fauna habitat values were assessed and documented by GHD (2018b).

The PTA has met with WAPC and DBCA to discuss the following:

- Current management measures WAPC conducts annually onsite including annual management cost.
- Proposed management measures to improve Ningana Bushland.
- Process to transfer management from WAPC to DBCA.

12.14.4 Actions to be undertaken

The following actions are to be undertaken for implementation of this offset:

- Undertake further site assessment to provide more information on existing threatening processes including weed infestation (mapping weeds particularly in degraded vegetation area to be improved), feral animal damage, and erosion prone areas.
- Prepare final Offset Strategy in consultation with the DBCA, WAPC and DWER.
- Prepare and execute a MOU between the PTA and DBCA to document the funding and delivery of this offset by the DBCA.
- Prepare a conservation management plan for the site detailing management measures, monitoring and contingencies to achieve the objective.
- Undertake upfront on ground conservation works, including:
  - rubbish removal
  - fencing integrated with design of fauna crossings
  - fire prevention and control measures
  - feral animal control integrated with design and implementation of fauna crossings
  - weed control focussed on degraded areas
  - signage
- Undertake ongoing conservation works for improvement of TEC quality including:
  - targeted weed removal and control with focus on degraded areas
  - feral animal control integrated with implementation of fauna crossings
  - strategic and selective seedling planting to assist in restoration of structure, cover, composition and species diversity characteristic in degraded areas (if determined appropriate by the DBCA)
  - monitor annually up to five years (extending only if desired quality not achieved).
- Beyond five years undertake conservation works to maintain condition at desired level by seven years including:
  - weed control
  - feral animal control responding also to any pressures from feral animals observed at fauna connection
  - vegetation condition inspections.

12.14.5 Success criteria

Table 12-29 indicates the success criteria for this offset proposal.

Table 12-29: Ningana Bushland on-ground management offset success criteria

Objective	Success criteria
Improve the condition of currently degraded areas of vegetation within Bush Forever site 289.	Condition/quality of at least 23.48 ha of vegetation mapped as degraded vegetation is increased to 'Good' or better and maintained at this level by seven years.
Reduce future risk of loss of vegetation and habitat from threatening processes in Bush Forever site 289.	Conservation Management Plan prepared, funded and implemented within 18 months of approval of Proposal.
Implement conservation measures that improve the likelihood of success of the proposed fauna connection.	Monitoring undertaken by the PTA for purpose of assessing success of fauna connection show a decrease in pressure from feral animals by seven years.

12.14.6 Risks and contingency measures

Key risks and contingency measures for this offset proposal are summarised in Table 12-30**.**

Table 12-30: Key risks and contingency measures for Ningana Bushland on-ground management offset

Risk/Trigger	Potential contingency measures
The DBCA cannot secure funding shortfall to manage entire Ningana site.	• Quantify shortfall and liaise with DBCA regarding funding requirements • Facilitate workshop with DBCA, WAPC and other relevant stakeholders to negotiate arrangements for transfer Investigate potential Bush Forever offset requirements of other METRONET projects • Investigate funding partnerships with other government agencies • Investigate Bush Forever offset banking opportunities • Pursue most favourable option and negotiate with DBCA and other government agencies • Should funding be unable to be secured, investigate alternative Bush Forever offset options
Condition of degraded vegetation not improved, or area of improved vegetation condition does not or is not likely to meet minimum area of 23.48 ha, within seven years despite conservation measures.	• Investigate cause. • Restrict access to affected areas. • Investigate cause and extent of vegetation decline (fire disturbance, pest, weed, pathogen, climate). • Review vegetation management measures. • Implement control and remedial measures in consultation with regulators, including supplementary planting, weed spraying, feral animal control, access management as required. • Monitor success of control and remedial measures.

12.15 Bush Forever offset proposal 2 – Keysbrook land acquisition, transfer to conservation

12.15.1 Overview of Offset

Where Bush Forever Offset Proposal 1 is unable to be implemented, it is intended that a privately owned Bush Forever site is purchased and transferred to from Rural Complimentary to Parks and Recreation to provide conservation and on-ground conservation management undertaken onsite. It is intended that an existing Bush Forever Site with the same environmental values as those being impacted by the YRE Part 2 Proposal is proposed for acquisition and conservation.

Keysbrook is the proposed site to offset Bush Forever impacts. Refer to Section 12.12 for a summary of the Keysbrook site land acquisition and environmental values.

Keysbrook zoning will be transferred from Rural complimentary to Parks and Recreation and on -ground conservation management is proposed to improve the condition and quality of degraded Bush Forever vegetation. Keysbrook is considered a suitable offset as it contains similar environmental values and those being impacted by the proposal, however, further surveys will be conducted should this option be pursued to confirm their presence and offset suitability.

The PTA proposes to increase the conservation significance of an area of at least 23.48 ha within the Keysbrook site through site management measures. A minimum of 23.48 ha of vegetation in Degraded condition within the un-impacted areas of the Bush Forever site will be targeted to increase conservation significance from 'medium' to 'high'. On-ground management measures will represent works beyond that currently conducted by the WAPC. This will be achieved through active management of threatening processes including weeds, feral animals, uncontrolled access, and fire.

The final Bush Forever offset and site chosen for management will be agreed in consultation with DWER, DBCA and WAPC.

12.15.2 Objectives and Intended Outcomes

The objectives of this offset proposal are to:

- Transfer zoning from Rural Complimentary to Parks and Recreation to increase the conservation status.
- Improve the condition of currently degraded areas of vegetation within the Keysbrook site.
- Reduce risk of losing vegetation and habitat from threatening processes in the Keysbrook site.

The intended outcome is to have a net increase in high conservation significant vegetation within the Keysbrook site, an overall improvement in conservation management of vegetation, and for an increase in the extent of Black Cockatoo breeding habitat in the long-term.

12.15.3 Actions to be undertaken

The following actions are to be undertaken for implementation of this offset:

- Liaise with WAPC, DBCA and EPA Services regarding agreed use of the site.
- Liaise with the DBCA/WAPC to discuss the proposed offset site and obtain all existing information on the site including an average cost to maintain the site per annum.
- Conduct a desktop review of available information to understand site environmental values, if required and not already available.
- Conduct a fauna and targeted Black Cockatoo survey of the site to if required and not already available to:
    - Assess terrestrial fauna values.
    - Assess the extent of Black Cockatoo habitat and values.
    - Map the area of Carnaby's, Forest Red-tailed and Baudin's Black Cockatoo foraging habitat, breeding habitat, roosting habitat and potential breeding trees.
    - Identify existing threatening processes relevant to Black Cockatoos.
- Conduct a vegetation survey, if required and not already available to:
    - Map the extent and condition of Banksia Woodlands of the Swan Coastal Plain TEC and the extent and condition of wetlands habitat.
    - Identify existing threatening processes relevant to and Banksia Woodlands of the Swan Coastal Plain TEC and wetlands.
- Undertake a site assessment to provide more information on existing threatening processes including weed infestation (mapping weeds particularly in degraded vegetation area to be improved), feral animal damage, and erosion prone areas.

- Prepare final Offset Strategy in consultation with the DBCA, WAPC and DWER.
- Prepare and execute a MOU between the PTA and DBCA to document the funding and delivery of this offset by the DBCA.
- Prepare a conservation management plan for the site detailing management measures, monitoring and contingencies to achieve the objective.
- Undertake upfront on ground conservation works, including:
  - rubbish removal
  - fencing
  - fire prevention and control measures
  - feral animal control
  - weed control focussed on degraded areas
  - signage.
- Undertake ongoing conservation works for improvement of TEC quality including:
  - targeted weed removal and control with focus on degraded areas
  - feral animal control
  - strategic and selective seedling planting to assist in restoration of structure, cover, composition and species diversity characteristic in degraded areas (if determined appropriate by the DBCA)
  - monitor annually up to five years (extending only if desired quality not achieved).
- Beyond five years undertake conservation works to maintain condition at desired level by seven years including:
  - weed control
  - feral animal control responding also to any pressures from feral animals observed at fauna connection
  - vegetation condition inspections.

12.15.4 Success Criteria

Table 12-31 indicates the success criteria for this offset proposal.

Table 12-31: Keysbrook site on-ground management offset success criteria

Objective	Success criteria
Improve the condition of currently degraded areas of vegetation within the Keysbrook site.	Condition/quality of at least 23.48 ha of vegetation mapped as degraded vegetation is increased to 'Good' or better and maintained at this level by seven years.
Reduce future risk of loss of vegetation and habitat from threatening processes in the Keysbrook site.	Conservation Management Plan prepared, funded and implemented within 18 months of approval of Proposal.

12.15.5 Risks and Contingency Measures

Key risks and contingency measures for this offset proposal are summarised in Table 12-32**.**

Table 12-32: Key risks and contingency measures for Keysbrook on-ground management offset

Risk/Trigger	Potential contingency measures
Condition of degraded vegetation not improved, or area of improved vegetation condition does not or is not likely to meet minimum area of 23.48 ha, within seven years despite conservation measures.	• Investigate cause. • Restrict access to affected areas. • Investigate cause and extent of vegetation decline (fire disturbance, pest, weed, pathogen, climate). • Review vegetation management measures. • Implement control and remedial measures in consultation with regulators, including supplementary planting, weed spraying, feral animal control, access management as required. • Monitor success of control and remedial measures.
Proposed site not able to be used as an offset site for all or some of the environmental values proposed/not suitable Bush Forever offset option.	Seek advice from the DBCA regarding: • Potential alternative acquisition sites. • Potential alternative offset options such as rehabilitation of existing Bush Forever sites.

12.16 Carnaby's Cockatoo research funding

The PTA proposes to provide funding to a body, such as Murdoch University to finance black cockatoo research. Warren et al. (2019) is an example of a research proposal that has been prepared and is being considered by the PTA. Funding for research is intended to comprise 10% of the total Carnaby's Black Cockatoo offset requirement, when delivered in addition to the land acquisition outlined in offset Black Cockatoo offset proposals 1 to 3.

12.16.1 Overview of offset

Provision of research funding is classified by the Commonwealth as an 'other compensatory measure' that is not a direct offset but is anticipated to lead to benefits for the impacted protected matter, in this instance, Carnaby's Cockatoo.

Western Australia's three endemic black cockatoo species, Carnaby's Cockatoos (*Calyptorhynchus latirostris)*, Baudin's Cockatoos (*Calyptorhynchus baudinii)* and Forest Red-tailed Black Cockatoos (*Calyptorhynchus banksii naso*) are threatened and receive special protection as MNES under the EPBC Act. Threats to the survivorship of these black cockatoo species are well documented, and include habitat loss and modification, urban and industrial expansion, disease, displacement by competing species, and climate shifts. Despite significant research to date, key information required to address the National Recovery Plan remains outstanding (Warren, K, Shephard, J et. al., 2019).

Murdoch's research proposal (Warren, K, Shephard, J et. al., 2019) aims to utilise innovative tracking methodologies to undertake a movement ecology study of Western Australia's three threatened black cockatoo species, to determine habitat use and threatening processes in modified landscapes. This includes tracking the three species of black cockatoos on the Perth-Peel Coastal Plain, and given the importance of the Perth-Peel Coastal Plain for Carnaby's Cockatoos during the non-breeding season, tracking Carnaby's Cockatoos at key breeding sites to better understand movement dynamics of this species across its distribution range.

Research will use remote sensing to produce predictive modelling of black cockatoo population movements and habitat use, in association with existing and emerging threats across key range areas. The project combines satellite/GPS derived movement data; other remotely sensed landscape data (e.g. vegetation, water); and existing fire and climate models, to identify crucial habitat characteristics and regions most resilient to impacts of threatening processes (fire, climate shifts, habitat modification, tree health, disease, urban expansion). The generated data and information will allow collaborators to develop policies and take action to manage land changes, and build resilience into modified landscapes to address black cockatoo declines.

Murdoch's research proposal is being considered as an offset by the PTA, however, a formal and transparent procurement process to be applied to the market has not commenced. The PTA has considered Murdoch's research proposal for the purpose of this offset strategy.

12.16.2 Objectives and intended outcome

The research proposal (Warren et. al., 2019) has the following objectives:

- Characterise black cockatoo movement and habitat use across the Perth-Peel Coastal Plain for all three black cockatoo species.
- Study known Carnaby's Cockatoo breeding sites focussing on characterising habitat suitability, food resource availability and selection, nestling health, specific threatening processes and fledgling dispersal routes.
- Identify new breeding sites in inland or southern areas for all three species based on migratory movement of birds to breeding grounds.
- Apply new ecotoxicology methods to investigate Carnaby's Cockatoo Hindlimb Paralysis Syndrome (CHiPs) toxicity cases, particularly in the agricultural zone.
- Predictively model survivorship scenarios for all three species of black cockatoo using movement, habitat use and threats.

The research proposal will deliver new flock movement and habitat use information and conservation outcomes with a clear focus on conservation and management in breeding regions and population source-sink dynamics within the northern and southern populations.

The proposal has the following direct conservation management outcomes:

- Identification and prioritisation of key habitat resources including food, water and vegetation corridors to maximise the retention of critical conservation value habitat for the long-term retention of Carnaby's Cockatoos, Baudin's Cockatoos and Forest Red-tailed Black Cockatoos across their historical range.
- Characterisation of appropriate roosting habitat for all three species of black cockatoo, particularly on the Perth-Peel Coastal Plain – this is important as it is not necessarily synonymous with appropriate feeding or nesting habitat.
- Characterisation of optimal provisioning distances based on energetics work to inform future offset purchases.
- Identification of new breeding sites (and nest hollow identification) for all three species of black cockatoo, facilitating additional long-term monitoring and protection of stronghold populations, and informing the purchase of off-set land.
- Additional knowledge about key threatening processes (disease, displacement spp., pesticide exposure etc.) on Perth-Peel Coastal Plain, in the south-west and at breeding sites.

- Additional knowledge about critical habitat resources and the overall health of breeding populations at key Carnaby's Cockatoo breeding sites, which is required to ensure appropriate long-term conservation management of these sites.
- Correlation of realised species movement ecology with existing PVA models.
- Facilitation of consultation with local government to maximise future urban and peri-urban design to retain birds on the Perth-Peel Coastal Plain and maximise conservation management.
- Continued liaison with stakeholder groups which consult with private landowners and industry, to manage properties and to maximise landscape and habitat integrity suitable to sustain black cockatoo populations over the long-term.

12.16.3 Compliance with Commonwealth criteria

The proposed research proposal's (Warren et. al., 2019) consideration of DoEE criteria for research (Commonwealth of Australia, 2012) is summarised in **Table 12-33**.

Table 12-33: Consideration of Commonwealth criteria for research (Commonwealth of Australia 2012)

Commonwealth criteria for research	Application of criteria to proposal
A suitable research program must endeavour to improve the viability of the impacted protected matter.	The objectives of the research proposal summarised in Section 12.16 endeavour to improve the viability of black cockatoos and inform future black cockatoo offset options.
A suitable research program must be targeted toward key research as identified in the relevant Commonwealth approved recovery plan, threat abatement plan, conservation advice, ecological character description, management plan or listing document. Where Commonwealth approved guidance documents are not available or are insufficient in detail, the department will consider additional information sources such as state management plans or peer reviewed scientific literature to inform priority offset activities.	The proposal has been developed in collaboration with DBCA to meet the requirements of the EPBC Act Referral Guidelines for the three black cockatoo species (DSEWPAC 2012a), as well as priority Actions and recommendations from the national Carnaby's Cockatoo Recovery Plan (DEC 2013), Forest Black Cockatoo Recovery Plan (DEC 2007), MNES Significant Impact Guidelines and the Consideration of MNES by the WA land use planning system Discussion Paper (DEWHA 2009).
A suitable research program must be undertaken in a transparent and scientifically robust and timely manner.	The research program will be: • Transparent as regular reporting will be provided to the PTA and the results will be published and made publicly accessible. • Scientifically robust as it has been based on similar research programs conducted by the same team since 2015. This includes the successful deployment of 84 tags and production of over 140,000 GPS location fixes, 33,000 km of track movement and over 2.8M accelerometer records. The methodology is proven, and facilitates individual and flock movement characterisation at spatial and temporal scales previously unattainable. • Conducted over a period of five years.

Commonwealth criteria for research	Application of criteria to proposal
A suitable research program must be undertaken by a suitably qualified individual or organisation in a manner approved by the department	The research program will be undertaken by suitably qualified and experienced Murdoch University research scientists and has been developed in collaboration with DBCA to meet the to meet the requirements of the EPBC Act Referral Guidelines for the three black cockatoo species (DSEWPAC 2012a), as well as priority Actions and recommendations from the national Carnaby's Cockatoo Recovery Plan (DEC 2013), Forest Black Cockatoo Recovery Plan (DEC 2007), MNES Significant Impact Guidelines and the Consideration of MNES by the WA land use planning system Discussion Paper (DEWHA 2009).
A suitable research program must consider best practice research approaches.	The research proposal will consider best practice research approaches.
The proponent is required to select an institution through an internationally available open tender process or provide evidence that the program can be undertaken in-house. Where appropriate, the tender should complement an existing research institution's work program as it relates to the MNES. This will be the responsibility of the proponent; however, the department will require that the proponents follow the department's guidelines.	The PTA will initiate an open tender process to engage the most suitable proponent to undertake the required research.
The proponent is required to provide updates on progress and key findings to the department through periodic reporting.	The PTA will require that monthly and annual progress reports are submitted to track research progress, with annual progress reports provided to regulators.
The proponent is required to ensure that funds are managed appropriately and that auditable financial records are kept and maintained.	The PTA will require that monthly and annual progress reports include distribution of PTA funding and will require that auditable financial records are kept and maintained.
The proponent is required to apply a 'no surprises' policy to the publication, whereby research publications and outputs are provided to the department at least 5 working days before release.	The PTA will apply a 'no surprises' policy to the publication, whereby research publications and outputs are provided to the department at least 5 working days before release.
Research programs will be tailored to at least a postgraduate level; however, there will be scope to engage other educational levels in educational programs.	The research proposal is tailored to at least a postgraduate level.
Research programs will present findings that can be peer reviewed.	The research proposal will present findings that can be peer reviewed.
Research programs will publish findings in an internationally recognised peer-reviewed scientific journal or be of a standard that would be acceptable for publication in such a journal. Publications should	The research proposal will publish findings in an internationally recognised peer-reviewed scientific journal or be of a standard that would be acceptable for publication in such a journal. Publications should be submitted to free

Commonwealth criteria for research	Application of criteria to proposal
be submitted to free open access journals. Data and information collected should have creative commons licensing and be free and accessible.	open access journals. Data and information collected will have creative commons licensing and be free and accessible.
Research outputs should inform future management decisions on the protected matter and, where possible, be readily applicable to other similar matters (species groupings etc.)	Research outputs will inform future management decisions on the protected matter and, where possible, be readily applicable to other similar matters (species groupings etc.)

12.16.4 Actions to be undertaken

The following actions are to be undertaken for implementation of this offset:

- Liaise with the DBCA, EPA and DoEE to discuss the proposed offset and funding arrangement/component to obtain endorsement.
- Update Offset Strategy in consultation with DBCA as required.
- Liaise with the research organisation conducting the research and other agencies contributing to fund the research proposal to establish an arrangement.
- Prepare and execute a MOU between the PTA, the research agency and other agencies funding the research in regard to the funding approach and delivery of this research proposal offset. This would include, but not be limited to, annual reporting requirements, and distribution and publication of data.
- Provide funding to the research agency.
- Research agency shall provide updates and periodic reporting throughout the duration of the research and associated reporting and publication of results.

12.16.5 Success criteria

Table 12-34 indicates the success criteria for this offset proposal.

Table 12-34: Murdoch research proposal success criteria

Objective	Success criteria
Contribute funding to research agency to commence research in accordance with their proposal.	Research agency obtains enough funding to commence and fund their proposal.
Research agency achieves research proposal objectives and data and information contribute substantially toward the identification of critical habitat, areas under threat and areas for potential offsets.	Future METRONET, PTA and other projects and associated offset strategies benefit from the outcomes of the research proposal.

12.16.6 Risks and contingency measures

Key risks and contingency measures for this offset proposal are summarised in **Table 12-35.**

Table 12-35: Key risks and contingency measures for the Murdoch research proposal

Risk/Trigger	Potential contingency measures
Research agency is unable to secure enough funding to commence the research proposal (i.e. funding from other parties falls through or is unable to be obtained in time for/to allow commencement of the research).	• Investigate short-fall and minimum funding required to commence research. • Work with agency to potentially seek funding from other stakeholders. • Consider future METRONET projects that may be able to contribute to funding as part of their offsets strategies. • Discuss potential to expand funding to a component greater than 10% of the total offset in accordance with DoEE and the EPA to investigate additional funding opportunities.
Research results are unavailable for use in future METRONET offset strategies due to delay in obtaining the data.	• Where data is delayed or METRONET projects are brought forward prior to data becoming available, the PTA will endeavour to use the data to inform offset strategies and future planning for future projects. • Data will be published and will be publicly available for use by other government agencies and industrial and commercial proponents.

12.17 Environmental Offset Strategy Summary

Table 12-36 below summarises the environmental offset strategy for the Proposal based on the information provided in Sections 12.8 to 12.16. The WA Offsets Template and Commonwealth Offsets Calculator are provided in Appendix U and Appendix V, respectively.

12.18 Consistency with Commonwealth Offset Principals

The described approach to mitigation and proposed offsets is consistent with the six principles outlined in the WA Environmental Offset Policy (Government of Western Australia 2011). Table 12-37 summarises how these principles have been considered in the development of the offset approach for SCP 26a, Bush Forever, Banksia Woodlands TEC and Carnaby's Cockatoo.

Table 12-36: Environmental Offsets Summary

Category	Environmental Aspect	Status (State/Commonwealth)	Impact (ha)	Offset Proposal Options	Potential Offset Site Options
TECs/PECs	Banksia Woodlands of the Swan Coastal Plain (SCP) TEC	Endangered (Cwlth)	8.03	1. Land acquisition and maintenance of approximately 47-53 ha (dependent on initial quality).	• Option 1: Mardella site; or • Option 2: Keysbrook site; or • Option 3: Cataby site.
	Melaleuca huegelii – M. acerosa (*M. systena*) shrublands on limestone ridges (SCP 26a)	Endangered (State)	0.05	1. Land acquisition and maintenance of approximately 0.2 to 0.3 ha (0.23 ha) (dependent on start quality).	• Option 1: Nowergup/Neerabup (approx. 7.3/19 ha TEC habitat); or • Option 2: Acquire 2 lots north of Lake Clifton; or • Option 3: Acquire 2 lots east of Lake Clifton.
Conservation significant fauna	Carnaby's Black Cockatoo foraging habitat and potential breeding trees	Endangered (State & Cwlth)	56.31 ha Carnaby's Black Cockatoo habitat and 45 potential breeding trees.	1. Land acquisition and maintenance of approximately 340 ha of foraging habitat (dependent on start quality) AND 2. Approximately 135 potential breeding trees (trees calculated on a 3:1 ratio). AND 3. Partial funding of Black Cockatoo research (up to 10% of total offset package)	• Option 1: Mardella site; or • Option 2: Keysbrook site; or • Option 3: Cataby site. AND Partial funding of Black Cockatoo research (up to 10% of offset).

Category	Environmental Aspect	Status (State/Commonwealth)	Impact (ha)	Offset Proposal Options	Potential Offset Site Options
Bush Forever Sites	Ningana Bushland (Site 289)	-	18.07	1. On-ground conservation management of approximately 69.59 ha of Degraded to Good vegetation e.g. rehabilitation/revegetation (calculated independent of Commonwealth calculator). OR 2. Land acquisition of approximately 23 ha of privately owned Bush Forever (calculated independent of Commonwealth calculator).	• Option 1: Funding to DBCA to provide rehabilitation and maintenance works to Bush Forever Site 289. OR • Option 2: Acquisition of privately owned Bush Forever site and transfer to conservation estate, e.g. Keysbrook.

Table 12-37: Consideration of principles of WA offsets policy

Principle	SCP 26a	Banksia Woodlands TEC	Bush Forever	Carnaby's Cockatoo
Environmental offsets will only be considered after avoidance and mitigation options have been pursued.	**Table 12-1** demonstrates how avoidance and mitigation (minimisation and rehabilitation) have been implemented before offsets proposed for significant residual impacts remaining after on-site.			
Environmental offsets are not	Environment offsets are appropriate for identified significant residual environmental impacts and they have not been applied to minor environmental impacts.			

Principle	SCP 26a	Banksia Woodlands TEC	Bush Forever	Carnaby's Cockatoo
appropriate for all projects.				
Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted.	The PTA has proposed three direct offset options for mitigation of impacts to SCP 26a. Assessment as to whether acquiring the identified site is cost effective is currently underway. The direct offsets prioritise the preservation and/or enhancement of vegetation representative of the identical TEC that is being impacted unless not practicable in which case an area of similar vegetation will be attained, which is consistent with this Principle. The area and condition of vegetation involved in the offset is proportionate to the significance of the area of TEC26a affected confirmed through application of the calculator	The co-location of the Banksia Woodlands TEC with the Carnaby's Cockatoo offset and/or Bush Forever offset is cost effective. The acquisition and/or implementation of conservation measures to protect existing high quality areas of the TEC are appropriate and the Commonwealth offset calculator was used to ensure the offset is proportionate to the impact.	The application of conservation measures to an area of existing Bush Forever site that does not have existing active conservation management is cost effective and is relevant to the impact as it involves the site that is directly affected by the Proposal. The area of offset involved is proportionate to the impact as calculated using the guidance in SPP 2.8 Appendix 4.	Offsets for Carnaby's Cockatoo involving land acquisition and conservation have been demonstrated to be cost effective. The offsets involve the preservation and maintenance of habitat identical or similar in value to that being impacted. The area and quality of habitat involved in the offset is proportionate to the significance of the area of Carnaby's Cockatoo affected as confirmed through application of the calculator using the areas and quality involved (as per DSEWPAC 2012a).

Principle	SCP 26a	Banksia Woodlands TEC	Bush Forever	Carnaby's Cockatoo
	using the areas and quality involved (in accordance with DSEWPC, 2012b).			
Environmental offsets will be based on sound environmental information and knowledge.	The quantum of impact to be offset has been calculated using reliable field survey data.			
	The offset proposal for SCP 26a has been based on objectives and sites identified in the TEC recovery plan (Luu and English 2005).	The offset proposals for Banksia Woodlands TEC have been based on objectives and sites identified in the TEC conservation notice (TSSC 2016).	A recent field survey has been undertaken of the Ningana Bushland (Bush Forever site 289) to confirm the environmental values it supports and the existing condition of vegetation and habitat (ELA 2018; Appendix O)	The offset proposals for Carnaby's Cockatoo have been based on objectives and actions to preserve important habitat as identified in the recovery plan for the species (DPaW 2013).
Environmental offsets will be applied within a framework of adaptive management.	Risks, monitoring and contingency measures have been identified for all proposed offsets.			
Environmental offsets will be focussed on longer term strategic outcomes	SPC 26a offsets are focussed on long-term preservation of areas of this community consistent with the TEC recovery plan (Luu and English 2005).	Banksia Woodlands offsets are focussed on long-term preservation of areas of this community consistent with the TEC conservation notice (TSSC 2016).	The Bush Forever offset is focussed on the long term preservation and improvement in condition of the Ningana Bushland (Bush Forever site 289)	Carnaby's Cockatoo offsets area focussed on the long-term protection and avoidance of loss of important habitat, consistent with recovery plan for the species (DPaW 2013).

12.19 Consistency with Commonwealth Offset Principals

The described approach to mitigation and proposed offsets is consistent with the ten offset principles outlined in the Commonwealth Environmental Offset Policy (Commonwealth of Australia, 2012). Table 12-38 summarises how these principles have been considered in the development of the offset approach for SCP 26a, Banksia Woodlands TEC and Carnaby's Cockatoo.

Table 12-38: Consideration of Commonwealth offsets principals

Principle	Banksia Woodlands TEC	Carnaby's Cockatoo
Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action.	The acquisition of bushland on the northern SCP (near Gingin) and the subsequent change in tenure, placement into the conservation reserve system, and active conservation management will significantly increase the ecological resilience and therefore the viability of the TEC and Carnaby's Cockatoo habitat on the SCP. The net representation of the TEC within the conservation estate will increase because of this offset. The proposed offset will result in an improved overall conservation outcome, ensuring protection and enhancement of vegetation that is representative of the TEC and Carnaby's Cockatoo habitat.	
Suitable offsets must be built around direct offsets but may include other compensatory measures	The acquisition of land supporting the Banksia Woodlands TEC and provision of funding for upfront management actions to be undertaken on the land is a direct offset for the proposed action. The minimum area of Banksia Woodlands TEC to be contained in the area to be acquired is based on mitigating 100% of the proposed action impact with this direct offset.	The acquisition of land supporting Carnaby's Cockatoo habitat including potential breeding trees and provision of funding for upfront management actions to be undertaken on the land is a direct offset for the proposed action. The minimum area of Carnaby's Cockatoo habitat to be contained in the area to be acquired is based on mitigating 90% of the proposed action impact with this direct offset. Other compensatory measures in the form of research are proposed to contribute to the remaining 10% of this offset.
Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter	The offsets proposed for the proposed action are consistent with DoEE policy, mitigating a minimum of 90% or greater of the impact as confirmed through application of the Commonwealth Offset Assessment Guide calculator. This Offset Assessment Guide calculator factors the level of statutory protection into the determination of the area required and nature of offset. As such, the offset is expected to be suitable and in proportion to the level of statutory protection that applies to Banksia Woodlands TEC and Carnaby's Cockatoo.	
Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter	The extent of Banksia Woodlands TEC subject to improved management and maintenance as a result of the offsets will be proportionate to the residual impacts on Banksia Woodlands TEC within the development envelope (as confirmed through application of the	The extent of Carnaby's Cockatoo habitat subject to improved management and maintenance as a result of the offsets will be proportionate to the residual impacts on Carnaby's Cockatoo habitat including potential breeding trees

Principle	Banksia Woodlands TEC	Carnaby's Cockatoo
	Commonwealth Offset Assessment Guide calculator). The proposed action will result in the clearing of approximately 8.03 ha of Banksia Woodlands TEC. The proposed offset site at Gingin may be up to 336 ha in size (to also account for black cockatoos), but supporting at least 48.8 to 51.6 ha of Banksia Woodlands TEC (depending on starting quality) in addition to provision of funds to DBCA for on-ground conservation management. These offsets are of a size and scale proportionate to the residual impacts on the protected matter providing 100% mitigation of the impact as confirmed by the Offset Assessment Guide.	within the development envelope (as confirmed through application of the Commonwealth Offset Assessment Guide calculator). The proposed action will result in the clearing of approximately 56.31 ha of Carnaby's Cockatoo habitat and 45 potential breeding trees. The proposed offset site at Gingin may be a minimum of 336 ha in size to offset Black Cockatoo habitat impacts (depending on starting quality). In addition, funds will be provided to DBCA for on-ground conservation management. These offsets are of a size and scale proportionate to the residual impacts on the protected matter providing 90% mitigation of the impact as confirmed by the Offset Assessment Guide. The additional 10% of the offset requirement will be in the form of scientific research.
Suitable offsets must effectively account for and manage the risks of the offset not succeeding	With regard to acquisition, the risk of the offset option not succeeding is expected to be very low with a 90% confidence in the result. Several candidate sites have been identified with the DBCA and there are limited constraints to acquire these sites. The candidate sites are currently used for rural purposes and subject to threatening processes. It is reasonable to expect that the acquisition and implementation of conservation measures will successfully reduce the risk of loss and prevent degradation of habitat over the long term.	
Suitable offsets must be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action)	The proposed offsets package for Carnaby's Cockatoos and Banksia Woodlands TEC is to satisfy State and Commonwealth offset requirements and policies. The acquisition of land and placement into active conservation management is not required or planned under any other planning or approval process and is entirely instigated as a result of this environmental impact assessment for the proposed action. Management of acquired land will be over and above that which is already experienced onsite. Further, at this stage, the proposed research proposal would not proceed without the PTA's contribution.	
Suitable offsets must be efficient, effective, timely,	The proposed acquisition sites contain multiple environmental values that require offsetting and land acquisition provides an efficient offset option as there is minimal time-lag in achieving benefits following site purchase.	

Principle	Banksia Woodlands TEC	Carnaby's Cockatoo
transparent, scientifically robust and reasonable	Proposed offsets are effective in meeting and in some cases exceeding the significant residual impacts. Further, land acquisition and management is an effective offset proposal. The change in tenure and transfer to the conservation estate will be effectively and timely following approval of the proposed action through entering of a sales agreement for the land and subsequent settlement. Time lag to achieve benefits is minimal through acquisition. The offsets strategy will be provided to the EPA, DoEE and other government agencies as required for review and approval. Offsets are published via the EPA on an offsets register which provides public transparency. Further, the public were able to comment on the project's referral and this ERD including this offset chapter. The proposed offsets will be efficiently managed in a transparent manner by the DBCA. Offsets and associated conservation measures will be reviewed and approved by the EPA, DoEE and other government agencies including the DBCA and DWER which are recognised organisations for applying scientifically robust methods in conservation management.	
Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced	The PTA will enter into a MOU with the DBCA (and other relevant parities as required) to implement the offset. This will include transparent governance and regular reporting on implementation and performance. Performance measures for the improvement of the direct offset will be measurable through the development of a baseline position and ongoing monitoring, assessment and reporting. Further, regular audits to assess compliance against the offsets strategy requirements and related site management plans and/or implementation strategies will be conducted.	
Suitable offsets must be informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty.	Offsets will be informed by scientifically robust information and will incorporate the precautionary principle in the absence of scientific certainty.	
Suitable offsets must be conducted in a consistent and transparent manner.	Offsets will be conducted in a consistent and transparent manner across significant residual impacts where applicable, the entire YRE project (parts 1 & 2), and across the METRONET program of works.	

Australian Government policy specifies direct offsets should make up at least 90% of the required offset package (DSEWPAC 2012b). Direct offsets comprising less than 90% of the total offset will be considered where it can be demonstrated that there will likely be a greater benefit to the protected matter through increasing the proportion of indirect offsets or where scientific uncertainty is so high that it is not possible to determine a direct offset likely to benefit the protected matter. However, for this proposal, the proposed offsets exceed the 90% requirement.

12.20 Arrangements for each Offset Proposal

The follows sections describe the arrangements for each of the offset Proposals described above.

12.20.1 Timelines and milestones

Key milestones and timing for implementation of offsets including funding and delivery of offsets will be agreed with the DBCA as part of the development of the various MOUs. Timeline progression and achievement of milestones will be reported monthly and annually in accordance with the terms of the MOU.

12.20.2 Monitoring to assess offset implementation

The PTA will monitor offset delivery, implementation of the management actions and progress through liaison with the DBCA and Murdoch and review of monthly and annual reports. This process and will be conducted in accordance the MOUs and would include reporting on the condition of the following as a minimum:

- Vegetation in acquired property (namely, SPC 26a and Banksia Woodlands of the SCP TEC)
- Areas mapped as degraded vegetation in Ningana Bushland by ELA (2018; Appendix O)
- Black cockatoo hollows and their observed use
- Carnaby's Cockatoo habitat.

Further, research proposal progress will be reported monthly.

12.20.3 Reporting details and timing

The PTA will provide an annual Compliance Assessment Report to DWER regarding:

- The activities undertaken in the previous 12 months for each offset.
- The activities proposed in the next 12 months for each offset.
- A summary of compliance with the final Offsets Strategy with regard to each offset.
- An evaluation of the results of site assessments and monitoring to identify progress in meeting the success criteria.

The MOU between the DBCA and the PTA (and other parties as required) will dictate the format, content and timing of reporting required. Monitoring would be supported for the first five years and only extended if monitoring indicates that success criteria have not or are unlikely to be met at seven years.

12.20.4 Financial arrangements

The PTA will fully fund the actions proposed under the offset Proposal including the:

- Acquisition and/or securing of the offset land and the conservation management measures to maintain the condition of the vegetation and/or increase the quality of the Carnaby's Cockatoo foraging and Banksia Woodlands of the Swan Coastal Plain TEC.
- Conservation management measures to increase the condition of the vegetation and address threatening processes such as in Bush Forever site 289 or DBCA managed SPC 26a sites.
- Contribution to the Black Cockatoo research Proposal.

12.20.5 Governance arrangements

Governance arrangements will be determined during preparation of the MOU.

12.21 Stakeholder consultation

Stakeholder consultation in relation to the coordination, development and implementation of the YRE Part 2 offset strategy conducted to date is summarised in Table 12-39**.**

Table 12-39: YRE Part 2 Offsets Strategy Consultation

Stakeholder	Date	Issues/topics
• Department of Planning, Lands and Heritage (DPLH).	15/05/2019	• Ningana Bushland offset strategy. • Activities and annual cost of DPLH's current management of Ningana Bushland. • Future steps in implementing the offsets strategy including funding arrangements and land management transfer.
• Western Australian Planning Commission (WAPC).	1/05/2019	• Discussed WAPC's historical purchase of land for the Strategic Assessment of the Perth and Peel Region for future offset requirements including METRONET.
• Department of Premier and Cabinet (DPC) • Department of Biodiversity Conservation and Attractions (DBCA) • METRONET	5/04/2019	• Coordinated approach to METRONET offsets. • Proposed METRONET offset strategy, specifically, land acquisition options and strategy. • State and Commonwealth offset strategy timeframes. • Use of SAPPR offsets.
• DPC • DBCA	3/04/2019	• Discussed land acquisition offset options for each YRE project significant residual impact including timing, strategy, risks and issues.
• WAPC	27/03/2019	• Discussed WAPC purchased offset sites available for METRONET use.
• DPC • METRONET	27/03/2019	• Coordinated approach to METRONET offsets. • Proposed METRONET offset strategy, specifically, land acquisition options and strategy. • State and Commonwealth offset strategy timeframes. • Use of SAPPR offsets.
• DBCA	21/03/2019	• Discussed land acquisition offset options for each YRE project significant residual impact including timing, strategy, risks and issues. • DBCA proposed acquisition sites and strategies.
• DPLH	14/03/2019	• Discussed cost to manage Bush Forever sites, namely BF Site north of Roe Highway and WAPC/DBCA reserve management process.
• DPLH	13/03/2019	• Discussed cost to manage Bush Forever sites, namely Ningana Bushland and WAPC/DBCA reserve management process.
• Main Roads WA	1/03/2019	• Discussed co-funding of Murdoch's Black Cockatoo research proposal offset case studies/experience/examples.
• Murdoch University	1/02/2019	• Discussed Murdoch's Black Cockatoo research proposal.
• City of Wanneroo.	7/12/2018	• Discussed priority local natural areas within the Alkimos Eglinton Biodiversity Planning Precinct that may be available for acquisition and/or rehabilitation as part of METRONET's offsets strategy.
• DBCA • Ecological Australia	24/10/2018	• Discussed land acquisition offset options for each YRE project significant residual impact including timing, strategy, risks and issues. • DBCA proposed acquisition sites and strategies.

12.22 Finalisation and implementation of offsets

A final standalone Offsets Strategy will be prepared following issue of conditions of approval for the proposal. The final Offsets Strategy once approved by the DWER will continue to be implemented until directed otherwise by the CEO of the Department. The PTA will review and revise this plan as and when directed, which may be specified by conditions.

13 Matters of National Environmental Significance

13.1 Matters of National Environmental Significance

The Commonwealth EPBC Act provides a legal framework for the protection of Matters of National Environmental Significance (MNES). The EPBC Act requires that all actions that will or may have a significant impact on a MNES must be referred to the Minister for the Environment via the DoEE. Protected matters under the EPBC Act include:

- World heritage properties
- National heritage places
- Wetlands of international importance
- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- A water resource, in relation to coal seam gas activities and large coal mining activities
- The Great Barrier Reef Marine Park
- Nuclear Actions including uranium mining

In addition, protected matters include the environment where actions proposed will affect Commonwealth land or proposed actions are being undertaken by a Commonwealth agency.

13.2 Proposed action and assessment

The Proposal includes approximately 7.2 km of proposed rail alignment from the future Eglinton Station, heading generally north before terminating north of the proposed Yanchep Station. The new station at Yanchep will include intermodal interchanges for bus services, 'park and ride', 'kiss and ride', active mode facilities and associated infrastructure.

The Proposal will involve the removal of 61.68 ha of remnant vegetation within a 72.86 ha development envelope (the proposed action). The balance of the development envelope comprises highly disturbed and cleared areas.

For consistency with the EPBC Act, the Proposal is referred to as the proposed action in this chapter. Further information regarding the proposed action is presented in Section 2.

A summary of existing environmental values relating to MNES is provided in the following sections:

- Section 5: Flora and vegetation
- Section 5: Terrestrial fauna

Based on the outcomes of the environmental assessments completed to date, one MNES will be impacted by the proposed action:

- Listed threatened species and ecological communities.

The following sections provide an overview of the MNES to be impacted by the proposed action, including specific diagnostic criteria and key threats associated with the species and ecological communities.

13.2.1 Controlled action provisions

The proposed action was referred to the DoEE on 20 July 2018 (EPBC Ref: 2018/8262). The proposed action has been determined to be a controlled action with assessment required under the EPBC Act.

The environmental values of the proposed action are as it relates to the EPBC Act have been determined through a review of:

- Previous environmental assessments, including flora and vegetation and fauna surveys and investigations.
- Known and available scientific information on relevant EPBC Act listed species in relation to their habitat needs and requirements.

The potential impacts of the proposed action were considered with reference to the following policy documents:

- *EPBC Act referral guidelines for three threatened black cockatoo species* (DSEWPAC 2012a).
- *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (Significant Impact Guidelines) (DoE 2013)

The proposed action has the potential to have a significant impact on the following matters:

- Listed threatened species and communities (sections 18 and 18A of the EPBC Act):
    - Banksia Woodlands of the Swan Coastal Plain TEC (Endangered)
    - Carnaby's Cockatoo (*Calyptorhynchus latirostris*) (Endangered)
    - Western Quoll (*Dasyurus geoffroii*).

The proposed action will not affect any Commonwealth land and is not being undertaken by a Commonwealth agency.

13.3 Listed threatened species and ecological communities

13.3.1 Flora

No flora listed under the EPBC Act were recorded within the development envelope (GHD 2019). Nine flora species protected under the EPBC Act were identified in a Protected Matters Search Tool (PMST) database search as having the potential to be present within 10 km of the development envelope (DoEE 2018b).

Table 13-1 lists flora species and a further consideration of likelihood of occurrence in the development envelope. All of these species are unlikely to occur within the development envelope or the surrounding area and will not be impacted by the proposed action.

Table 13-1: EPBC Act flora species within 10 km of the development envelope

Species	EPBC Act Status	Likelihood of occurrence within the development envelope
Slender Andersonia (*Andersonia gracilis*)	Endangered	**Highly unlikely.** No suitable habitat within the development envelope. Closest record is greater than 50 km from the proposed action.

Species	EPBC Act Status	Likelihood of occurrence within the development envelope
Dwarf Green Kangaroo Paw (*Anigozanthos viridis* subsp. *Terraspectans*)	Vulnerable	**Highly unlikely.** No suitable habitat within the development envelope. Closest record is greater than 45 km from the proposed action.
King Spider-orchid (*Caladenia huegelii*)	Endangered	**Highly unlikely.** The development envelope is outside the known range of *Caladenia huegelii* which occurs further south (from just north of Perth to the Busselton area and is generally associated with sands of the Bassendean dune system (DEC 2009).
Dwarf Bee-orchid (*Diuris micrantha*)	Vulnerable	**Highly unlikely.** There is no suitable habitat within the development envelope and the closest record of this species is greater than 40 km from the proposed action (GHD 2018b).
Purdie's Donkey-orchid (*Diuris purdiei*)	Endangered	**Highly unlikely.** Purdie's donkey orchid occurs from the southern metropolitan area to Harvey, growing on sandy clay soils in low-lying areas subject to winter inundation (DBCA 2019). There is no suitable habitat within the development envelope.
Glossy-leafed Hammer Orchid (*Drakaea elastica*)	Endangered	**Highly unlikely** There is no suitable habitat within the development envelope and the closest record of this species is greater than 40 km from the proposed action (GHD 2018b).
Dwarf Hammer-orchid (*Drakaea micrantha*)	Vulnerable	**Highly unlikely.** There is no suitable habitat within the development envelope and the closest record of this species is greater than 40 km from the proposed action (GHD 2018b).
Keighery's Eleocharis (*Eleocharis keigheryi*)	Vulnerable	**Unlikely.** No suitable habitat is present within the development envelope (GHD 2018b). This species can be cryptic however the survey was undertaken during the reported flowering period. It is unlikely there is suitable habitat adjacent to the proposed action.
Yanchep Mallee, Wabling Hill Mallee (*Eucalyptus argutifolia*)	Vulnerable	**Unlikely.** There is suitable habitat within the development envelope (VT02, VT03, VT04, VT08). However, this species is distinctive and was not detected during targeted survey in the development envelope (GHD 2018b). There is suitable habitat immediately adjacent to the proposed action.

Species	EPBC Act Status	Likelihood of occurrence within the development envelope
Beaked Lepidosperma (*Lepidosperma rostratum*)	Endangered	**Unlikely.** No suitable habitat is present within the development envelope (GHD 2018b). It is unlikely there is suitable habitat adjacent to the development envelope. The closest record is approximately 16 km northeast of the proposed action.

13.3.2 Ecological communities

Three TECs were identified with the potential to occur within 10 km of the development envelope (DoEE 2018b) summarised in Table 13-2.

Table 13-2: EPBC Act ecological communities within 10 km of the development envelope

Threatened Ecological Community	EPBC Act Status	Likelihood of Occurrence
Banksia Woodlands of the Swan Coastal Plain TEC	Endangered	**Present.** Vegetation types VT04 and VT09 met the key diagnostic criteria for this TEC (GHD 2018b) within the development envelope. A total of 8.03 ha of Banksia Woodlands TEC is located within the development envelope. The 8.03 ha comprises of Banksia Woodlands TEC in the following conditions: • 2.05 ha in Excellent condition • 4.09 ha in Very Good condition • 0.10 ha in Very Good–Good condition • 1.79 ha in Good condition.
Aquatic Root Mat Community in Caves of the Swan Coastal Plain	Endangered	**Unlikely.** Only six locations of Aquatic Root Mat Community TEC have been identified since the mid-1990's following extensive surveys. These locations are located within high likelihood karstic geological areas of Yanchep National Park (Invertebrate Solutions 2018b). None of the identified locations of the Aquatic Root Mat Community TEC occur within the development envelope (Invertebrate Solutions 2018b). Aquatic Root Mat Community TEC is not expected to occur within the development envelope as: • All occurrences of Tuart vegetation are located in low likelihood karstic geological areas; • Regional decline in the groundwater level has largely removed all habitat for this TEC in the region as Aquatic Root Mat Community TEC is reliant upon flows of groundwater for its existence; and

Threatened Ecological Community	EPBC Act Status	Likelihood of Occurrence
		• Large depth to groundwater within the development envelope (greater than 11 m) • no established caves or areas of clay flats are present within the development envelope.
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Endangered	**Likely.** Desktop occurrences of this TEC (including 2 km buffer) intersect the southern section of the development envelope (GHD 2018b), however, there were no records of this TEC within the development envelope from previous investigations conducted for the YRE Project and development envelope.

An assessment of significance for Banksia Woodlands of the Swan Coastal Plain TEC is presented in Table 13-3**.**

A total of 8.03 ha of Banksia Woodlands TEC predominantly in Very Good condition will be impacted by the proposed action. This assessment was based on the key characteristics described in the DoEE advice relating to the Banksia Woodlands TEC. The Banksia vegetation association is consistent with the Endangered Banksia woodlands of the Swan Coastal Plain TEC.

Table 13-3: Significant impact criteria for Banksia Woodlands of the Swan Coastal Plain TEC – Endangered

Significance criteria	Response
Will the action reduce the extent of an ecological community?	The proposed action will involve the clearing of up to 8.03 ha of Banksia Woodlands TEC which ranges from Excellent to Good condition. The Banksia Woodlands TEC is well represented and protected within a number of conservation reserves located in close proximity to the development envelope as shown in Figure 5-6, including potential occurrence of 78.28 ha in Ningana Bushland (Bush Forever Site No. 289) (ELA 2018;Appendix O) and in Yanchep National Park. In addition, t a regional scale (NW subregion), two vegetation associations (949 and 1001) are listed as likely to comprise a major component of the Banksia Woodlands ecological community (TSSC 2016). Vegetation association 949 is present at a local scale. Just under half of vegetation association 949 occurs within conservation areas at a local scale (Table 5-2).

Significance criteria	Response
Will the action fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines?	The proposed action may increase fragmentation of an ecological community as clearing will result in removal of previously uncleared vegetation for linear infrastructure. The proposed action will involve the clearing of up to 8.03 ha of Banksia Woodlands TEC predominantly in Very Good condition to allow for the proposed rail alignment. The vegetation proposed to be cleared is of a linear nature and is comprised of small isolated patches of the TEC within the development envelope. The Banksia Woodlands TEC is widespread throughout the SCP and the proposed action will clear a small portion of the Banksia Woodlands TEC located in the local area, and will clear Banksia Woodlands TEC already isolated in patches.
Will the action adversely affect habitat critical to the survival of an ecological community?	The proposed action will involve the clearing of up to 8.03 ha of Banksia Woodlands TEC predominantly in Very Good condition. Due to the fragmented nature of the vegetation and the extent of the TEC protected within close proximity to the proposed action, the proposed action is unlikely to adversely affect habitat critical to the survival of the ecological community as the proposed clearing only represents a small portion of the Banksia Woodlands TEC located in the local area and a very small portion of the Banksia Woodlands TEC total known extent and range across the SCP.
Will the action modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns?	The impacts are confined to the clearing of 8.03 ha of the ecological community. The proposed action does not represent a threat to the survival of patches of the ecological community that will be retained in adjacent areas. No abstraction or dewatering is proposed for this Proposal.
Will the action cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting?	While the proposed action will clear up to up 8.03 ha of Banksia Woodlands TEC predominantly in Very Good condition, extensive areas of Banksia Woodlands TEC are also available within large conservation areas surrounding the development envelope (including Ningana Bushland and Yanchep National Park). It is unlikely that the proposed action will cause a substantial change to the ecological community. Disturbance for the proposed action is unlikely to cause a substantial change in the species composition of the ecological community.

Significance criteria	Response
Will the action cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: – assisting invasive species, that are harmful to the listed ecological community, to become established, or – causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community?	The clearing of 8.03 ha of Banksia Woodlands TEC will not cause a substantial reduction on the quality or integrity of an occurrence of the ecological community. Sixty-two introduced flora taxa were recorded in the development envelope (GHD 2018b). Of the 62 introduced flora species, six are Declared Pests and/or Weeds of National Significance (WoNS). The remaining introduced taxa are considered environmental weeds and have been previously recorded on the SCP (GHD 2018b). The proposed action may have indirect impacts on remaining vegetation including weeds and dieback, however this would not be expected to cause a substantial reduction in the quality or integrity of an occurrence of the Banksia Woodlands TEC, particularly when management is implemented.
Will the action interfere with the recovery of an ecological community?	The proposed action is unlikely to interfere with the recovery of the ecological community, given the amount of Banksia Woodlands TEC retained within local conservation areas.

13.3.3 Fauna

Two fauna species protected under the EPBC Act was identified using the PMST (DoEE 2018b) likely to occur within 10 km of the development envelope:

- Western Quoll (*Dasyurus geoffroii*); and
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*).

Table 13-4 lists fauna species and likelihood of occurrence in the development envelope.

Table 13-4: EPBC Act fauna species within 10 km of the development envelope

Species	EPBC Act Status	Likelihood of occurrence
Western Quoll, (*Dasyurus geoffroii*)	Vulnerable	**Unlikely.** Suitable habitat present.
Carnaby's Cockatoo (*Calyptorhynchus latirostris*)	Endangered	**Present.** Suitable habitat present – 56.31 ha of high and moderate habitat and 45 potential breeding trees within the development envelope. Historical records are also present within 10 km of the proposed action.

Western Quoll (Dasyurus geoffroii)

The Western Quoll (Chuditch) uses a variety of habitats, can travel large distances, has a large home range and is sparsely populated through a large portion of its range. As outlined in Section 6.3, Western Quoll was assessed to have suitable habitat present within the development envelope. The Western Quoll is expected only as a vagrant and the development envelope does not provide any ecological function such as facilitating dispersal between populations (Bamford 2019 a). As such, the

development envelope is not expected to be significant habitat for the Western Quoll and is considered by Bamford (2019a) as unlikely to occur in the development envelope.

Carnaby's Cockatoo (Calyptorhynchus latirostris)

The EPBC Act referral guidelines for three threatened black cockatoo species (DSEWPAC 2012a) state that an action is regarded as having a high risk of significant impact on habitat for black cockatoos if it involves:

- Clearing of any known nesting tree.
- Clearing or degradation of any part of a vegetation community known to contain breeding habitat (namely trees of species known to support breeding within the range of the species which either have a suitable nest hollow or are a suitable diameter to develop a nest hollow).
- Creation of a new gap of more than 4 km between patches of habitat suitable for breeding, foraging or roosting.
- Clearing of more than 1 ha of quality foraging habitat.

For the purpose of assessing the significance of a site as potential habitat for Black Cockatoos, the guidelines specify that the threshold for significance will only be met if there is a "real chance or possibility" that an action will:

- Lead to a long term decrease in the size of a population
- Reduce the area of occupancy of the species
- Fragment an existing population into two or more populations
- Adversely affect habitat critical to the survival of the species
- Disrupt the breeding cycle of a population
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that that species is likely to decline
- Result in an invasive species that are harmful to a critically endangered or an endangered species becoming established in the endangered or critically endangered species' habitat
- Introduce a disease that may cause a species to decline, or
- Interfere with the recovery of the species.

As outlined in Section 6.3, Carnaby's Cockatoo (*Calyptorhynchus latirostris*) was observed in several small groups foraging and flying over the development envelope. A total of approximately 77% of the development envelope (comprising 56.31 ha) provides suitable foraging habitat for Carnaby's Cockatoo, including 45 potential breeding trees (GHD 2019). None of these trees were assessed to be suitable size to support breeding and did not contain evidence of being previously used for nesting (GHD 2018b). However, they are considered potential breeding trees as they may in future become large enough to contain features used for breeding, such as hollows.

An assessment of the proposed action on Carnaby's Cockatoo is detailed in Table 13-5, with reference to the *Significant Impact Guidelines* (DoE 2013). The assessment against the significant impact criteria for Carnaby's Cockatoo shows that the proposed action may impact on Carnaby's Cockatoo, including the removal of 45 potential breeding trees. However, given the abundance of adjacent reserved foraging and breeding habitat and habitat retained in the Yanchep area, the proposed clearing is unlikely to result in a significant impact to either species.

Table 13-5: Significant impact criteria for Carnaby's Cockatoo

Significance criteria	Response
Lead to a long-term decrease in the size of a population	The proposed action is located adjacent to Yanchep National Park, an 'A Class' Reserve, vested with the Conservation Commission of Western Australia. Yanchep National Park, comprising an area of approximately 2,858 ha, adjoins Gnangara-Moore River State Reserve comprising a total area of approximately 66,117 ha. The reserves comprise known foraging and breeding habitat for Black Cockatoos. It is therefore expected that Carnaby's Cockatoo would utilise these areas and surrounding vegetation in the larger reserves for foraging and potential breeding activities. Given the proximity to large reserved areas comprising Black Cockatoo habitat, it is unlikely the proposed action will result in a long-term decrease in the size of an important population for the species.
Reduce the area of occupancy of the species	The proposed action will not significantly reduce the area of occupancy of Carnaby's Cockatoo. The proposed action is located adjacent to the Yanchep National Park, which adjoins Gnangara-Moore River State Reserve, providing suitable potential foraging and breeding habitat for the species. In addition, Ningana Bushland will also be retained and provides potential foraging and breeding habitat and resources for Carnaby's Cockatoo. On this basis, is it unlikely that the proposed action will significantly reduce the area of occupancy of Carnaby's Cockatoo.
Fragment an existing population into two or more populations	The proposed action will not result in the fragmentation of an existing population. Surrounding reserves are located less than 3 km to the proposed action, including the 'A Class' Yanchep National Park and extensive Gnangara-Moore River State Reserve. Carnaby's Cockatoos are highly mobile species and the area of the proposed clearing will not present a barrier to movement between these reserves.
Adversely affect habitat critical to the survival of a species	Habitat critical to survival for Carnaby's cockatoos can be summarized as (outlined in DPaW (2013): Eucalyptus woodlands that provide nest hollows used for breeding, together with nearby vegetation that provides feeding, roosting and watering habitat that supports successful breeding; Woodland sites known to have supported breeding in the past and which could be used in the future, provided adequate nearby food and/or water resources are available or are re-established; In the non-breeding season the vegetation that provides food resources as well as the sites for nearby watering and night roosting that enable the cockatoos to effectively utilise the available food resources. The proposed action will remove up to 56.31 ha of Carnaby's Cockatoo habitat and 45 potential breeding trees that contain no nesting hollows. The proposed action is unlikely to result in a significant impact to

Significance criteria	Response
	available habitat and; therefore, affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	The removal of approximately 45 potential breeding trees, none of which contain hollows, will not significantly impact breeding individuals. No breeding by this species or breeding trees with suitable hollows was identified within the development envelope. The impacts from the proposed action are unlikely to disrupt the breeding cycle of the species, given the availability of breeding habitat in the adjacent Yanchep National Park and the surrounding area.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Given the proximity of the development envelope to the surrounding reserved vegetation in conservation areas, including Yanchep National Park and Gnangara-Moore River State Reserve, the linear nature of the proposed action, and the remnant vegetation being retained in Ningana Bushland adjacent to the development envelope, it is highly unlikely that removal of this habitat will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	The proposed action will not introduce any invasive species that are not already present in the surrounding local area.
Introduce disease that may cause the species to decline	Without appropriate hygiene practices, the proposed action has the potential to inadvertently introduce dieback (*Phytophthora cinnamomi*) into the adjacent remnant vegetation in Ningana Bushland which could lead to the decline in vegetation health. Disturbance from the proposed action is unlikely to introduce new plant diseases to the adjacent remnant vegetation.
Interfere with the recovery of the species	The Recovery Plan for Carnaby's Cockatoo outlines six broad management actions for a ten-year period (DPaW 2013): Protect and manage important habitat: This includes identifying feeding and breeding habitat critical for the survival of this species Undertake regular monitoring: The recovery team will monitor population parameters, habitats, threats and status of Carnaby's Cockatoo Conduct research to inform management. Including undertaking research into the biology, ecology and conservation management of Carnaby's Cockatoo Manage other impacts. Monitor the impacts and implement strategies to reduce anthropogenic factors affecting Carnaby's Cockatoo, and support rehabilitation programs Engage with the broader community. Engage and involve people across the community in the conservation of Carnaby's Cockatoo

Significance criteria	Response
	Undertake Information and Communication Activities: Develop and distribute educational and guidance materials for decision makers, establish joint management agreements and provide for information sharing. The proposed action is not expected to interfere with the recovery of Carnaby's Cockatoo given: Limited clearing associated with the development Extensive areas of potential foraging, breeding and roosting habitat close to the development envelope.

Table 13-6 assesses the proposed action against referral triggers identified in the *EPBC Act referral guidelines for three threatened black cockatoo species* (DSEWPAC 2012a) to determine the risk of significant impact.

Table 13-6: Assessment of the proposed action against the Black Cockatoo Referral Guidelines

Referral trigger	Assessment of significance impact	Assessment of proposed action against referral trigger
Clearing of any known nesting tree	Unlikely to have a significant impact	A Black Cockatoo habitat assessment was undertaken over the development envelope, in accordance with survey methods outlined in the *EPBC Act referral guidelines for three threatened black cockatoo species* (DSEWPAC 2012a). No evidence that trees have been used or were currently being used by Black Cockatoos for nesting purposes was recorded within the development envelope. Also, no known Black Cockatoo breeding sites have been recorded within the development envelope. Therefore, the proposed action will not result in the clearing of any known nesting trees and is not at variance with this referral trigger.
Clearing or degradation of any part of a vegetation community known to contain breeding habitat	May have a significant impact	There is no known breeding habitat within the development envelope or in proximity to the site. A total of 70 potential breeding habitat trees with a DBH greater than 500 mm were identified by GHD (2019) within the development envelope and Additional Survey Area. Of these trees, up to 45 potential breeding trees will be removed within the development envelope. The proposed action may therefore have a significant impact as 45 potential breeding trees will be removed within the development envelope, and will be at variance with this referral trigger.
Clearing or degradation of more than 1 ha of quality foraging habitat	May have a significant impact	Up to 56.31 ha of high and moderate quality habitat for Carnaby's Cockatoo may be cleared within the development envelope.

Referral trigger	Assessment of significance impact	Assessment of proposed action against referral trigger
		There is sufficient foraging and breeding habitat within a 6–12 km radius of the development envelope including Yanchep National Park located approximately 2 km east of the development envelope. As the proposed action will clear more than 1 ha of quality foraging habitat, the proposed action may have significant impact and is at variance with this referral trigger.
Clearing or degradation of a known night roosting tree	Unlikely to have a significant impact	No known night roosting trees have been recorded within the development envelope. Given this, the proposed action will not result in the clearing of any known roosting trees and is not at variance with this referral trigger.
Creating a gap of more than 4 km between patches of black cockatoo habitat	Unlikely to have a significant impact	The proposed action is a linear development that intersects approximately 3 km of Ningana Bushland. Conservation areas outside of the development envelope will continued ecological connectivity with other Black Cockatoo habitat locally including: Yanchep National Park – 2 km east of the development envelope Yanchep National Park is immediately east of the development envelope and; therefore, a gap of greater than 4 km will not be formed as a result of proposed action. As such, the proposed action is not at variance with this referral trigger.

13.4 Potential impacts and management measures

13.4.1 Potential impacts

The potential impacts to MNES include the following:

- Removal of 8.03 ha of Banksia Woodlands TEC.
- Introduction and/or spread of Declared Pests and other weed species or disease within the development envelope and/or into vegetation adjacent to the development envelope:
    - leading to a reduction in vegetation health on adjacent Banksia Woodlands TEC occurrences; and
    - leading to a reduced availability of foraging resources for Carnaby's Cockatoo
- Injury/mortality of fauna.
- Loss of 56.31 ha of Carnaby's Cockatoo habitat including high and moderate value foraging habitat.
- Removal of 45 potential breeding trees for Black Cockatoo.
- Degradation of adjacent remnant vegetation from:

- contamination of surface water and groundwater during construction and operation, alteration of surface hydrology, rainfall infiltration and/or increased sedimentation during construction and operation; and
- fragmentation of vegetation.

Potential degradation of adjacent remnant vegetation may also lead to leading to a reduction in vegetation health on adjacent Banksia Woodlands TEC occurrences and reduced availability of foraging resources for Carnaby's Cockatoo.

13.4.2 Proposed management for MNES

A summary of residual impacts to MNES following implementation of management and mitigation measures is presented in Table 13-9**.**

Banksia Woodlands TEC

The proposed action will result in the removal of 8.03 ha of Banksia Woodlands TEC. Without mitigation, the removal of Banksia Woodlands TEC is not expected to be significant based on the scale of clearing, and the presence of Banksia Woodlands TEC in adjacent conservation reserves. The proposed action will increase fragmentation of the ecological community by removing previously uncleared vegetation for linear infrastructure and increase the risk for the spread of weeds and/or disease. The following management measures are proposed to further minimise impacts to Banksia Woodlands TEC:

A CEMP will be implemented during construction to manage dust emissions, clearing boundaries, hygiene protocols and best practice to use and store any chemicals/hazardous materials
PTA will implement appropriate stormwater design to minimise potential impact from stormwater or wastewater on adjacent land.

Carnaby's Cockatoo

The proposed action will result in the removal of 56.31 ha of high and moderate value Carnaby's Cockatoo habitat and 45 potential breeding trees. Without mitigation, the proposed action is not expected to be significant based on the known presence of foraging and breeding habitat for Carnaby's Cockatoo in adjacent conservation areas, and the potential breeding trees containing no hollows or previous use for breeding. The proposed action may increase risk/mortality of Black Cockatoos during removal of habitat if present in the development envelope during clearing. The following management measures are proposed to further minimise impacts to Carnaby's Cockatoos:

- A CEMP will be implemented during construction to manage risk/injury of Black Cockatoos including:
  - undertake progressive clearing to allow fauna to move away from clearing activities
  - pre-clearing survey for potential nesting Black Cockatoos prior to construction works
  - accurately delineating the approved clearing boundary to provide accuracy to the limits of the allowable clearing lines.

Western Quoll

The proposed action is not considered to have a significant impact on habitat for the Western Quoll. The species is very rarely recorded on the SCP; and the nearest recent record was in Ellenbrook approximately 35 km southeast of the development envelope (Bamford 2019a). Western Quoll movement will be restricted during operations by fencing parallel to the proposed railway alignment, however, there are larger areas of similar or better quality habitat near the development envelope within

Ningana Bushland and other Bush Forever Sites. The development envelope does not provide any ecological function, such as facilitating dispersal between populations, and as such, the vegetation within the development envelope is not considered significant for the species.

13.5 Consistency with relevant recovery plans and other guidance

A range of guidance exists to guide the protection and conservation of the MNES identified in Section 13.3. The available guidance varies but generally includes recovery plans, conservation advice and threat abatement plans. Guidance documents include measures for minimising further impacts as well as broader conservation initiatives.

To the extent the guidance is relevant to this impact assessment, this section describes how the proposed action has had regard to, and is not inconsistent with, relevant recovery plans, conservation advices and threat abatement plans. Broader conservation initiatives are typically the focus of organisations with those responsibilities and capabilities and are therefore not considered further in this section.

13.5.1 Carnaby's Cockatoo

The relevant plans and guidance documents for Carnaby's Cockatoo are:

- EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species (DSEWPAC 2012a)
- Carnaby's Cockatoo (*Calyptorhychus latirostris*) Recovery Plan (DPaW 2013).

There are no threat abatement plans relevant to this species.

The EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species (DSEWPAC 2012a) provide an outline of the requirements for proponents on habitat quality, survey expectations, standards for mitigating impacts and significant impacts. These referral guidelines were used to guide the assessment of the proposed action's potential impacts to the Carnaby's Cockatoo and development of appropriate mitigations.

The Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan (Recovery Plan) identifies that an action that leads to the permanent loss of native vegetation that forms habitat of Carnaby's Cockatoo as an act that should be avoided, minimised or mitigated if it cannot be avoided. While 56.31 ha of Carnaby's Cockatoo habitat will be impacted by the proposed action, this habitat will be mitigated by the on-ground management offset described in Section 12.9 and the land acquisition offsets described in Sections 12.11, 12.12 and 12.13. All offsets contain extensive amounts of Carnaby's Cockatoo habitat and will add to important habitat reserves for the species.

Table 13-7 shows the demonstrates an assessment of the proposed action against determination of unsuccessful recovery plan for Carnaby's Cockatoo.

Table 13-7: Assessment of the proposed action for inconsistencies with relevant recovery plans

Criteria for the objectives of the recovery plan not being met	Assessment of the proposed action against the criteria
The area of occupancy declines by more than 10% Current area of occupancy = 60,525 km^2	The area of occupancy is defined as only including records of breeding, feeding and night roosting. While the development envelope is not located within any areas where breeding or night roosting has been recorded, the proposed

Criteria for the objectives of the recovery plan not being met	Assessment of the proposed action against the criteria
	action will result in the clearing of 56.31 ha of Carnaby's Cockatoo habitat. This loss represents 0.0009% of the current known area of occupancy. As this is an insignificant loss compared to the 10% threshold, the proposed action is not considered to be inconsistent with the recovery plan.
The number of breeding pairs of Carnaby's cockatoos at monitored breeding sites across the breeding range decreases by more than 10% averaged over three consecutive years	As there are no known breeding sites within the development envelope, the proposed action is not considered to be inconsistent with the recovery plan.
The estimated number of adult and proportion of juvenile Carnaby's cockatoos at known night roost sites decreases by more than 10% averaged over three consecutive years	As no known night roosting trees have been recorded within the development envelope, the proposed action is not considered to be inconsistent with the recovery plan.
The extent of nesting habitat (trees with nesting hollows), feeding habitat (as defined by vegetation complexes) and night roosting habitat (as identified through community survey) decreases by more than 10% throughout the species' range Current extent of occurrence = 364,200 km^2	None of the trees located within the development envelope were assessed to be of suitable size to support nesting and no night roosting habitat was identified within the development envelope. However, the proposed action will result in the clearing of 56.31 ha of Carnaby's Cockatoo habitat located within the development envelope, resulting in an overall loss of less than 0.0001% of the current known extent of occurrence. As this is an insignificant loss compared to the 10% threshold, the proposed action is not considered to be inconsistent with the recovery plan.

The proposed action is unlikely to interfere with the recovery of Carnaby's Cockatoo given:

- The proposed direct offset and on-ground management of Ningana Bushland.
- No nesting habitat is present in the proposed action area for this species.
- The extensive areas of potential foraging, breeding and roosting habitat close to the proposed action area as illustrated in **Figure 5-6**.

The proposed action is considered to be consistent with the recovery plan, in particular the protection and management of suitable habitat proposed to be included in offsets.

13.5.2 Banksia Woodlands TEC

The relevant plans and guidance documents for the Banksia Woodlands TEC are:

- Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community (TSSC 2016) (the conservation advice)

- Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* (DoEE 2018c) (the dieback threat abatement plan).

The conservation advice was used to guide the assessment of the proposed action's potential impacts to the Banksia Woodlands TEC and development of appropriate mitigations.

The conservation objective for this community as stated in the conservation advice is "to mitigate the risk of extinction of the Banksia Woodlands of the Swan Coastal Plain ecological community and help recover its biodiversity and function" though protection and the implementation of priority conservation actions.

Clearing associated with the proposed action is not inconsistent with the objective listed in the conservation advice as clearing of 8.03 ha of Banksia Woodlands TEC predominantly in Very Good condition within the development envelope will not increase the risk of extinction of this ecological community. This area represents only a small portion of the Banksia Woodlands TEC located in the local area, already isolated in patches and is already well retained within local conservation areas.

While it is acknowledged that the greatest threat to the Banksia Woodlands TEC is clearing and fragmentation, the proposed action counterbalances the clearing impacts through the land acquisition and land management offsets set out in Sections 12.9, 12.11, 12.12 and 12.13. These offsets will add to the areas of reserved Banksia Woodlands TEC within the local area. The direct offsets through land acquisition for the proposed action area aligns with the priority protection actions of the conservation advice. Retaining high quality remnants of the Banksia Woodlands TEC provides the most cost-effective way to conserve the community. The conservation advice also preferences offsets matching the same sub-community (Floristic Community Type) as those impacted, which has been reflected in the offsets provided for the proposed action.

The mitigation measures outlined in Section 5.6 and the offsets set out in Sections 12.9, 12.11, 12.12 and 12.13 are consistent to the extent practicable with the other priority protection and restoration actions outlined in the conservation advice, namely:

- Preventing vegetation clearance and direct habitat damage
- Preventing weeds, feral animals, dieback and other diseases
- Identify and implement appropriate fire regimes
- Preventing grazing damage.

Given the above, the proposed action is not considered to be inconsistent with the conservation advice.

The dieback threat abatement plan lists the Banksia Woodlands TEC as an ecological community at risk of *Phytophthora* dieback. *Phytophthora* dieback is recognised as a key threatening process under the EPBC Act due to its actual and potential impacts on ecological communities. The goal of the dieback threat abatement plan is to minimise the impacts of *Phytophthora* dieback on MNES and priority biodiversity assets identified by the actions of this plan through the implementation of four main actions:

1. Identify and prioritise for protection biodiversity assets that are, or may be, impacted by *Phytophthora* dieback.
2. Reduce the spread and mitigate the impacts of *Phytophthora* dieback.
3. Inform and engage the community by promoting information about *Phytophthora* dieback, its impacts on biodiversity and actions to mitigate these impacts.
4. Encourage research on *Phytophthora* species and options to manage infestations and protect biodiversity assets.

A CEMP will be prepared and implemented for the proposed action (as outlined in Section 5.6) which outlines *Phytophthora* dieback management actions to be implemented during the construction. Proposed dieback management is broadly aligned with the goals of priority action 2, i.e. to avoid introducing or spreading dieback. Priority actions 1, 3 and 4 are not applicable to the PTA as the PTA is not a land management authority. The proposed action is therefore not considered to be inconsistent with the dieback threat abatement plan.

13.5.3 Western Quoll (Chuditch) (*Dasyurus geoffroii*)

The relevant plans and guidance documents for the Western Quoll are:

- Western Quoll (*Dasyurus geoffroii*) Recovery Plan (DEC 2012a)
- Threat abatement plan for predation by feral cats (DoE 2015)
- Threat abatement plan for competition and land degradation by rabbits (DoEE 2016)
- Threat abatement plan for predation by the European red fox (DEWH 2008).

The recovery plan objective for the Western Quoll (Chuditch) is "to reduce threats to the Chuditch and increase population densities to ensure long-term survival" with the recovery plan deemed successful if the Chuditch can be delisted from Vulnerable under the EPBC Act within 10 years from adoption (DEC 2012a). Nine recovery actions were developed to achieve this plan. Table 13-8 assesses whether the proposed action is inconsistent with the recovery actions for the Western Quoll (Chuditch).

Table 13-8: Assessment of the proposed action for inconsistencies with relevant recovery plans for the Chuditch

Recovery actions	Consistency of proposed action with the recovery action
Retain and improve habitat critical for survival	The development envelope does not contain habitat critical for the survival of the Western Quoll (Chuditch). While this species has the potential to occur within the development as a vagrant, it is considered to be locally extinct in the coastal northern portion of the SCP. As the proposed action will not impact on habitat critical for the survival of the Chuditch, it is not inconsistent with this recovery action.
Determine impacts of feral cats on Chuditch	As the Western Quoll (Chuditch) is not expected to occur within the development envelope and the proposed action is not expected to increase the presence or abundance of feral animals, the proposed action is not inconsistent with this recovery action.
Determine the impact of feral cat control methods on Chuditch	As the Western Quoll (Chuditch) is not expected to occur within the development envelope and the proposed action is not expected to increase the presence or abundance of feral animals, the proposed action is not inconsistent with this recovery action.
Continue, expand and improve baiting of foxes and feral cats	As the Western Quoll (Chuditch) is not expected to occur within the development envelope and the proposed action is not expected to increase the presence or abundance of feral animals, the proposed action is not inconsistent with this recovery action.
Determine population abundance and distribution of Chuditch populations	Numerous studies have been conducted on the fauna assemblages within the development envelope consistent with this recovery action. No Western Quoll (Chuditch) individuals or evidence has been recorded within the area to date as set out in Section 6.3.6.

Recovery actions	Consistency of proposed action with the recovery action
Establish reference sites for monitoring Chuditch population abundance to evaluate the effectiveness of fox and cat control	This species is not expected to occur within the development envelope. As such, reference sites to monitor the Western Quoll (Chuditch) have not been established within the development envelope. The proposed action is therefore not inconsistent with this recovery action.
Undertake and monitor translocations to increase the extent of occurrence	As the Western Quoll (Chuditch) is not expected to occur within the development envelope, no translocations are proposed. No Chuditch are known to have been translocated into the development envelope or immediately vicinity. This recovery action is therefore not applicable to the proposed action.
Increase public awareness through community education and enforcement of regulations	This recovery action is not applicable to the proposed action.
Coordinate recovery implementation	This recovery action is not applicable to the proposed action.

The proposed action is not expected to interfere with the recovery of the Western Quoll as this species was considered by Bamford (2019) to unlikely occur in the development envelope, and habitat critical to the survival of the species is not present within the development envelope.

The threat abatement plans relevant to the Western Quoll aim to minimise the impacts of feral cats, rabbits and European red foxes by protecting affected threatened species and ecological communities, as well as preventing further species and ecological communities from becoming threatened. The actions of the three threat abatement plans include:

- Controlling with the aim of reducing, already established populations of feral animals.
- Improving effectiveness of existing control options and investigation into the development of alternative control options.
- Preventing the spread of impact of feral animals.
- Educating and increasing public awareness of these impact of these feral animals and the control options currently being utilised.

The proposed action is consistent with the objectives and actions outlined in the three threat abatement plan objectives and actions. This is demonstrated in the PTA's proposed on ground management of Ningana Bushland for the proposed action, which considers feral animal control and includes the management of other threatening processes including weeds and disease (as outlined in Section 12).

Table 13-9: Summary of residual impacts to MNES following implementation of management and mitigation measures

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Loss and fragmentation of vegetation, including TEC/PECs and fauna habitat	• Development envelope was modified during the design phase to avoid the direct impacts to Bush Forever Site No. 130, Bush Forever No. 288 and nearby parks and reserves potentially containing fauna habitat • 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 intentionally avoid direct impacts to vegetation which may have otherwise been able to be retained within future POS reservations.	Measures to minimise the impacts to vegetation will be detailed in a CEMP (ELA 2019; Appendix Q), which will include: • The development envelope will be demarcated to prevent clearing outside of approved areas. • Manage indirect impacts to surrounding vegetation. • Minimise clearing to as low as reasonable practicable. • Should batters be of a suitable gradient and material and not required for operational infrastructure purposes, they will be stabilised with planting of locally endemic species where possible and/or bioengineering controls. • Measures to prevent the distribution of declared Pests and other weed species offsite and prevent introduction of *Phytophthora* dieback to the surrounding vegetation as detailed below.	Not applicable.	• Removal of 8.03 ha of Banksia Woodlands TEC • Removal of 56.31 ha of Carnaby's Cockatoo habitat
Loss of life/injury to wildlife	Not applicable.	• Implementation of a CEMP that will include the following measures: o undertake progressive clearing to allow fauna to move away from clearing activities	• Fauna injured during fauna habitat clearing will be rehabilitated by a wildlife carer, where practical.	• Loss of fauna individuals during clearing of fauna habitat.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		○ pre-clearing survey for potential black-cockatoos prior to construction works ○ accurately delineating the approved clearing boundary to provide accuracy to the limits of the allowable clearing lines • further contingency measures to be developed in consultation with DBCA and implemented to avoid or minimise impacts to significant fauna if identified during searches.		
Lack of or loss of younger age class trees required to replace old trees that die or are destroyed, leading to a shortage of hollows in the future.	• A total of 30 potential breeding trees have been avoided during the design phase of the development envelope	• Implementation of a CEMP that will include measures to delineate the approved clearing boundary.	Not applicable.	• Removal of 45 potential breeding trees
Loss and degradation of habitat by indirect impacts such as introduction of dieback caused by *Phytophthora cinnamomi* (and other plant diseases), weed invasion leading to local hydrological changes	Not applicable.	Measures to minimise the impacts to vegetation will be detailed in a CEMP (ELA 2019; Appendix Q), which will include: • Inspection of all vehicles and machinery at exit and entry locations to be free of weeds and soil prior to entering the development envelope. • Manage any newly identified declared weeds within the development envelope in accordance with the BAM Act and subsidiary regulations.	Not applicable.	Potential residual impacts are as low as reasonably practicable.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		• Require all personnel to complete a site induction that will include hygiene training with regards to weed management requirements.		
Contamination of groundwater impacting on vegetation	Not applicable.	Implementation of the CEMP to minimise the risk of contamination, including: • Installation of drainage diversion around chemical storage areas. • Implementation of drainage controls to prevent offsite discharge of runoff. • Spill response procedures and training. • Storage of fuels or chemicals in bunds capable of storing 110% of the capacity of the largest storage tank. • Secondary spill containment around tanks (with a perimeter bund) with sufficient freeboard capacity to contain all captured rainwater from a 20-year average return interval, 72-hour storm. • Spill kits located in storage and refuelling areas. Implementation of the PTA's standard spill response framework for operational rail corridors. Stormwater and surface water management measures and controls will be designed with	Not applicable.	Potential residual impacts are as low as reasonably practicable. Contamination risk is managed with no significant residual impact flora or vegetation.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
		consideration of best practice WSUD principles, maximising infiltration at source.		
Altered hydrology affecting water availability for vegetation	• No surface water features or drainage lines are located within the development envelope. • No dewatering or abstraction is proposed for this Proposal.	Best practice WSUD will be incorporated in the design to protect existing hydrological regimes, as detailed in Section 9.6.1.	Not applicable.	No residual impact to flora or vegetation based on changes to the hydrological regime.

13.6 Other matters required to be addressed

The DoEE has requested additional items relevant to the assessment of impacts under the EPBC Act to be included in this ERD. These additional items are provided in **Appendix P**.

The *Environment Protection and Biodiversity Regulations 2000* (EPBC Regulations) require a Public Environment Report prepared under the EPBC Act to provide particular information relating to the proposed action as set out in Schedule 4 of the EPBC Regulations. This information is provided in **Appendix B**.

14 Holistic impact assessment

The preliminary key environmental factors relevant to the Proposal are:

- Flora and vegetation
- Landforms
- Terrestrial fauna
- Subterranean fauna
- Inland waters
- Social surroundings.

These factors are addressed separately in Sections 5 to 10 and Table ES 3 provides a summary of the predicted outcomes in relation to the EPA's environmental objectives, after the application of the EPA's mitigation hierarchy (avoid, minimise, rehabilitate). A review of how the Proposal addresses the principles outlined in the EP Act is provided in **Table 4-1**. Other environmental factors are considered in Section 11.

The PTA acknowledges the linkages between environmental factors and that those interrelationships may require consideration and management to achieve good environmental outcomes.

Table 14-1 provides a summary of the key linkages between the preliminary key environmental factors (grouped by the relevant EPA theme) and examples of proposed mitigation that reflect the linkages (shared with mitigation proposed for individual environmental factors).

The linkages between environmental factors have been identified and the mitigation proposed in this ERD is considered sufficient to meet the principles contained in the EP Act and the EPA's objectives for individual factors, as set out in Section 4.2 and Sections 5 to 10 respectively. Where a significant residual impact has been identified in the assessment, offsets are proposed. These impacts are summarised below and offsets are discussed in Section 12:

- Loss of:
    - 0.05 ha of SPC 26a
    - 8.03 ha Banksia dominated woodlands of the Swan Coastal Plain TEC in good to excellent condition
    - 18.07 ha regionally significant bushland in Bush Forever site 289 (Ningana Bushland)
    - 56.31 ha of Carnaby's Cockatoo habitat
    - 45 potential breeding trees.

Where possible, management and mitigation measures have been considered from a holistic perspective. For example, Ningana Bushland represents a key regional ecological linkage and important remnant bushland and has been considered for targeted measures to protect and enhance its values. As part of the Proposal's mitigation against fragmentation of Ningana Bushland and the fauna habitat within it, a fauna crossing will be constructed to maintain the east-west ecological linkage and provide for the long-term movement of fauna in this area (Section 5.3.7). The proposed offset for the impacts to regionally significant bushland within Ningana Bushland is on-ground conservation management of Ningana Bushland to improve the condition and quality of degraded vegetation within the unimpacted areas of the site (Section 12.9). Despite the Proposal's impact to Ningana Bushland, the mitigation measures and the Ningana Bushland offset Proposal are complementary measures that should provide an ongoing benefit to Ningana Bushland, particularly in the future when adjacent urban development is likely to increase pressures on the site.

Offsets are a key consideration in ensuring that the EPA's objectives for key environmental factors can be met. In addition to offsetting the significant residual impacts of the Proposal, offsets can be opportunities to secure strategic environmental assets in local areas and/or within the region. The PTA is currently planning several METRONET projects, some of which share similar environmental impacts and have similar offset requirements. Where possible and consistent with relevant policies and guidance, the PTA will consider opportunities to aggregate offset requirements across projects, which can enable offsets with better overall conservation outcomes to be provided; for example, the acquisition of a larger environmental asset with better long-term prospects compared with acquisition of two smaller assets at greater risk from threatening processes. The PTA notes that offsets are yet to be finalised (see Section 12.21).

Table 14-1: Key linkages between environmental factors

Theme	Factor	Key linkage	Examples of relevant mitigation
Land	Flora and vegetation	• Provision of habitat to terrestrial fauna • Contribution to maintenance of subterranean fauna habitat (e.g. through organic carbon) • Contribution to maintenance of inland water quality, terrestrial environmental quality and landforms (e.g. through erosion, sediment release) • Contribution to social wellbeing in urban environments (e.g. mitigation of urban heat islands and maintenance of air quality)	• Vegetation clearing has been reduced to the minimum area required for construction and operations. • Prior to topsoil spreading in areas intended for revegetation, the site will be prepared to ease compaction. • Soil stabilisers may be applied to revegetation areas following spreading of topsoil and planting to improve revegetation success.
	Landforms	• Supports habitat for flora and vegetation • Provides habitat for subterranean fauna • Scientifically and culturally important	• The CEMP has been prepared to restrict clearing to the development envelope and stabilise batters post construction via mulching and revegetation. • Parabolic dune formations will be stabilised by the planting of locally endemic flora species or bioengineering controls, as practicable.
	Terrestrial fauna	• Disperse and pollinate flora and vegetation • Contribute to social wellbeing in urban environments • Scientifically and culturally important	• A fauna crossing will be constructed as part of the Proposal to maintain the local east-west local ecological linkage and provide for the long-term movement of native fauna. • The CEMP has been prepared to manage the potential impacts to terrestrial fauna from weed dispersal, noise etc. during the construction of the Proposal.
	Subterranean fauna	• Contribute to maintenance of water quality • Scientifically and culturally important	• Dewatering will not be required to facilitate construction. • Groundwater abstraction is not proposed for this Proposal.

Theme	Factor	Key linkage	Examples of relevant mitigation

Water	Inland waters	• Hydrological regimes:
		  ○ support terrestrial and subterranean fauna, flora and vegetation
		  ○ contribute to inland water quality and consequent provision of safe water for people
		  ○ shape and connect landforms
		  ○ are significant culturally
			• Stormwater and surface water management measures and controls will be implemented during construction to limit the risk of significant alteration of surface water flows offsite, and offsite sedimentation is controlled. These measures will consider best practice WSUD principles.
			• Groundwater dewatering and abstraction are not proposed for this Proposal.

People	Social surroundings	• Provision of services for people can place pressures on other environmental factors • Aboriginal Heritage • Bushfire	• Trains will utilise regenerative braking technology which returns at least 20% of the electricity produced by braking back into the electrical distribution system, reducing greenhouse gas emissions. • Provision has been made for 'park and ride' in the operation of the Proposal. • The PTA is investigating numerous beneficial re-use opportunities for the excess sand and limestone generated during construction. • The PTA will ensure an Aboriginal monitor is present onsite during clearing of groundcover and initial groundworks at the Yanchep station site, to identify and manage any potential artefacts or objects of Aboriginal significance which may be unearthed during construction. • The PTA has developed a Bushfire Management Strategy which responds to this requirement and aims to reduce the risk of bushfire to human settlement, economic, environmental and cultural assets on the PTA land. • Bushfire risk management actions and a full risk assessment will be provided in a BRMP pre-construction.

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Appendix A Environmental Scoping Document

Appendix B Scoping Checklist EPBC Regulations

Appendix C Environmental Impact Assessment – Yanchep Rail Extension: Part 2 – Eglinton Station to Yanchep Station

Appendix D Yanchep Rail Extension Part 2 Biological Assessment

Appendix E Yanchep Rail Extension Part 2 Biological Factors – Context and Impact Assessment

Appendix F Yanchep Rail Extension Part 2 Fauna Desktop Study

Appendix G Yanchep Rail Extension Part 2 Fauna Underpass Statement

Appendix H Short Range Endemic Invertebrate Desktop Review and Risk Assessment

Appendix I Subterranean Fauna Desktop Review and Risk Assessment

Appendix J METRONET - YRE Hydrology Assessment

Appendix K Transportation Noise and Vibration Assessment, METRONET - Yanchep Rail Extension

Appendix L Noise and Vibration Management Plan, METRONET - Yanchep Rail Extension

Appendix M Aboriginal Heritage Survey of Proposed Northern Suburbs Railway Extension Alignment

Appendix N Addendum to Report on the Aboriginal survey of the Northern Suburbs Railway Extension Alignment

Appendix O Environmental (Bush Forever site 289) Candidate Offset Site Investigation, Yanchep Railway Extension

Appendix P Other matters required by DoEE for assessment of impacts under the EPBC Act

Appendix Q Construction Environmental Management Plan - Yanchep Rail Extension: Part 2 - Eglinton to Yanchep

Appendix R Proposed for Fauna Crossings; Response to the Outcome of May 2019 Workshop

Appendix S Qualitative Air Quality Assessment

Appendix T Carbon and Energy Assessment

Appendix U WA Offset template

Appendix V Commonwealth Offsets Calculator

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ISO 14001 Environmental Management

AS/NZS 4801:2001 Occupational Health and Safety Management

ISO 9001 Quality Management

HEAD OFFICE
Suite 2, Level 3
668-672 Old Princes Highway
Sutherland NSW 2232
T 02 8536 8600
F 02 9542 5622

SYDNEY
Suite 1, Level 3
101 Sussex Street
Sydney NSW 2000
T 02 8536 8650
F 02 9542 5622

HUSKISSON
Unit 1, 51 Owen Street
Huskisson NSW 2540
T 02 4201 2264
F 02 9542 5622

CANBERRA
Level 2
11 London Circuit
Canberra ACT 2601
T 02 6103 2314
F 02 9542 5622

NEWCASTLE
Suites 28 & 29, Level 7
19 Bolton Street
Newcastle NSW 2300
T 02 4910 3412
F 02 9542 5622

NAROOMA
5/20 Canty Street
Narooma NSW 2546
T 02 4302 1266
F 02 9542 5622

COFFS HARBOUR
22 Ray McCarthy Drive
Coffs Harbour NSW 2450
T 02 6651 5484
F 02 6651 6890

ARMIDALE
92 Taylor Street
Armidale NSW 2350
T 02 8081 2685
F 02 9542 5622

MUDGEE
Unit 1, Level 1
79 Market Street
Mudgee NSW 2850
T 02 4302 1234
F 02 6372 9230

PERTH
Level 1, Bishop's See
235 St Georges Terrace
Perth WA 6000
T 08 6218 2200
F 02 9542 5622

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2203
F 02 9542 5622

ADELAIDE
Level 2, 70 Pirie Street
Adelaide SA 5000
T 08 8470 6650
F 02 9542 5622

MELBOURNE
Level 1, 436 Johnston St
Abbotsford, VIC 3076
T 03 9290 7173
F 02 9542 5622

BRISBANE
Level 5, 12 Creek Street
Brisbane QLD 4000
T 07 3503 7192
F 02 9542 5622

1300 646 131
www.ecoaus.com.au