

**Tantabiddi Boating Facility Project:
Terrestrial Fauna and Stygofauna Assessment**



Tantabiddi Sinkhole near the Tantabiddi boat ramp. Photo: M. Bamford

Prepared for: Department of Transport
140 William St, Perth WA 6000

Prepared by: Mike Bamford, Kristen Bleby and Bill Humphreys
M.J. & A.R. BAMFORD CONSULTING ECOLOGISTS
23 Plover Way
KINGSLEY WA 6026



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Executive Summary

The Department of Transport is proposing to construct a new boating facility, The Tantabiddi Boating Facility Project (the Project) near Exmouth in the Ningaloo Marine Park. The existing Tantabiddi boat ramp is too small for current demand and therefore an upgrade has been proposed; this consists of a much larger facility at a new site about 1 km south-west of the existing boat ramp.

Bamford Consulting Ecologists (BCE) was commissioned by the Department of Transport to undertake two environmental studies in the project area that are required to support these referrals:

- A Basic (formally called Level 1) terrestrial fauna survey, including a desktop review, fauna habitat identification and a site inspection (conducted by BCE); and
- A desktop stygofauna (fauna that live permanently in a body of water) and hydrology assessment (conducted by Bill Humphreys).

This report presents the results of these two environmental studies. The purposes of this report are to provide information on the fauna values of the project area, a discussion on the interaction of proposed development on the site with these fauna values and functions, and to provide some context and assess the importance of this larger area for fauna, in particular the importance of the coastline for waterbirds, including migratory species.

BCE uses a 'values and impacts' assessment process with the following components:

- The identification of fauna values:
 - Assemblage characteristics: uniqueness, completeness and richness;
 - Species of conservation significance;
 - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
 - Patterns of biodiversity across the landscape; and
 - Ecological processes upon which the fauna depend.
- The review of impacting processes such as:
 - Habitat loss leading to population decline;
 - Habitat loss leading to population fragmentation;
 - Degradation of habitat due to weed invasion leading to population decline;
 - Ongoing mortality from operations;
 - Species interactions including feral and overabundant native species;
 - Hydrological change;
 - Altered fire regimes; and
 - Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts (if requested).

Description of project area

The Tantabiddi Boating Facility Project is proposed for a new site approximately 1 km south-west of the existing Tantabiddi boat ramp, which is too small for current demand and therefore an upgrade has been proposed by the Department of Transport for a much larger facility at the new site. The

project area lies within the Ningaloo Coast World Heritage Area and the Jurabi Coastal Park, giving it a high degree of environmental significance.

Both the existing and the proposed boat ramp lie immediately adjacent to the coast and the biggest terrestrial impact is for parking. The vegetation consists broadly of shrublands and hummock grasslands with soils ranging from white coastal sands to red sands and grey loam-clays of intermittently damp flats. There is a small tidal creek beside the existing parking area that is the outlet of a small and intermittent drainage line. The coastline consists of sandy and pebbly beaches with a narrow littoral zone. The area is underlain by limestone (exposed along the drainage line) and a low limestone escarpment lies over 1 km inland. The underlying limestone is known to support a rich stygofauna.

Key fauna values

Vegetation and Substrate Associations (VSAs) that provide habitat for fauna.

Eight major VSAs were identified in the project area: Beach (VSA 1), Foredunes (VSA 2), Secondary Dunes (VSA 3), Chenopod low shrubland (VSA 4), Open shrubland over hummock grassland (VSA 5), Tantabiddi Creek (VSA 6), Tantabiddi Sinkhole and associated subterranean environment (VSA 7), and Buffel Grass Grassland (VSA 8). The proposed development affects mainly VSAs 1 to 4, but significantly lies close to Tantabiddi Sinkhole and potentially over part of VSA 7.

Fauna assemblage

The desktop study identified 363 vertebrate fauna species as potentially occurring in the project area, with a further 20 species considered to be locally extinct. The presence of 46 species (one subterranean fish, six reptiles, 36 birds and three mammals) was confirmed during the 2021 site visit. The desktop study also identified a rich assemblage of invertebrate stygofauna for the region. The assemblage is rich but only moderately intact due to the high loss of mammal species. The reptile assemblage in particular is rich and distinctive due to the biogeography of the region. The stygofauna is part of a rich and distinctive assemblage.

Species of conservation significance. Of the 51 vertebrate species of conservation significance recorded or that may be present in the project area, most are expected only as visitors or irregular visitors in small numbers. This includes migratory waterbirds and sea turtles, which make little use of the coastline in the immediate vicinity of Tantabiddi. Of most interest are two subterranean fish (present in the subterranean environment and one visible in Tantabiddi Sinkhole), the Keeled Slider Lizard (present in VSAs 2 and 3), the Eastern Osprey (present and nesting in the existing boat ramp area), and the Brush-tailed Mulgara (unconfirmed record in VSA 5 just east of the existing boat ramp). Invertebrate stygofauna of conservation significance are expected to be present but are poorly documented from Tantabiddi Sinkhole. The amphipod shrimp *Grandidierella* sp. nov. is known only from Tantabiddi Sinkhole and while not of listed conservation significance, can be assigned the informal 'locally significant' status.

Patterns of biodiversity. The subterranean environment (VSA 7; represented by a surface expression at Tantabiddi Sinkhole) supports a rich and distinctive stygofauna assemblage. VSA 5 is likely to be richest in fauna species due to the soil type, structural complexity of vegetation and presence of

termite mounds. Other VSAs may have fewer species but differences in soil and vegetation type mean that there will be difference in species composition between VSAs.

Key ecological processes. The ecological processes that currently have major effects upon the fauna assemblage include hydrology, the presence of feral species, fire, and habitat degradation (due to weeds). Hydrology may be particularly important due to surface drainage patterns and the presence of stygofauna.

Potential impacts upon fauna

Threatening processes reviewed in relation to the proposed development included: habitat loss, habitat fragmentation, degradation due to weed invasion, direct mortality, impacts of feral and overabundant native species, hydrological change, fire and disturbance (dust, noise and light). Hydrological change and risk of groundwater contamination are considered to be a significant risk and require management. Feral species are also a concern with some potential for feral predators to increase in abundance. Potential impacts are considered to be minor (or less) because of the small areas involved and in the assumption of management, particularly with regard to drainage.

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1 Introduction

The Department of Transport is proposing to construct a new boating facility, The Tantabiddi Boating Facility Project (the Project) near Exmouth in the Ningaloo Marine Park. The existing Tantabiddi boat ramp is too small for current demand and therefore an upgrade has been proposed; this consists of a much larger facility at a new site about 1 km south-west of the existing boat ramp (Figure 1).

Ningaloo Marine Park is an environmentally sensitive A Class Marine Reserve and is located within the Ningaloo Coast World Heritage Area. The Project will require detailed environmental studies and referral under both *The Environmental Protection Act 1986* (WA) and *The Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).

Bamford Consulting Ecologists (BCE) was commissioned by the Department of Transport to undertake two environmental studies in the project area that are required to support these referrals:

- A Basic (formally called Level 1) terrestrial fauna survey, including a desktop review, fauna habitat identification and a site inspection (conducted by BCE); and
- A desktop stygofauna (fauna that live permanently in a body of water) and hydrology assessment (conducted by Bill Humphreys).

This report presents the results of these two environmental studies. A Basic flora and vegetation survey was also conducted by botanist Vicki Long and Assoc., and these results are presented in a separate report.

1.1 General approach to fauna impact assessment

The purpose of impact assessment is to provide government agencies with the information they need to decide upon the significance of impacts of a proposed development, and to provide information to proponents to help them to develop appropriate strategies for avoiding and minimising impacts of their activities. This relies on information on the fauna assemblage and its environment, and BCE uses an approach with the following components:

- The identification of **fauna values**:
 - Assemblage characteristics: uniqueness, completeness and richness;
 - Species of conservation significance;
 - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
 - Patterns of biodiversity across the landscape; and
 - Ecological processes upon which the fauna depend.
- The review of **impacting processes** such as:
 - Habitat loss leading to population decline;
 - Habitat loss leading to population fragmentation;
 - Degradation of habitat due to weed invasion leading to population decline;
 - Ongoing mortality from operations;
 - Species interactions including feral and overabundant native species;
 - Hydrological change;

- Altered fire regimes; and
- Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts (if requested).

1.2 Study Objectives

Based on the impact assessment process above, the objectives of the study are therefore to:

1. Conduct a desktop literature review and searches of Commonwealth and State databases for terrestrial fauna;
2. Conduct a desktop literature review and searches of Commonwealth and State databases for stygofauna;
3. Review the list of terrestrial fauna and stygofauna expected to occur on the site in the light of fauna habitats present; with a focus on investigating the likelihood of significant species being present;
4. Identify significant or fragile fauna habitats within the project area;
5. Identify any ecological processes in the project area upon which fauna may depend;
6. Identify general patterns of biodiversity within or adjacent to the project area, and
7. Identify potential impacts upon fauna and propose recommendations to minimise impacts.

Descriptions and background information on these values and processes can be found in Appendices 1 to 4. In particular,

[Appendix 1. Explanation of fauna values.](#)

[Appendix 1](#) explains and defines the fauna values, including the recognition of three classes of species of conservation significance (CS): those listed under legislation (CS1), those listed as priority by the Department of Biodiversity, Conservation and Attractions (DBCA; CS2), and those that can be considered of local or other significance, but which have no formal listing (CS3). [Appendix 2](#) outlines the legal definitions and classes of conservation significance. Appendices 3 and 4 provide background information on threatening processes.

1.3 Description of Project Area

The Tantabiddi Boating Facility Project is proposed for a new site approximately 1 km south-west of the existing Tantabiddi boat ramp (Figure 1). The existing Tantabiddi boat ramp is too small for current demand and therefore an upgrade has been proposed by the Department of Transport for a much larger facility at the new site (Proposed Development Site, see Figure 1). The basic terrestrial fauna and desktop stygofauna assessments were conducted within the Site Boundary (see Figure 1) to provide some context and assess the importance of this larger area for fauna, in particular the importance of the coastline for waterbirds, including migratory species. This area will be referred to hereafter as the “Project Area”.

The project area lies within the Ningaloo Coast World Heritage Area and the Jurabi Coastal Park. The environmental significance of the broader region is high because of the high degree of biodiversity, coral reefs and the karst and subterranean fauna in the area (EPA 1999, Humphreys 1993 (ed.)).

Both the existing and proposed boat ramp lie immediately adjacent to the coast and the biggest terrestrial impact is for parking. The vegetation consists broadly of shrublands and hummock

grasslands with soils ranging from white coastal sands to red sands and grey loam-clays of intermittently damp flats. There is a small tidal creek beside the existing parking area that is the outlet of a small and intermittent drainage line. The coastline consists of sandy and pebbly beaches with a narrow littoral zone. The area is underlain by limestone (exposed along the drainage line) and a low limestone escarpment lies over 1 km inland.

1.4 Description of Existing Environment

1.4.1 IBRA Region Description

The Interim Biogeographic Regionalisation of Australia (IBRA) has identified 26 bioregions in Western Australia which are further divided into subregions (DAWE 2020b). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA 2020). The project area is within the Cape Range (CAR01) subregion of the Carnarvon bioregion, as mapped in Figure 1. This bioregion falls within the Bioregion Group 2 (Eremaean Botanical Province) classification (EPA 2020).

The Carnarvon bioregion and Cape Range subregion are described by Kendrick and Mau (2003) and a summary of their work follows here. The Carnarvon bioregion is composed of quaternary alluvial, aeolian and marine sediments overlying Cretaceous strata. A mosaic of saline alluvial plains with samphire and saltbush low shrublands, Bowgada low woodland on sandy ridges and plains, Snakewood scrub on clay flats, and tree to shrub steppe over hummock grasslands on and between red sand dune fields. Limestone strata with *Acacia stuartii* or *A. bivenosa* shrubland outcrop in the north, where extensive tidal flats in sheltered embayments support mangal.

Within the Cape Range (CAR01) subregion, Cape Range and Giralia dunefields form the northern part of Carnarvon Basin and support rugged tertiary limestone ranges and extensive areas of red aeolian dunefield, Quaternary coastal beach dunes and mud flats. *Acacia* shrublands over *Triodia* occur on limestone (*Acacia stuartii* or *A. bivenosa*) and red dunefields, *Triodia* hummock grasslands are associated with sparse Eucalyptus trees and shrubs on the Cape Range. Extensive hummock grasslands (*Triodia*) occur on the Cape Range and eastern dune-fields. Tidal mudflats of sheltered embayments of Exmouth Gulf support extensive mangroves. Beach dunes support *Spinifex* communities. An extensive mosaic of saline alluvial plains with samphire and saltbush low shrublands occur along the eastern hinterland of Exmouth Gulf. Islands of the Muiron, Barrow, Lowendal and Montebello groups are limestone-based.

Underlying the Cape Range peninsula is an extensive karst topography renowned for a rich and distinctive stygofauna. Tantabiddi Sinkhole lies within the project area and is a surface expression of this system. The groundwater in the sinkholes is affected by the marine tides and so is classified as an anchialine system (Bishop *et al.* 2015) which, together with observations on abandoned pastoral wells, indicates that the carbonate strata of the coastal plain is replete with open conduits and would be especially vulnerable to groundwater pollution events.

The project area lies within the Ningaloo Marine Park which is included in the Migratory Shorebird Directory (Weller *et al.* 2021), but the Park does not feature as either a Key Biodiversity Area or a Flyway Network site.

1.4.2 Climate Information

For the Eremaean Botanical Province, temperatures increase along a northward latitudinal gradient and rainfall is summer-dominated in the north and more evenly spread across the year in the south (EPA 2020). Episodic summer thunderstorms and rain-bearing depressions are key bioclimatic activators and hence drive vertebrate activity (EPA 2020).

For the Cape Range (CAR01) subregion, climate is arid, or semi-desert to sub-tropical, with variable summer and winter rainfall (Kendrick and Mau 2003). Cyclonic activity can be significant, and cyclonic systems may affect the coast and hinterland annually (Kendrick and Mau 2003).

Climate averages (temperate, rainfall, sunshine) for the project area, as provided by BOM (2021), are presented in Table 1.

Table 1: Climate averages for the project area (BOM 2021).

Site name = Learmonth Airport, *Site number* = 005007

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Mean Max Temp (°C)	38.0	37.5	36.5	33.4	28.6	24.9	24.4	26.5	29.5	32.8	34.6	32.0
Mean Min Temp (°C)	23.1	24.0	23.0	20.5	16.0	13.1	11.5	12.1	13.8	16.4	18.5	20.9
Rainfall												
Mean Rainfall (mm)	29.6	39.2	40.9	18.1	41.9	42.9	21.8	11.3	2.0	1.5	1.7	6.1
Other Daily Elements												
Mean No of Clear Days	17.9	14.4	16.6	14.6	16.1	15.5	19.6	21.4	23.0	24.5	23.3	22.9
Mean No of Cloudy Days	4.2	5.5	5.4	6.5	6.4	6.4	4.9	3.3	1.4	1.1	1.7	2.1



Figure 1. IBRA Subregions in Western Australia indicating the approximate location of Tantabiddi in CAR1 (Cape Range).

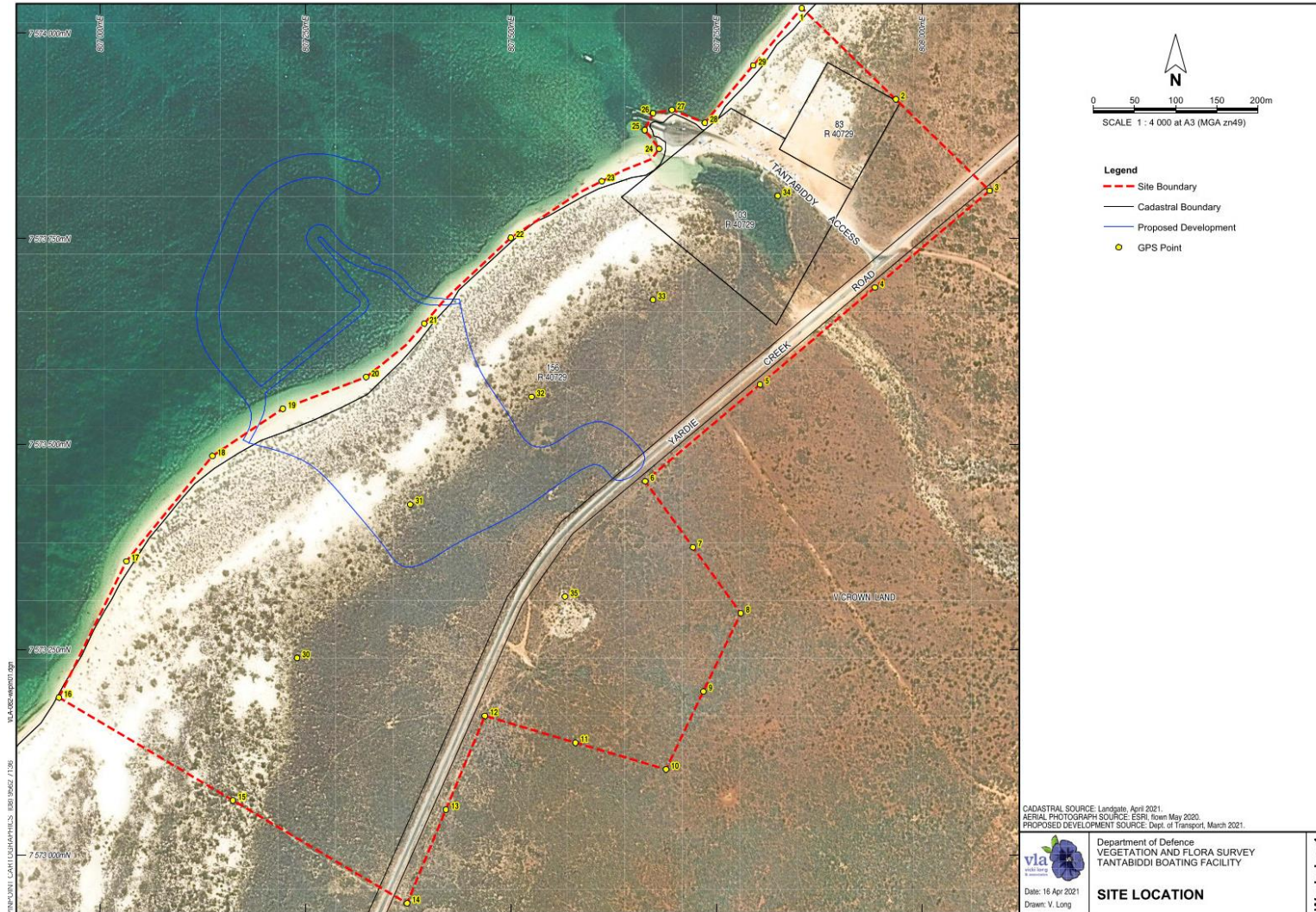


Figure 2. Layout of the existing (in the north) and proposed (blue polygon in the centre) Tantabiddi Boat Launch facilities.

2 Methods

2.1 Overview

This approach to fauna impact assessment has been developed with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (EPA) on fauna surveys and environmental protection (EPA 2002, 2016c, 2016b, 2020), and Commonwealth biodiversity legislation (DotE 2013; DSEWPaC 2013a). The EPA (2020) recommends three levels of investigation that differ in their approach for field investigations:

- **Basic** – a low-intensity survey, conducted at the local scale to gather broad fauna and habitat information (formerly referred to as ‘Level 1’). The primary objectives are to verify the overall adequacy of the desktop study, and to map and describe habitats. A basic survey can also be used to identify future survey site locations and determine site logistics and access. The results from the basic survey are used to determine whether a detailed and/or targeted survey is required. During a basic survey, opportunistic fauna observations should be made and low-intensity sampling can be used to gather data on the general faunal assemblages present. While referred to as ‘basic’, this level of survey is involved and powerful, and should be considered the primary level of assessment. Other levels of assessment (where deemed necessary) add information to inform this primary level.
- **Detailed** – a detailed survey to gather quantitative data on species, assemblages and habitats in an area (formerly referred to as ‘Level 2’). A detailed survey requires comprehensive survey design and should include at least two survey phases appropriate to the biogeographic region (bioregion). Surveys should be undertaken during the seasons of maximum activity of the relevant fauna and techniques should be selected to maximise the likelihood that the survey will detect most of the species that occur, and to provide data to enable some community analyses to be carried out.
- **Targeted** – to gather information on significant fauna and/or habitats, or to collect data where a desktop study or field survey has identified knowledge gaps. Because impacts must be placed into context, targeted surveys are not necessarily confined to potential impact areas. A targeted survey usually requires one or more site visits to detect and record significant fauna and habitats. For areas with multiple significant species there may not be a single time of year suitable to detect all species. In these cases, multiple visits, each targeting different species or groups, should be conducted.

The level of assessment recommended by the EPA (2020) is determined by geographic position, with a generic statement that detailed surveys are expected across all of the state except the south-west, but also recommending that site and project characteristics be considered, such as the survey objectives, existing available data, information required, the scale and nature of the potential impacts of the proposal and the sensitivity of the surrounding environment in which the disturbance is planned. These aspects should be considered in the context of the information acquired by the desktop study. When determining the type of survey required, the EPA (2020) suggested that the following be considered:

- level of existing regional knowledge
- type and comprehensiveness of recent local surveys

- degree of existing disturbance or fragmentation at the regional scale
- extent, distribution and significance of habitats
- significance of species likely to be present
- sensitivity of the environment to the proposed activities
- scale and nature of impact.

A 'basic' level survey (desktop review, fauna habitat identification and a site inspection) is considered appropriate for the Tantabiddi Boating Facility Project. This is based upon the level of existing knowledge, the extent, distribution and significance of habitats (widespread) and the significance of species likely to be present (generally a limited assemblage of significant species including stygofauna with very specific habitat requirements).

The approach and methods utilised in this report are divided into three groupings that relate to the stages and the objectives of impact assessment:

- **Desktop assessment.** The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the project area based on unpublished and published data using a precautionary approach.
- **Field investigations.** The purpose of the field investigations carried out for a Basic assessment is to gather information on the vegetation and soil associations ('habitats') that support the fauna assemblage and place the list generated by the desktop review into the context of the environment of the project area. The brief field investigations that form part of a Basic assessment also allow for some fauna observations to be made and assist the consultant to develop an understanding of the ecological processes that may be operating in the project area.
- **Impact assessment.** Determine how the fauna assemblage may be affected by the proposed development based on the interaction of the project with a suite of ecological and threatening processes.

2.2 Identification of vegetation and substrate associations (VSAs)

Vegetation and substrate associations (VSAs) combine vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna.

2.3 BCE deliberately makes the distinction between 'habitat' (a species-specific term that may encompass the whole or part of one or more VSAs and is the physical subset of an ecosystem that a given species, or species group, utilises) and 'VSA' (a general, discrete and mutually exclusive spatial division of a target area, based on soil, vegetation and topography). It is recognised, however, that, within the broader EIA literature/guidance, the former term is used more or less synonymously to indicate the latter (e.g. 'habitat assessment' used by EPA 2020). Further discussion is provided in [Appendix 1. Explanation of fauna values.](#)

[Appendix 1.](#)

For the current assessment, VSAs were identified based on the consultants' previous experience in the area and on observations made during the field investigations.

2.3.2.4 Desktop assessment

2.3.2.4.1 Sources of information

Information on the fauna assemblage of the survey area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Atlas of Living Australia (ALA), the WA Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap, the Western Australian Museum's FaunaBase (from 2005), BirdLife Australia's Birddata (Atlas) Database (BA), the EPBC Protected Matters Search Tool and the Bamford Consulting Ecologists (BCE) Database ([Error! Reference source not found, Table 2](#)). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns are listed in Table 3. The literature used for the stygofauna desktop assessment are listed in Table 4.

Table 2. Sources of information used for the 2021 desktop assessment.

Database/Literature	Type of records held on database	Area searched
Atlas of Living Australia (ALA 2021)	Records provided by collecting institutions, individual collectors and community groups	21.9128°S, 113.9782° E – plus 20 km buffer.
NatureMap (DBCA 2021)	Records in the WAM and DBCA databases. Includes historical data and records on Threatened and Priority species in WA.	21.9128°S, 113.9782° E – plus 20 km buffer.
BirdLife Australia Birddata (Atlas Database) 2021	Records of bird observations in Australia, 1998-2018.	21.9128°S, 113.9782° E – plus 20 km buffer.
EPBC Protected Matters 2021	Records on matters of national environmental significance protected under the EPBC Act.	21.9128°S, 113.9782° E – plus 20 km buffer.
BCE Ecological Survey in 2005	Detailed (formerly Level 2) ecological survey.	Learmonth Air Weapons Range

Table 3. Sources of information used for general patterns of terrestrial fauna distribution.

Taxa	Sources
Frogs	Tyler <i>et al.</i> (2000), and Anstis (2013).
Reptiles	Storr <i>et al.</i> (1983, 1990, 1999 and 2002), and Wilson and Swan (2020-6 th Edition).
Birds	Blakers <i>et al.</i> (1984), Kendrick (1993), Johnstone and Storr (1998, 2004), Barrett <i>et al.</i> (2003), and Menkhorst <i>et al.</i> (2017).
Mammals	Kendrick (1993), Menkhorst and Knight (2004), Churchill (2008), and Van Dyck and Strahan (2008).

Table 4. Literature sources for the desktop review of stygofauna.

Author	Title
Adams and Humphreys (1993)	Patterns of genetic diversity within selected subterranean fauna of the Cape Range peninsula, Western Australia: systematic and biogeographic implications.
Bruce and Humphreys (1993)	<i>Haptolana pholeta</i> , sp. nov., the first subterranean flabelliferan isopod crustacean (Cirrolanidae) from Australia.
Holthius (1959)	Two new species of atyid shrimps from subterranean waters of N.W. Australia (Decapoda natantia) <i>Crustaceana</i> 1:47-57.
Humphreys (1993a)	Cave fauna in semi-arid tropical Western Australia: a diverse relict wet-forest litter fauna.
Humphreys (1993b)	Stygofauna in semi-arid tropical Western Australia: a Tethyan connection?
Humphreys (1993c)	The significance of the subterranean fauna in biogeographical reconstruction: examples from Cape Range peninsula, Western Australia.
Humphreys (1999)	Relict stygofaunas living in sea salt, karst and calcrete habitats in arid northwestern Australia contain many ancient lineages.
Humphreys (2001)	<i>Milyeringa veritas</i> Whitley 1945 (Eleotridae), a remarkably versatile cave fish from the arid tropics of northwestern Australia.
Jaume and Humphreys (2001)	A new genus of epacteriscid calanoid copepod from an anchialine sinkhole in northwestern Australia.
Juame <i>et al.</i> (2001)	New stygobiont copepods (Calanoida; Misophrioida) from Bundera sinkhole, an anchialine cenote on north-western Australia.
Kornicker <i>et al.</i> (2006)	Description of the anchialine ostracode <i>Danielopolina</i> sp. cf. <i>D. kornickeri</i> from Christmas Island, Indian Ocean.
Humphreys and Adams (1991)	The subterranean aquatic fauna of the North West Cape peninsula, Western Australia.
Humphreys <i>et al.</i> (1999)	Effects of research diving on the physico-chemical profile of Bundera Sinkhole, an anchialine remiped habitat at Cape Range, Western Australia.
Humphreys <i>et al.</i> (2012)	Geochemical and microbial diversity of Bundera Sinkhole, an anchialine system in the eastern Indian Ocean.
Mees (1962)	The subterranean fauna of Yardie Creek station, North West Cape, Western Australia. <i>Journal of the Royal Society of Western Australia</i> .
Poore and Humphreys (1992)	First record of Thermosbaenacea (Crustacea) from the Southern Hemisphere: a new species from a cave in tropical Western Australia.
Whitely (1945)	New sharks and fishes from Western Australia.
Wilson and Humphreys (2001)	<i>Prionospio thalanji</i> sp. nov. (Polychaeta: Spionidae) from an anchialine cave, Cape Range, northwest Western Australia.
Yager and Humphreys (1996)	<i>Lasionectes exleyi</i> , sp. nov., the first remipede crustacean recorded from Australia and the Indian Ocean, with a key to the world species.

2.3.22.4.2 Previous fauna surveys

BCE conducted a level 2 ecological survey in 2005 for Ecoscape Australia Pty Ltd on behalf of the Department of Defence Corporate Services and Infrastructure (HLA Envirosiences and Ecoscape (2005)). The site was located at Learmonth Air Weapons Range, adjacent to the Ningaloo Marine park and Cape Range National Park on the Cape Range Peninsula. The Department of Biodiversity, Conservation and Attractions (DBCA) reported on the accumulated environmental data thus far

(further work undergoing) immediately surrounding the Tantabiddi boating facility (1 km buffer) in 2020 (DBCA 2020a). In addition, both Kendrick (1993) and Meissner (2010) provide detailed reviews of the fauna assemblage of the Cape Range region.

2.3.32.4.3 *Nomenclature and taxonomy*

As per the recommendations of the EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia 2016. The authorities used for each vertebrate group were: amphibians (Doughty *et al.* 2019a), reptiles (Doughty *et al.* 2019b), birds (Johnstone and Darnell 2016), and mammals (Travouillon 2016). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place, including the use of the group name 'Black-Cockatoo' (e.g. the BirdLife Australia working list of names for Australian Birds). English names of species where available are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

2.3.42.4.4 *Interpretation of species lists*

2.3.4.12.4.4.1 *Expected occurrence*

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the project area. Therefore, some species that were returned by one or more of the database and literature searches have been excluded because their ecology, or the environment within the project area, determine that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the site is of no importance. Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the project area at least occasionally, whether or not they were recorded during field surveys, and whether or not the project area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status, the expected occurrence, in the project area. The status categories used are:

- **Resident:** species with a population permanently present in the project area;
- **Regular migrant or visitor:** species that occur within the project area regularly in at least moderate numbers, such as part of an annual cycle;
- **Irregular Visitor:** species that occur within the project area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the project area in at least moderate numbers and for some time;
- **Vagrant:** species that occur within the project area unpredictably, in small numbers and/or for very brief periods. Therefore, the project area is unlikely to be of importance for the species; and
- **Locally extinct:** species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the project area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which the site is not important in a conservation sense, and species which

use the site in other ways but for which the site is important at least occasionally. This is particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times. The status categories are assigned conservatively based on the precautionary principle. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence the site will not support it, and even then, it may be classed as a vagrant rather than assumed to be absent if the site might support dispersing individuals. It must be stressed that these status categories are predictions only and that often very intensive sampling would be required to confirm a species' status.

The results of the database searches were reviewed and interpreted, and obvious errors and out of date taxonomic names were deleted.

2.3.4.2.4.4.2 Conservation significance

All expected species were assessed for conservation significance as detailed in [Appendix 1. Explanation of fauna values.](#)

[Appendix 1.](#) Three broad levels of conservation significance are used in this report:

- Conservation Significance 1 (CS1) – species listed under State or Commonwealth Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (BC Act);
- Conservation Significance 2 (CS2) – species listed as Priority by DBCA but not listed under State or Commonwealth Acts; and
- Conservation Significance 3 (CS3) – species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

2.5 See [Appendix 1. Explanation of fauna values.](#)

[Appendix 1](#) for an expanded discussion of these categories and [Appendix 2](#) [Appendix 2](#) for a description of the categories used in the legislation (EPBC and BC Acts) and by the DBCA.

2.4.2.6 Field investigations

2.4.2.6.1 Overview

A site inspection was conducted to familiarise the consultants with the project area. This involved looking around as much of the project area as possible; including walking through areas that did not have direct vehicle access. This enabled:

- identification of VSAs (that provide fauna habitats);
- targeted searches for significant fauna and an assessment of their likelihood of occurrence based on VSAs present;
- continuous recording of bird species encountered; and
- opportunistic fauna observations.

In addition to a thorough inspection of the project area, coastal and near-coastal sites south as far as Yardie Creek were visited to obtain some regional context. Notes were made on the landscape and some fauna observations were made in these other areas.

2.4.22.6.2 *Dates*

The project area was visited on the 18th-20th April 2021.

2.4.32.6.3 *Personnel*

Personnel involved in the field investigations and report preparation (including desktop review) are listed in **Error! Reference source not found.** Table 5. Dr Humphries was not involved with the April 2021 field investigations, but has previously visited Tantabiddi Sinkhole and nearby sites of interest with respect to stygofauna on multiple occasions.

Table 5. Personnel involved in the field investigations and report preparation.

Personnel	EIA Experience	Field Investigations	Report Preparation
Dr Mike Bamford <i>BSc (Biol.), Hons (Biol.), PhD (Biol.)</i>	40 years	+	+
Dr Kristen Bleby <i>BSc and Hons (Nat Res Mgmt), PhD (Zool.)</i>	17 years		+
Dr Bill Humphries		+	+

2.4.42.6.4 *Survey limitations*

The EPA Guidance Statement 56 (EPA 2004) and the EPA (2020) outline a number of limitations that may arise during field investigations for Environmental Impact Assessment. These survey limitations are discussed in the context of the BCE investigation of the project area in

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~~Table 6~~ Table 6. No limitations were identified.

The lack of detailed survey (i.e. intensive sampling of the fauna assemblage) is not considered a limitation as this assemblage is well-understood in the area due to multiple previous field investigations. Furthermore, EPA guidance does not consider limitations related to the effectiveness of field sampling for fauna but appears to make an assumption that the purpose of such sampling is to confirm the fauna assemblage. This is implicit in the EPA (2020) technical guidance that does provide suggestions for sampling techniques, but the level of field investigations suggested cannot confirm the presence of an entire assemblage, or confirm the absence of a species. This requires far more work than is possible (or recommended) for studies contributing to the EIA process because fauna assemblages vary seasonally and annually, and often have high levels of variation even over short distances (Beta diversity). For example, in an intensive trapping study, How and Dell (1990) recorded in any one year only about 70% of the vertebrate species found over three years. In a study spanning over two decades, Bamford *et al.* (2010) found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a set of sites only defines the assemblage of those sites at the time of sampling. The limited effectiveness of short periods of fauna sampling is not a limitation for impact assessment *per se*, as long as database information is interpreted effectively and field investigations are targeted appropriately. That is the approach taken by BCE.

Table 6. Survey limitations as outlined by EPA (2020).

EPA Survey Limitations	BCE Comment
Availability of data and information	Abundant information from databases and previous studies (see Section 2.4.12.3.1). Not a limitation.
Competency/experience of the survey team, including experience in the bioregion surveyed	The ecologists have had extensive experience in conducting desktop reviews and reconnaissance surveys for environmental impact assessment fauna studies, and have undertaken a number of studies within the immediate region. See also Error! Reference source not found, Table 5 for further details. Not a limitation. The specialist area of stygofauna was addressed by a recognised expert in the field.
Scope of the survey (e.g. were faunal groups were excluded from the survey)	The survey focused on terrestrial vertebrate fauna, fauna values and stygofauna. Not a limitation.
Timing, weather and season	Timing is not of great importance for Basic level field investigations in this region. Conditions were ideal for a site inspection. Not a limitation.
Disturbance that may have affected results	None. Not a limitation.
The proportion of fauna identified, recorded or collected	All fauna observed were identified. Not a limitation.
Adequacy of the survey intensity and proportion of survey achieved (e.g. the extent to which the area was surveyed)	The site was adequately surveyed to the level appropriate for a Basic level assessment. Fauna database searches covered a 25 km radius beyond the centroid of the project area. The Basic level assessment was completed. Not a limitation.
Access problems	There were no access problems encountered. Not a limitation.
Problems with data and analysis, including sampling biases	There were no data problems. Not a limitation.

2.52.7 Presentation of Results for Impact Assessment

While some impacts are unavoidable during a development, of concern are long-term, deleterious impacts upon biodiversity. This is reflected in documents such as the Significant Impact Guidelines provided by DSEWPaC (2012) (see [Appendix 4Appendix 4](#)). Significant impacts may occur if:

- There is direct impact upon a VSA and the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna.
- There is direct impact upon conservation significant fauna.
- Ecological processes are altered and this affects large numbers of species or large proportions of populations, including significant species.

The impact assessment process therefore involves reviewing the fauna (terrestrial and stygofauna) values identified through the desktop assessment and field investigations with respect to the project

and impacting processes. The severity of impacts on the fauna assemblage and conservation significant fauna can then be quantified on the basis of predicted population change.

The presentation of this assessment follows the general approach to impact assessment as given in Section 1.1, but modified to suit the characteristics of the site. Key components to the general approach to impact assessment are addressed as follows:

Fauna values

This section presents the results of the desktop and field investigations in terms of key fauna values (described in detail in

2.8 Appendix 1. Explanation of fauna values.

~~Appendix 1~~) and includes:

- Recognition of ecotypes or vegetation/substrate associations (VSAs);
- Assemblage characteristics (uniqueness, completeness and richness);
- Species of conservation significance;
- Patterns of biodiversity across the landscape; and
- Ecological processes upon which the fauna depend.

Impact assessment

This section reviews impacting processes (as described in detail in ~~Appendix 3~~~~Appendix 3~~) with respect to the proposed development and examines the potential effect these impacts may have on the faunal biodiversity of the project area. It thus expands upon Section 1.1 and discusses the contribution of the project to impacting processes, and the consequences of this with respect to biodiversity. A major component of impact assessment is consideration of threats to species of conservation significance as these are a major and sensitive element of biodiversity. Therefore, the impact assessment section includes the following:

- Review of impacting processes; will the proposal result in:
 - Habitat loss leading to population decline, especially for significant species;
 - Habitat loss leading to population fragmentation, especially for significant species;
 - Weed invasion that leads to habitat degradation;
 - Ongoing mortality;
 - Species interactions that adversely affect native fauna, particularly significant species;
 - Hydrological change;
 - Altered fire regimes; or
 - Disturbance (dust, light, noise)?
- Summary of impacts upon significant species, and other fauna values.

The impact assessment concludes with recommendations for impact mitigation, based upon predicted impacts. Note that the terms direct and indirect impacts are not used in this report; for further explanation see Appendix 2.

2.5.12.8.1 *Criteria for impact assessment*

Impact assessment criteria are based on the severity of impacts on the fauna assemblage and conservation significant fauna, and quantified on the basis of predicted population change ([Table](#)

[Table 7](#)). Population change can be the result of direct habitat loss and/or impacts upon ecological processes.

The significance of population change is contextual. The EPA (2016c) suggested that the availability of fauna habitats within a radius of 15 km can be used as a basis to predict low, moderate or high impacts. In this case, a high impact is where the impacted environment and its component fauna are rare (less than 5% of the landscape within a 15 km radius or within the Bioregion), whereas a low impact is where the environment is widespread (e.g. >10% of the local landscape). Under the Ramsar Convention, a wetland that regularly supports 1% of a population of a waterbird species is considered to be significant. These provide some guidance for impact assessment criteria. In the following criteria ([Table 7Table-9](#)), the significance of impacts is based upon percentage population decline within a 15 km radius (effectively local impact) and upon the effect of the decline upon the conservation status of a recognised taxon (recognisably discrete genetic population, sub-species or species). Note that percentage declines can usually only be estimated on the basis of the distribution of a species derived from the extent of available habitat while for a few species, such as the Black-Cockatoos, there is guidance for the assessment of impact significance.

While habitat impacts across a region of 15 km from an impact area may be an appropriate scale for terrestrial fauna, and particularly vertebrates, it may not be appropriate for fauna with highly restricted ranges, such as at least some of the stygofauna present in the Cape Range region. This issue is discussed below in the relevant section.

The impact assessment concludes with recommendations based upon predicted impacts and designed to mitigate these.

Table 7. Assessment criteria for impacts upon fauna.

Impact Category	Observed Impact
Negligible	Effectively no population decline; at most few individuals impacted and any decline in population size within the normal range of annual variability.
Minor	Population decline temporary (recovery after end of project such as through rehabilitation) or permanent, but < 1% within 15 km radius of centre-point of impact area (or within bioregion if this is smaller). No change in viability or conservation status of taxon.
Moderate	Permanent population decline 1-10% within 15 km radius. No change in viability or conservation status of taxon.
Major	Permanent population decline 10-50% within 15 km radius. No change in viability or conservation status of taxon.
Critical	Taxon decline > 50% (including local extinction) within 15 km and/or change in viability or conservation status of taxon.

3 Results - Fauna Values

3.1 Vegetation and substrate associations (VSAs) ['habitat assessment']

Vegetation and substrate associations within the project area are a complex mosaic, largely reflecting soil types. Eight major vegetation and substrate associations (VSAs) were identified in the project area:

VSA 1. Beach. Sand and small stones. A moderate slope so effectively no tidal flats. See Plate 1.

VSA 2. Foredunes. These support true spinifex (*Spinifex longifolia longifolius*) but with a lot of bare sandy areas. Also exposed limestone and shell grit within and behind the foredunes. In behind the foredune was a swale with very scattered *Triodia epactia* and *Acanthocarpus preissii*. **Vegetation type SI1.** See Plate 2.

VSA 3. Secondary Dunes. Transition between *Spinifex longifolius* and *Triodia epactia* sp hummock grassland on white sand. Scattered shrubs. **Vegetation type EaTe 1** and the majority of **AtAcTeCc 2**. See Plate 2.

VSA 4. Chenopod (bluebush *Atriplex bunburyana*, *Frankenia pauciflora*) **low shrubland** on grey clayey loam low in the landscape. Occurs more in south of project area between secondary dunes and road. Also occurs around Tantabiddi Sinkhole where there is a lot of Saltwater Couch (*Sporobolus virginicus*) amongst the low shrubs. **Combines a suite of vegetation types: AbuFpSvTe 1 to 4.** See [Plate 3](#).

VSA 5. Open shrubland of *Acacia bivenosa* and *Rhagodia preissii* subsp *obovata* **over Triodia epactia hummock grassland on red sandy loam.** Occurs slightly higher in the landscape in the north and east of the project area. Termite mounds present. Often heavy invasion of Buffel Grass. **Combines a suite of vegetation types: AtAcTeCc 1** and a small area of **AtAcTeCc 2; AbiTdTe 1** and **AbiTdTe 2.** See [Plate 4](#).

VSA 6. Tantabiddi Creek. This is a complex of vegetation and substrate types. Beside the facility is an open tidal pool fringed with a few mangroves and an area of salt marsh (*Tecticornia* sp and *Muellerolimon salicorniaceum*, *Sporobolus virginicus*). The upstream section of the creek is seasonal with exposed limestone platform, scattered shrubs and *Triodia* but lies east of Yardie Creek Road and outside the project area. The salt marsh includes vegetation types **FpSv 1 and 2.** See [Error! Reference source not found.](#)

VSA 7. Tantabiddi Sinkhole and subterranean environment. Four depressions (three containing brackish water) in a gentle hollow supporting Saltwater Couch *Sporobolus virginicus* on grey clayey loam. Some exposed limestone around sinkholes. Water connects to underlying labyrinth so the sinkhole is effectively a portal into this. **Vegetation type Sv 1 occurs around the sinkholes.** See Plate 6.

VSA 8. Buffel Grass Grassland. Occurs in a 5 m wide strip along Yardie Creek Road, while hard surfaces are present (roads and parking areas). **Vegetation type Cc 1.** See Plate 7.

The extent of the VSAs in the project area is mapped in Figure 3. The project area is on the western edge of a coastal plain with an abrupt limestone escarpment several kilometres inland. The landscape is broadly similar north and south of the project area, with the limestone escarpment occasionally close to the coast such as at Yardie Creek to the south. Tantabiddi Creek is one of several small, intermittent drainage lines that cross the coastal plain. The coastline is mostly sand (as at

Tantabiddi Creek) with occasional limestone platforms. The only extensive area of mangrove and of tidal mudflats is at Mangrove Bay about 15 km south of Tantabiddi Creek.



Plate 1. VSA 1: Beach.



Plate 2. VSA 2 and VSA 3: foredunes on the right with *Spinifex longifolius* and secondary dune swale on the left with *Tridonia epactica*.



Plate 3. VSA 4: Chenopod low shrubland.



Plate 4. VSA 5: Open shrubland. Note termite mounds in distance.



Plate 5. VSA 6: Tantabiddi Creek.



Plate 6. VSA 7: Tantabiddi Sinkhole.



Plate 7. VSA 8: Buffel Grass Grassland.

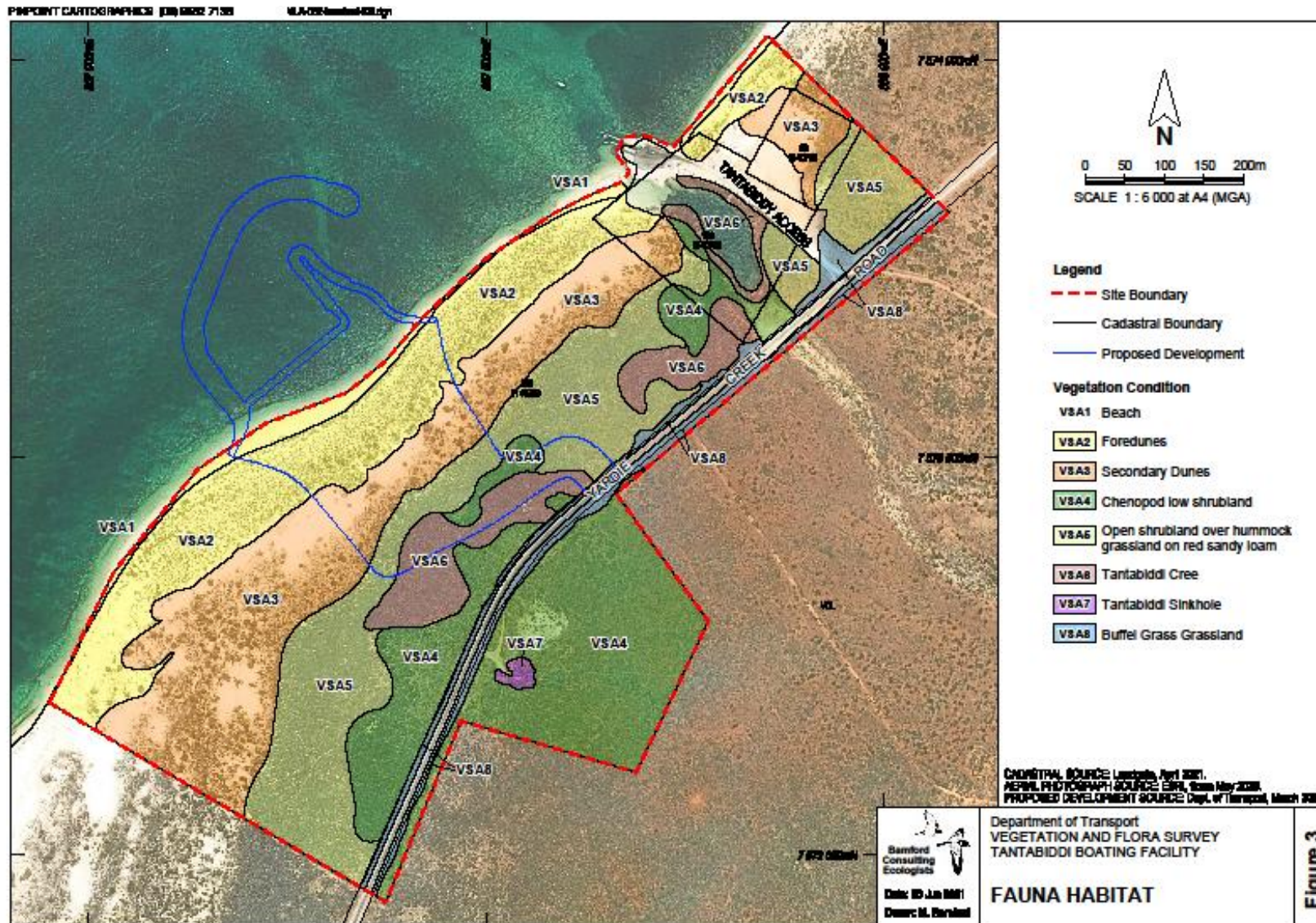


Figure 3. The distribution of Vegetation and Substrate Associations (VSAs) in the project area.

3.2 Desktop assessment – expected fauna assemblage

3.2.1 Overview of expected vertebrate fauna assemblage

The desktop study identified 383 vertebrate fauna species as potentially occurring in the project area: two fish, five frogs, 111 reptiles, 221 birds and 44 mammals. These species are listed in [Appendix Appendix 5](#). Note that this assemblage includes at least one bird and 19 mammal species that are now considered locally extinct; thus the extant assemblage is composed of 363 species. The presence of at least 46 species in the project area (1 fish, 6 reptiles, 36 birds and 3 mammals) was confirmed during the 2021 site inspection (as presented in Appendix 6).

The composition of the expected vertebrate fauna is summarised in [Table 8Table 8](#). As the assemblage is drawn from databases over a radius of 20km from the project area, which includes environments not present within the project area, the assemblage includes many more species than might actually be present. Species that might occur nearby and might rarely occur in the project area are classified as irregular visitors or vagrants, and assemblage composition is discussed further for each major taxonomic group below. Stygofauna and significant invertebrates are discussed separately (section 3.2.5).

Table 8. Composition of expected vertebrate fauna assemblage of the project area.

The number of introduced species is shown in parentheses. Expected species includes those now considered locally extinct.

Taxon	Expected Species	Recorded Species	Number of species in each status category				
			Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Freshwater fish	2	1	2				
Frogs	5 (1)	0	4	0	0	1	0
Reptiles	111 (1)	6	99		11	1	0
Birds	221 (2)	36	27	112	59	22	1
Mammals	44 (7)	3 (1)	25	4	2	0	19
Total	383	46 (1)	157	116	72	24	20

3.2.2 *Expected vertebrate fauna*

Freshwater fish

Two freshwater fish are known from the subterranean environment in the general area, with the Blind Cave Gudgeon *Milyeringa veritas* observed in Tantabiddi Sinkhole during the site inspection (Plate 8), and the Blind Cave Eel *Ophisternon candidum* known from the nearby Tantabiddi Well historically (Humphreys 1999a) and almost certainly present within or very close to the project area. Both species are of conservation significance and are discussed further below.



Plate 8. Four Blind Cave Gudgeons in Tantabiddi Sinkhole (19th April 2021). Up to six were seen at once in the early morning but were not visible by late morning.

Frogs

Five frog species are known from the general area but only four are expected as resident. These may breed in seasonal pools along Tantabiddi Creek and shelter in the ground and/or along the limestone escarpment in slightly moist crevices. They are likely to be active only after rain. The fifth species, the Green Tree Frog, is not native to the area and the record (from Atlas of Living Australia) may be from an animal accidentally transported in a caravan. The Green Tree Frog appears to have recently established itself in Onslow, about 100km to the north-east, probably as a result of this sort of transportation. None of the frog species is of conservation significance.

Reptiles

The reptile assemblage of the general area is very rich; Bamford (2005) recorded over 50 reptile species in the nearby Learmonth Air Weapons Range which makes the region one of the richest locations for reptile species in the world. This species richness may be the result of a varied landscape

and the biogeography of the region which is an 'overlap' zone, with outlying species from the Kimberley, Pilbara and South-West, as well as typically widespread species and a suite of Cape Range endemics. The project area lacks the landscape variability seen over the broader region, but without intensive sampling it has to be assumed that the majority of reptile species are likely to be residents. On this basis, 98 reptile species are classed as resident in the project area, with the remaining 12 species being marine and considered only irregular visitors or vagrants to the terrestrial environment. These include five marine turtles, but the coastline immediately around Tantabiddi is not considered to be regularly used for breeding. A single track of a sea turtle was found in the project area during the site inspection. Three lizards, two snakes and the sea turtles are of conservation significance (see below).

Six reptile species were observed during the site inspection and included the Priority 1 Keeled Slider which appeared abundant in the white sands of the secondary dunes.

Birds

The bird assemblage appears to be extremely rich, but birds are easily detected and often targeted by birdwatchers, with the result that many species can be detected while only being irregular visitors or vagrants that do not depend on a site. The assignment of a local status to each species in the project area reflects this, with just 27 species (12% of the assemblage) considered resident in the project area, and 81 species (36% of the assemblage) considered irregular visitors or vagrants. Many of these irregular visitors and vagrants are waterbirds, including seabirds. Nearly half (46 species) of the 112 species classed as regular visitors are also waterbirds and while they may be present regularly, they are likely to be present only in small numbers. For example, during the site visit there was a single Grey Teal and a single Great Eastern Egret on Tantabiddi Creek, while there was a single Greater Sand Plover on the beach just south of the creek. Many of the waterbirds are of conservation significance (listed as Migratory) and these are discussed further below. One bird, the Striated Grasswren, is believed to be locally extinct.

Of the 36 bird species observed during the site inspection, only 21 were in the project area (Appendix 6). Other species were seen either in town or were observed between Tantabiddi and Yardie Creek. The species recorded were species considered to be resident or regular visitors. Notable observations on birds were:

- A few waterbirds using the tidal pool of Tantabiddi Creek.
- An estimated four parties of White-winged Fairy-wrens and about eight calling Rufous fieldwrens within the project area. These two resident species probably occur at similar densities right along the coastal plain in the region.
- All locations where the coastline could be accessed were visited between Tantabiddi and Yardie Creek, and the only locations with even small numbers of waterbirds were South Mandu and T-Bone. These provided shelter from the birds (from the wind) amongst ridges of pebbles and small rocks, but were also the only coastal locations where there were not large numbers of people.
- Mangrove Bay was the only location with tidal mudflats that might have attracted migratory shorebirds but there were no birds present when the site was visited.
- A pair of Eastern Ospreys was present at the current Tantabiddi Boat Ramp site, and has a nest on a tall metal pole.

Mammals

The 44 species that comprise the mammal assemblage include 19 species considered to be locally extinct and seven species that are introduced; therefore the extant assemblage of native mammals consists of just 18 species, of which 15 are either residents or regular visitors. Nine of these residents or regular visitors are bats that either roost along the limestone escarpment or in mangroves at Mangrove Bay. Of the seven introduced species, four are considered to be residents. Native species expected to be only irregular visitors include the significant Black-flanked Rock-Wallaby which may be present along the adjacent escarpment.

Few mammals were observed during the site inspection. The introduced Rabbit was abundant in the secondary dune system and tracks which appeared to be those of a Mulgara (presumably the Brush-tailed Mulgara *Dasycercus blythi*), were found just outside the project area and east of the existing boat ramp. This species is Priority 4 and is discussed further below. Note that tracks of a young Rabbit would be similar, but the individual footpads would be expected to be larger (difficult to distinguish in soft sand), and the sets of four pads would usually be closer together in the Rabbit compared with a Mulgara.



Plate 9. Tracks thought to be those of a Mulgara.

3.2.3 *Vertebrate fauna of conservation significance*

The extant vertebrate fauna assemblage of 363 species includes 55 species of conservation significance (Appendix 5, Table 9 and

~~Table 10~~ **Table 10**). A further nine species of conservation significance are considered to be locally extinct (Appendix 5). The majority (49) of conservation significant species are listed under legislation (CS1), with 26 (55%) of these being waterbirds listed as Migratory only. There are six species listed as priority (CS2), with most of these being reptiles. No species are listed as CS3 (locally significant) largely because of lack of information on the local status and distribution of many elements of the fauna assemblage, but also because it is an intact and protected landscape, with the CS3 listing often being used in fragmented landscapes where local populations are under threat. Only eight of the conservation significant species are considered to be resident: three CS1 and five CS2. The majority of the migratory waterbirds are considered to be regular visitors but some species are considered to be irregular visitors and two species are considered to be vagrants. Conservation significant species (and in some cases groups of species) are discussed further below.

Table 9. The number of conservation significant species in the extant vertebrate fauna assemblage.

See [▲]

[Appendix 1. Explanation of fauna values.](#)

[Appendix 1](#) for full explanation of Conservation Significance (CS) levels: CS1 = listed under WA State and/or Commonwealth legislation; CS2 = listed as Priority by DBCA; CS3 = considered locally significant.

CLASS	CONSERVATION SIGNIFICANCE			
	CS1	CS2	CS3	Total
Fish	2			2
Frogs	0	0	0	0
Reptiles	6	4	0	10
Birds	40	1	0	4139
Mammals	1	1	0	2
Total	49	6	0	55

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Table 10. Conservation significant vertebrate fauna species expected to occur within the project area.

Species are listed in taxonomic order.

CS1, CS2, CS3 = (summary) levels of conservation significance. See [Appendix 1. Explanation of fauna values.](#) [Appendix 1](#) for full explanation.

EPBC Act listings: C = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory (see [Appendix 2Appendix 2](#)).

WA Biodiversity Conservation Act 2016 (BC Act) listings: S1 to S7 = Schedules 1 to 7 (see [Appendix 2Appendix 2](#)).

DBCA Priority species: P1 to P4 = Priority 1 to 4 (see [Appendix 2Appendix 2](#)).

SPECIES	COMMON NAME	STATUS	WA Status	EPBC Status	EXPECTED OCCURRENCE
<i>Milyeringa veritas</i>	Blind Cave Gudgeon	CS1	S3 (V)	V	Resident
<i>Ophisternon candidum</i>	Blind Cave Eel	CS1	S3 (V)	V	Resident
<i>Chelonia mydas</i>	Green Turtle	CS1	S3 (V) S5 (M)	V,M	Irregular Visitor
<i>Caretta caretta</i>	Loggerhead Turtle	CS1	S2 (E) S5 (M)	E,M	Irregular Visitor
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	CS1	S2 (E) S5 (M)	E,M	Irregular Visitor
<i>Natator depressus</i>	Flathead Turtle	CS1	S3 (V) S5 (M)	V,M	Irregular Visitor
<i>Dermochelys coriacea</i>	Leatherback Turtle	CS1	S2 (E) S5 (M)	E,M	Vagrant
<i>Diplodactylus capensis</i>	Cape Range Stone Gecko	CS2	P2		Resident
<i>Lerista allochira</i>	Cape Range Slider	CS2	P3		Resident
<i>Lerista planiventralis maryani</i>	Keeled Slider	CS2	P1		Resident
<i>Aniliios</i> sp. 'Cape Range'	Blind snake 'Cape Range'	CS2	P1		Resident
<i>Aipysurus apraefrontalis</i>	Short-nosed Sea-Snake	CS1	S1 (Cr)	Cr	Irregular Visitor
<i>Fregata ariel</i>	Lesser Frigatebird	CS1	S5 (M)	M	Irregular visitor
<i>Phaethon rubricauda</i>	Red-tailed Tropicbird	CS2	P4		Irregular visitor
<i>Limosa limosa</i>	Black-tailed Godwit	CS1	S5 (M)	M	Regular visitor
<i>Limosa lapponica</i>	Bar-tailed Godwit	CS1	S1 (Cr) S5 (M)	Cr, M	Regular visitor
<i>Numenius madagascariensis</i>	Eastern Curlew	CS1	S1 (Cr) S5 (M)	Cr, M	Regular visitor
<i>Calidris ferruginea</i>	Curlew Sandpiper	CS1	S1 (Cr) S5 (M)	Cr, M	Regular visitor
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	CS1	S5 (M)	M	Regular visitor
<i>Actitis hypoleucos</i>	Common Sandpiper	CS1	S5 (M)	M	Regular visitor
<i>Numenius minutus</i>	Little Curlew	CS1	S5 (M)	M	Irregular visitor
<i>Tringa stagnatilis</i>	Marsh Sandpiper	CS1	S5 (M)	M	Regular visitor
<i>Tringa glareola</i>	Wood Sandpiper	CS1	S5 (M)	M	Regular visitor
<i>Calidris falcinellus</i>	Broad-billed Sandpiper	CS1	S5 (M)	M	Irregular visitor
<i>Xenus cinereus</i>	Terek Sandpiper	CS1	S5 (M)	M	Regular visitor
<i>Tringa nebularia</i>	Common Greenshank	CS1	S5 (M)I	M	Regular visitor
<i>Calidris subminuta</i>	Long-toed Stint	CS1	S5 (M)I	M	Vagrant
<i>Tringa brevipes</i>	Grey-tailed Tattler	CS1	S5 (M)I	M	Regular visitor
<i>Calidris alba</i>	Sanderling	CS1	S5 (M)I	M	Regular visitor
<i>Numenius phaeopus</i>	Whimbrel	CS1	S5 (M)I	M	Regular visitor
<i>Arenaria interpres</i>	Ruddy Turnstone	CS1	S5 (M)I	M	Regular visitor

<i>Calidris ruficollis</i>	Red-necked Stint	CS1	S5 (M)I	M	Regular visitor
<i>Calidris tenuirostris</i>	Great Knot	CS1	S1 (Cr) S5 (M)	Cr, M	Regular visitor
<i>Calidris canutus</i>	Red Knot	CS1	S2 (E) S5 (M)I	E, M	Regular visitor
<i>Glareola maldivarum</i>	Oriental Pratincole	CS1	S5 (M)	M	Irregular visitor
<i>Rostratula australis</i>	Australian Painted-snipe	CS1	S2 (E)	E	Vagrant
<i>Pluvialis fulva</i>	Pacific Golden Plover	CS1	S5 (M)	M	Regular visitor
<i>Charadrius leschenaultii</i>	Greater Sand Plover	CS1	S5 (M)	M	Regular visitor
<i>Charadrius veredus</i>	Oriental Plover	CS1	S5 (M)	M	Irregular visitor
<i>Pluvialis squatarola</i>	Grey Plover	CS1	S5 (M)	M	Regular visitor
<i>Charadrius mongolus</i>	Lesser Sand Plover	CS1	S2 (E) S5 (M)	E	Regular visitor
<i>Hydroprogne caspia</i>	Caspian Tern	CS1	S5 (M)	M	Regular visitor
<i>Sternula nereis</i>	Fairy Tern	CS1	S3 (V)	V	Regular visitor
<i>Sternula albifrons</i>	Little Tern	CS1	S5 (M)	M	Irregular visitor
<i>Chlidonias leucopterus</i>	White-winged Black Tern	CS1	S5 (M)	M	Regular visitor
<i>Sterna dougallii</i>	Roseate Tern	CS1	S5 (M)	M	Regular visitor
<i>Thalasseus bergii</i>	Crested Tern	CS1	S5 (M)	M	Regular visitor
<i>Anous stolidus</i>	Common Noddy	CS1	S5 (M)	M	Irregular visitor
<i>Pandion cristatus</i>	Eastern Osprey	CS1	S5 (M)	M	Resident
<i>Falco peregrinus</i>	Peregrine Falcon	CS1	S7		Regular visitor
<i>Falco hypoleucos</i>	Grey Falcon	CS1	S3 (V)	V	Irregular visitor
<i>Pezoporus occidentalis</i>	Night Parrot	CS1	S1 (Cr)	E	Vagrant
<i>Apus pacificus</i>	Fork-tailed Swift	CS1	S5 (M)	M	Irregular visitor
<i>Dasyercus blythi</i>	Brush-tailed Mulgara	CS2	P4		Resident
<i>Petrogale lateralis</i>	Black-footed Rock-Wallaby	CS1	S2 (E)	E	Irregular visitor

3.2.4 Conservation significant species accounts

A list of all conservation significant species expected within the project area is provided in

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~~Table 10~~ ~~Table 10~~; these comprise 51 vertebrates. Information on the conservation status, distribution and habitat, salient ecology and expected occurrence within the project area if provided for each of these species is below.

3.2.4.1 Conservation Significance 1

Blind Cave Gudgeon and Blind Cave Eel

Conservation status. Both are Vulnerable under EPBC Act and Schedule 3 (Vulnerable) under BC Act.

Distribution and habitat. Aquatic and subterranean but the Blind Cave Gudgeon is regularly seen in surface expressions of the groundwater system such as at Tantabiddi and Bundera Sinkholes. The Blind Cave Gudgeon is restricted to the Cape Range area with a related species on Borrow Island. On the Cape Range, it occurs as far south as Jarvis Well (-22.5978; 113.6900) and on the east side of the range as far south as Mowbowra Creek (21.9928; 114.1220) (Humphreys 1999a). The Blind Cave Eel is more widespread, occurring in the Cape Range, the western Pilbara (Robe River valley Moore *et al.* (2018)) and on Barrow Island.

Ecology. Both are predators on other subterranean fauna and on surface fauna that falls into the system. The presence of the Blind Cave Gudgeon in Tantabiddi sinkhole is well-known but appears to be intermittent, and it is known to feed on other stygofauna, insect larvae and prey trapped in the surface film (Humphreys and Feinberg 1995; Humphreys 2001).

Expected occurrence. Residents. Both are present in the groundwater systems in the vicinity of Tantabiddi with the Blind Cave Gudgeon observed in the Tantabiddi Sinkhole in April 2021 (~~Plate 8~~ ~~Plate 8~~). Therefore likely to be present beneath or very close to the project area.

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Sea turtles

Conservation status. Vulnerable or endangered (see Table 10).

Distribution and habitat. Wholly marine tropical to sub-tropical species except they leave the ocean to nest on beaches. Most species have very broad distributions around the world but the Flatback Turtle is confined to Australian waters. Hawksbill and Green Turtles are the two main species to breed on the Ningaloo coast (Coote *et al.* 2012), which is at the southern extent of their breeding range, with the Loggerhead Turtle also present and breeds as far south as Shark Bay (Burbidge 2004). While breeding along the Ningaloo coast occurs at least as far south as Yardie Creek, and includes occasional records around Tantabiddi, the main turtle breeding beaches appear to lie north of Jurabi Point, which is c. 5km north of the existing Tantabiddi boat ramp (Coote *et al.* 2012, Cary *et al.* 2000). Beaches in the project area therefore are not known to be used regularly or by large numbers of animals, but the track of one turtle was found in the swale between the primary and secondary dunes within the project area.

Ecology. Wholly marine except for breeding. Most species are predators but the Green Turtle is largely herbivorous.

Expected occurrence. Irregular visitors to vagrant. Will occur regularly in the adjacent waters. Small numbers of Hawksbill, Green and/or Loggerhead Turtles may breed on the beaches of the project area, but most local breeding occurs to the north of Tantabiddi Creek.

Short-nosed Sea-Snake

Conservation status. Critically Endangered under EPBC Act and Schedule 1 (Critically Endangered) under BC Act.

Distribution and habitat. Wholly marine and occurs off the Pilbara and Kimberley coast on reef flats and reef edges, with the Ningaloo Coast at the extreme southern end of the species' range.

Ecology. Wholly marine. A predator of small reef fish (Wilson and Swan (2017)).

Expected occurrence. Irregular visitor. May be present just offshore on adjacent reefs but probably only irregularly and would not occur on terrestrial environments except accidentally.

Migratory and other significant waterbirds

Conservation status. There are 37 waterbird species listed as significant (Table 10). Most of these are Migratory (26 shorebirds (sandpipers, plovers and allies) the Lesser Frigatebird, six tern species and the Eastern Osprey). Some of these migratory species have additional listings as threatened (see Table 10). There are also three significant waterbird species that are not migratory; the Australian Painted-snipe is Endangered, the Fairy Tern is Vulnerable and the Red-tailed Tropicbird is P4.

Distribution and habitat. These are birds of coastal environments and wetlands, although a few will also forage and roost on grasslands (Little Curlew, Oriental Pratincole and Oriental Plover; Hayman *et al.* 1991). The Australian Painted-snipe is a bird of vegetated freshwater wetlands. The terns include species that forage offshore but will roost and breed in coastal environments. The Eastern Osprey does likewise and is notable for a pair nesting on a pole at the existing Tantabiddi Boat Ramp. Shorebirds favour tidal mudflats and in some cases shallow freshwater wetlands. All species have extensive distributions, with the shorebirds breeding in the northern hemisphere.

Ecology. Great variety of life histories within such a diverse group. Shorebirds feed on invertebrates often obtained by probing in damp mud and fine tidal sediments. The frigatebird, tropicbird, terns and Eastern Osprey are largely piscivores. Most species will roost on beaches, reef platforms and islands. While the shorebirds breed in the northern hemisphere, the frigatebird, tropicbird, terns and the Eastern Osprey have Australian-breeding populations.

Expected occurrence. Regular visitors to vagrants. The project area provides little habitat for this suite of birds. Tidal mudflats are very limited on the Ningaloo Coast except at a few locations such as Mangrove Bay to the south. Roosting areas tend to be sandy or rocky points that are not represented along the fairly straight coast of the project area, but do occur further south. However, such roosting areas were noted to be compromised by high levels of human activity. Tantabiddi Creek provides limited foraging habitat for waterbirds but can be expected to support small numbers of sandpipers and plovers occasionally; a single Greater Sand Plover was present along the nearby beach during the site inspection. The pair of Eastern Ospreys observed, with a nest in the existing carpark, is probably the most significant usage of the project area by significant waterbirds. Weller *et al.* (2021) include the Ningaloo Coast (from North-West Cape to Point Billie; a distance of c. 100km) as a shorebird area in their Australia-wide review of important habitat for shorebirds, but incorrectly describe the coastline as *'dominated by oceanic beaches, extensive intertidal mudflats which are occasionally interrupted by small creek entrances with mangrove lined channels and surrounding mudflats. The mudflats are typically unvegetated and support high numbers of waders.'* Extensive tidal mudflats are not a feature of most of this coastline (there are some tidal mudflats near Point Billie) with sandy beaches and occasional reef platforms dominating. Indeed, a feature of this coastline is the presence of coral reef just offshore, with such reef not forming where there are fine sediments associated with tidal mudflats. Furthermore, Weller *et al.* (2021) do not report 'high numbers of waders' (shorebirds), but record only two species in numbers of significance: a count of 98 Grey-tailed Tattlers (2008) and a count of 65 Eastern Curlews (2006). These counts meet the criterion for a nationally significant site and the Eastern Curlew record is important as this species is Migratory and listed as Critically Endangered. The project area does not provide suitable habitat for either of these species, although individuals are likely to be present regularly for short periods of time.

Grey Falcon

Conservation status. Not listed under the EPBC Act but listed as Schedule 3 (Vulnerable) under the BC Act.

Distribution and habitat. Sparsely distributed through central, northern and north-western Australia, this species appears to have a distribution that is centred around wooded ephemeral or permanent drainage lines (Menkhorst *et al.* 2017).

Ecology. An aerial, diurnal predator that predominantly forages on pigeons and parrots, although may also take invertebrates, reptiles and small mammals (Debus 2019). Resident when seasonal conditions are favourable, nomadic in times of drought (Debus 2019).

Expected occurrence. Irregular visitor. There is no suitable habitat in the project area or nearby, but some riverine woodlands in the greater region.

Peregrine Falcon

Conservation status. Not listed under the EPBC Act but listed as Schedule 7 (Other protected fauna) under the BC Act.

Distribution and habitat. More or less cosmopolitan and found throughout Australia (Menkhorst *et al.* 2017). This species occurs in a variety of habitats but is usually reliant on cliff faces or tall trees for nesting (Debus 2019).

Ecology. A highly adept aerial predator that predominantly forages on birds, although will also occasionally take invertebrates, fish, reptiles and mammals (Debus 2019). Mostly diurnal or crepuscular.

Expected occurrence. Irregular visitor. The project area is likely to be within the foraging range of a pair, with potential breeding habitat along the nearby limestone escarpment.

Night Parrot

Conservation status. Endangered under the EBPC Act and Schedule 1 (Endangered) under the BC Act

Distribution and habitat. Highly elusive and known from only a very small number of records, it is difficult to ascertain the distribution and habitat of this species. DAWE (2020c) lists central Western Australia, north-eastern South Australia and south-western Queensland as 'core' areas, although the Night Parrot may occur throughout any part of inland Australia. Habitat associations are also tenuous but the species may occur in areas of spinifex grassland and/or chenopod shrublands, or in areas of shrubby samphire (TSSC 2016).

Ecology. The Night Parrot was recorded more or less regularly through the late 19th Century but appeared to decline early in the 20th Century, with a lack of reliable records from the 1930s to the end of the century leading to some speculation that it was extinct. In the early 20th Century, however, there have been multiple records including in the eastern Pilbara, northern Murchison and western deserts of Western Australia (Davis and Metcalf 2008; Hamilton *et al.* 2017; Jackett *et al.* 2017), and a population has been studied in south-western Queensland since 2013 (DAWE 2020c). The species has been mired in controversy due to the implications of records close to development proposals, and after researchers falsified recordings and subsequently retracted recent Night Parrot records from South Australia (Jones *et al.* 2019). It is likely to be predominantly nocturnal and granivorous.

Expected occurrence. Vagrant. There are no recent or historical records of the Night Parrot in the Cape Range area. Locations where the species has been found recently in Australia have had big, long-unburnt spinifex and extensive areas of chenopod shrublands associated with broad drainage systems and therefore the environment of the project area and Cape Range in general seems unlikely to be suitable.

Fork-tailed Swift

Conservation status. Migratory under the EPBC Act and Schedule 5 under the BC Act.

Distribution and habitat. The swift is a largely aerial species of unpredictable occurrence in Western Australia. There are scattered records from the south coast, widespread in coastal and subcoastal areas between Augusta and Carnarvon, scattered along the coast from south-west Pilbara to the north and east Kimberley region. Sparsely scattered inland records, especially in the Wheatbelt, but more common in the north and north-west Gascoyne Region, north through much of the Pilbara Region, and the south and east Kimberley (Higgins 1999; DAWE 2020b). Aerial, usually flying from as low as one metre to in excess of 300 m above the ground.

Ecology. A diurnal, aerial insectivore, this species often forages along the edge of low pressure systems in flocks of ten to 1000 birds (Higgins 1999; DAWE 2020b). Breeds in Siberia (April to July) and spends the non-breeding season (October to mid-April) in Australia. Being aerial, it is effectively independent of terrestrial ecosystems when in Australia.

Expected occurrence. Irregular visitor that is likely to pass over the project area in small numbers occasionally.

Black-footed Rock-Wallaby

Conservation status. Endangered under the EPBC Act and Schedule 2 (Endangered) under the BC Act. Predation by Foxes appears to be a key threat.

Distribution and habitat. Formerly widespread but now confined to scattered populations from the Kimberley to the Wheatbelt, including inland (Burbidge 2004). Associated with extremely rocky environments. There is a small population in the Cape Range area, most visible on the cliffs along Yardie Creek but also potentially present along the limestone escarpment north and south.

Ecology. A largely nocturnal herbivore. Shelters in rock crevices during the day but forages around and adjacent to rocky landscapes at night.

Expected occurrence. Irregular visitor. May be present in nearby limestone cliffs to the east, and therefore individuals could potentially visit the project area infrequently.

3.2.4.2 Conservation Significance 2

Cape Range Gecko, Cape Range Slider, Keeled Slider and blind snake 'Cape Range'

Conservation status. These are all priority species due to restricted ranges (see Table 10).

Distribution and habitat. Largely restricted to the Cape Range area although the Keeled Slider extends to Onslow and south/inland to Barridale. The Keeled Slider occurs on near-coastal sands and in an extensive survey near Onslow, was found to be restricted to this environment (Bancroft and Bamford 2005a). One was seen during the site inspection and tracks assumed to be from this species were common. The Cape Range Slider is apparently restricted to limestone gorges in the Cape Range Area (Wilson and Swan 2017), and the Cape Range Gecko is also associated with rocky, limestone surfaces (Doughty *et al.* (2008). The habitat preferences of the blind snake are uncertain; it was not returned from databases but is present on the DBCA threatened fauna list.

Ecology. The Cape Range Gecko is terrestrial while the remaining species are fossorial. All are insectivorous.

Expected occurrence. The Keeled Slider is probably abundant in the sandy soils of the secondary dunes and adjacent areas within the project area. The Cape Range Slider and Cape Range Gecko may only be present where underlying limestone is exposed along Tantabiddi Creek so may not actually occur within the project area, but would be present nearby. Due to habitat uncertainty, the blind snake 'Cape Range' has to be assumed to be resident in the project area.

Brush-tailed Mulgara

Conservation status. Listed as Priority 4 by the DBCA.

Distribution and habitat. Pilbara and inland, central Western Australia, as well as central Australia (southern Northern Territory and northern South Australia). This species is often compared with its congener, the Crest-tailed Mulgara (*D. cristicauda*), as the two are sympatric over parts of their range (Van Dyck and Strahan 2008). In general, the Brush-tailed Mulgara is less closely associated with the dune fields than the Crest-tailed Mulgara (Woolley *et al.* 2013). Where the two co-occur, the Crest-tailed Mulgara is restricted to sandridges with an understorey dominated by spinifex (*Triodia*), whereas the Brush-tailed Mulgara occupies sand plain and gibber plain (Pavey *et al.* 2011). Not listed for the Cape Range area by Kendrick (1993) or Miessner (2010), but tracks that appeared to be of this species found during the site inspection ([Plate 9](#)~~Plate-9~~). These were in a sandy-loam area supporting spinifex (*Triodia* sp.) just east of the project area and the existing boat ramp.

Ecology. A nocturnal predator, the Brush-tailed Mulgara is among the largest native predatory mammals remaining in Australia's deserts (Pavey *et al.* 2011). Its main prey include rodents, other dasyurid marsupials, reptiles, small birds and a wide range of invertebrate taxa (Pavey *et al.* 2011). Generally solitary (Van Dyck and Strahan 2008). This species constructs characteristic burrows for shelter (Triggs 1996; Van Dyck and Strahan 2008).

Expected occurrence. Resident. Assuming the identification of the tracks is correct, the species would appear to be resident in spinifex on sand and sandy-loam immediately adjacent to the project area, with some individuals very likely to be within the project area.

3.2.5 Invertebrate fauna of conservation significance

Invertebrate fauna of conservation significance known from the Cape Range area is dominated by the rich stygofauna known from the region. This stygofauna is better-documented on the east side of the Range compared with along the coastal plain in the west, due to their being few monitoring sites in the latter area (W. Humphreys, pers. obs.).

Despite the scarcity of sites on the western coastal plain, the most significant site in the wider region is the Bundera Sinkhole, which lies on the plain south of Yardie Creek and within the Learmonth Air Weapons Range overfly zone. It is by far the most significant stygofauna site owing to the presence of Remipedia and related fauna, which comprise a community type known only from Bundera, Lanzarote in the Canary Islands (volcanic) and islands on the American Plate (carbonate karst) in the northern Caribbean region.

The Tantabiddi Sinkholes may also contain a rich stygofauna assemblage, but the pools have been rarely and sparingly sampled for fauna (W. Humphreys pers. obs.). The Tantabiddi Sinkholes are a series of small anchialine pools (pools that are inland, tidally affected pools of groundwater with no surface connect with the sea (Bishop *et al.* 2015)) up to 8 m apart, which are located 740 m southwest of the facilities block at the current Tantabiddi Boat Ramp. These pools are the only known site for *Grandidierella* sp. nov. (Amphipoda: Aoridae). It is not of listed conservation significance, but can be assigned the informal 'locally significant' status (Conservation Significance level 3). The nearby Tantabiddi Well is in the same area and although frequently examined has not yielded any stygofauna in recent decades (Humphreys 1999a). Like many stock wells in the region, it is shallow and only weakly intersects the aquifer. [Appendix 7](#) ~~Appendix 7~~ includes stygofauna recorded from Tantabiddi Well (W. Humphreys unpubl. data).

The project area sits within DBCA's Pilbara management region (DBCA 2021a), and additional information on invertebrates in the region was obtained from DBCA (2021b) which lists 49 threatened or priority invertebrate fauna in this region, as outlined in [Appendix 7](#). ~~Appendix 7~~. At least 29 of these species can be ruled out from occurring within the project area and the reasons for exclusion are presented in [Appendix 7](#). ~~Appendix 7~~ (e.g. absence of suitable habitat in the project area, distance from known populations). To help ascertain the status of the remaining 20 species, all location records from ALA (2020) and WAM (2021h) were compiled, collated and mapped in relation to the project area. A map of these DBCA-listed threatened and priority species is provided in [Error! Reference source not found.](#) ~~Figure 4~~.

There are no records of listed threatened invertebrate fauna within the project area (DBCA 2021b), but six species in this database have records within 15 km of the site, and an additional two significant species are known (at least historically) in nearby Tantabiddi Well (W. Humphreys unpubl. data). These eight species of interest are (See [Appendix 7](#) ~~Appendix 7~~): *Bamazomus subsolanus* (Eastern Cape Range Bamazomus), *Bamazomus vespertinus* (Western Cape Range Bamazomus), *Draculoides brooksi* (Northern Cape Range Draculoides), *Draculoides julianneae* (Western Cape Range Draculoides), *Stygiochiropus isolatus* (a stygiochiropus millipede), *Stygiochiropus sympatricus* (a stygiochiropus millipede), *Stygiocaris lancifera* (Lance-beaked Cave Shrimp) and *Stygiocaris stylifera* (Spear-beaked Cave Shrimp). Of these, the Eastern Cape Range Bamazomus and Northern Cape Range Draculoides are only known from the eastern side of the Cape Range Peninsula) and are unlikely to occur in the project area (Harvey 2001; Harvey *et al.* 2008). *S. isolatus* is only known from Cameron's Cave and

Loop Cave, both in the vicinity of Exmouth townsite, and is unlikely to be present in the project area on western side of Cape Range (Humphreys and Brooks 2015). *S. sympatricus* is only known from a single cave on the north-western tip of Cape Range (Humphreys and Adams 1993; Shear and Humphreys 1996) and is also probably unlikely to occur within the project area. Therefore, it is the Western Cape Range Bamazomus and the Western Cape Range Draculoides that are most likely to occur in the vicinity of the project area, as well as the Lance-beaked and Spear-beaked Cave Shrimps that are known (at least historically) from Tantabiddi Well.

For the remaining 13 species from DBCA (2021b), the records displayed in [Error! Reference source not found. Figure 1](#) all occur more than 15 km from the project area, and many are restricted to a single location (see [Appendix 7. Appendix 7](#) for details). All but one of these species are not expected to occur in the vicinity of the project area (see [Appendix 7. Appendix 7](#)). *Nocticola flabella* (Cape Range Blind Cockroach) occurs on 'Cape Range' (Roth 1991) and the available locations in the ALA/WAM databases suggest that it occurs centrally along the peninsula (see [Error! Reference source not found. Figure 4](#)). Roth (1991) did not provide a general description of the range of this species so it is included here on a precautionary basis.

Species of greatest interest with respect to the proposed development are those recorded or possibly present in Tantabiddi Sinkhole or nearby, and that are of conservation significance. It should be noted that the ecology and distribution of short-range endemic invertebrates is often poorly understood or documented, and the project area occurs in a region that is remote and likely to be poorly-surveyed for these groups. Thus, there may be undetected SRE species present.

From the information above, six known invertebrate species of listed conservation significance are most likely to occur in the vicinity of the project area:

- Western Cape Range Bamazomus – CS1 (S2);
- Western Cape Range Draculoides – CS1 (S2);
- Cape Range Blind Cockroach – CS2 (P4);
- Lance-beaked Cave Shrimp – CS1 (S3);
- Spear-beaked Cave Shrimp - CS2 (P4) and
- The amphipod *Grandidierella* sp. nov.

Therefore, Tantabiddi Sinkhole has no invertebrate stygofauna of listed conservation significance and just one of 'local significance', but this is likely to reflect lack of sampling.

Other invertebrates returned from databases, including some collected from Tantabiddi Sinkhole, are widespread and not stygofauna. Such species from Tantabiddi Sinkhole include dytiscid beetles (water beetles that fly between wetlands), ants, and a chironomid midge (*Kiefferulus intertinctus*) recorded at several locations across Australia.

Virtually all collection of invertebrates in the Cape Range area appears to have focussed on caves and sinkholes, and collection in general appears to have been limited in the west (W. Humphreys pers. comm.). The limestone escarpment east of the project area may support invertebrates with restricted ranges (Short Range Endemics; SREs), and the low-lying landscape of VSA 4 may also support SREs as

it is locally mesic with a distinctive substrate type. However, both these environments are well-represented within the Cape Range Region.

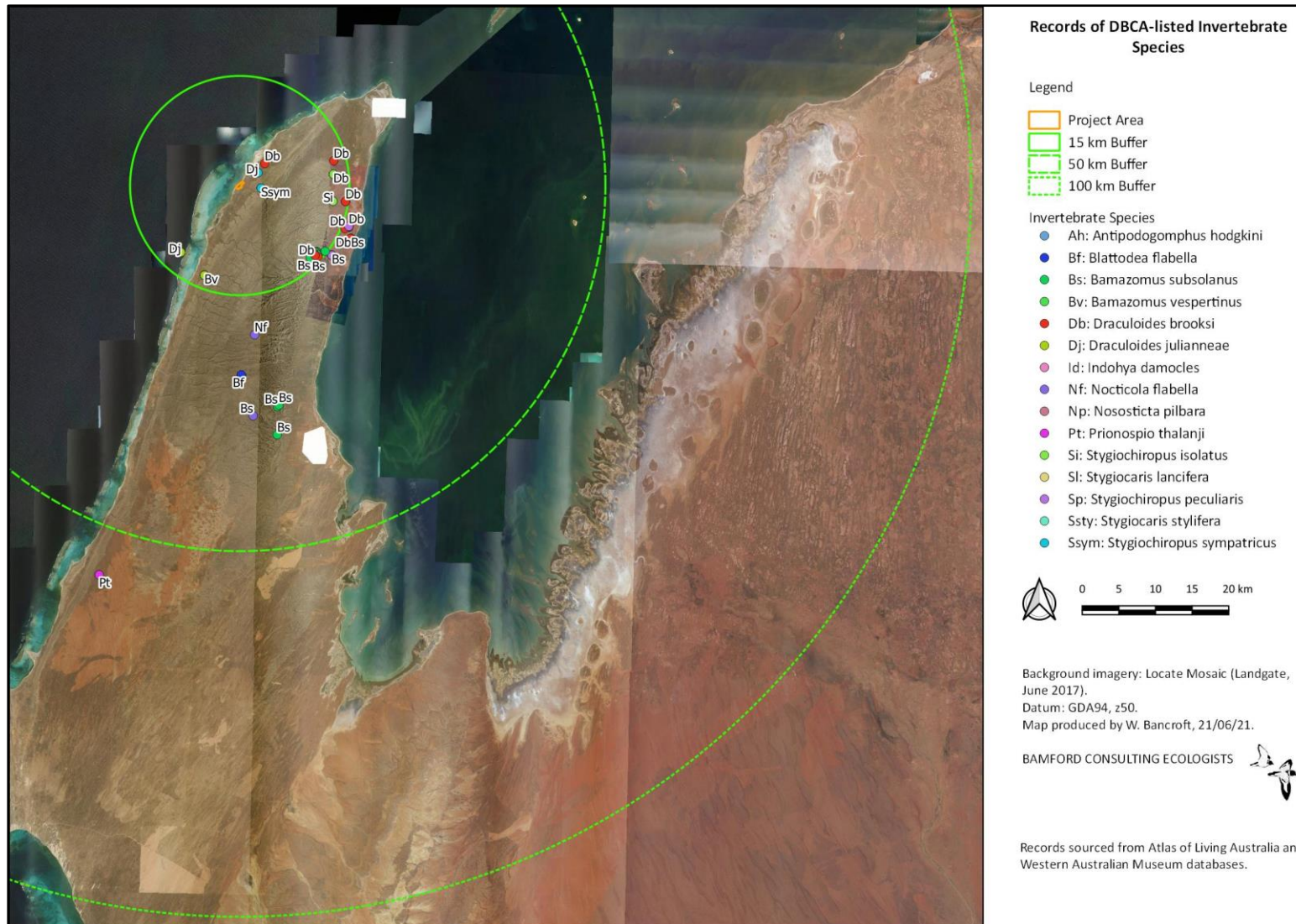


Figure 4. Records of DBCA-listed (threatened or priority) invertebrate species within 100 km of the project area.

3.2.6 *Patterns of biodiversity*

Investigating patterns of biodiversity can be complex and are often beyond the scope even of detailed or targeted investigations (see Section 2.1 above), but it is possible to draw some general conclusions based upon the different landscapes in the project area and on the previous studies that have taken place in area. The following several patterns of biodiversity can be concluded:

- The subterranean environment supports a rich and very distinctive fauna assemblage and while only visible at Tantabiddi Sinkhole, this probably extends beneath at least part of the project area.
- VSA 5 is likely to be richest in fauna as it has the most structurally complex vegetation, spinifex (*Triodia*) and sandy to sandy-loam soils. It also has termite mounds which have been identified as supporting concentrations of reptile species at high densities (Thompson and Thompson 2020).
- Areas of high weed invasion (Buffel Grass), mostly along Yardie Creek Road and in VSA 5, may be low in fauna species richness, although the value of these introduced species as fauna habitat has not been properly investigated.
- VSAs 2 and 3 (foredunes and secondary dunes) may be low in species richness but are the key area for the significant Keeled Slider. They would also be where sea turtles nest (albeit in small numbers).
- VSA4 has distinctive vegetation and substrate, and is likely to provide seasonally moist conditions compared with adjacent VSAs, so may have a distinctive invertebrate assemblage that could include SRE species. The nearby limestone escarpment is also a distinctive and restricted environment but lies outside the project area.
- The small inlet of Tantabiddi Creek provides a small amount of habitat for waterbirds.

3.2.7 *Ecological processes*

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see [Appendix 4](#) ~~Appendix 4~~ for descriptions and other ecological processes). These include the aspects discussed below.

Local hydrology. The project area includes low-lying areas that may be seasonally damp (VSA 4), Tantabiddi Creek flows in from the east (intermittently) and, of particular significance, there is a subterranean aquatic ecosystem that supports a rich stygofauna. This is affected by but not connected to ocean tides. The surface hydrology may also be partly independent of groundwater, at least where heavy clay soils trap surface water. This all makes for a complex hydrological system that is critical for local biodiversity and that is likely to be sensitive to altered flows and spills (discussed below under impacts).

Fire. Native vegetation throughout the project area is subject to fire and while appropriate fire regimes can benefit biodiversity, inappropriate regimes can lead to a loss of biodiversity. There is probably no current managed fire regime.

Feral species and interactions with over-abundant native species. Feral species occur throughout Western Australia and are a major component of the current mammal fauna of the project area. They have contributed to local extinctions and may be affecting populations of extant species. Rabbits were abundant in VSA 3 and both Foxes and Cats are likely to be present. The landscape and vegetation in the project area has probably been altered through grazing by feral species, such as the Rabbit, and by livestock.

Habitat degradation due to weed invasion. Weed invasion has substantially altered some VSAs; most notably Buffel Grass in VSA 5. Soils in other VSAs may be less suitable for this species. Weed invasion can be exacerbated by earthworks and developments (discussed further in Section 4).

Connectivity and landscape patterns

Except for Yardie Creek Road and immediately around the existing boat ramp, the landscape is intact and continuous. Because of the coastal plain position, VSAs tend to be linear and parallel to the coast, as is the inland limestone escarpment. There is therefore likely to be a linear pattern to the local distribution and movements of many fauna species.

3.3 Summary of fauna values

The desktop study identified 363 vertebrate fauna species as potentially occurring in the project area (two subterranean fish, five frogs, 11 reptiles, 165 birds and 25 mammals), with a further 20 species considered to be locally extinct. Many of the species may not occur regularly due to the coastal location of the project area, with a lot of species associated with limestone landscapes slightly further inland. The presence of 46 species (one fish, six reptiles, 36 birds and three mammals) was confirmed during the 2021 site visit. The desktop study also identified a rich assemblage of invertebrate stygofauna for the region, although with only a portion of this likely to be present within or close to the project area.

Fauna assemblage. Moderately intact but with a suite of mammal species locally extinct. The reptile assemblage in particular is rich and distinctive due to the biogeography of the region. The stygofauna is part of a rich and distinctive assemblage.

Species of conservation significance. Of the 51 vertebrate species of conservation significance recorded or that may be present in the project area, only two fish (CS1), four lizards (CS2), the Eastern Osprey (CS1) and the Brush-tailed Mulgara (CS2) are expected to occur as residents. The two fish are almost certainly present in the subterranean environment beneath the project area, while the Eastern Osprey was present during the site inspection, with a nest at the existing boat ramp. One of the four lizard, the Keeled Slider, appeared abundant but probably restricted to VSAs 2 and 3. Mulgara were identified by tracks in sandy soil just east of the project area and should be considered unconfirmed. While 'only' a priority 4 species (ie not listed under legislation), if correct the record is the first for the species in the Cape Range area. While migratory waterbirds are part of the assemblage, they are likely to occur only in very small numbers due to the limited availability of habitat. The project area and Tantabiddi Sinkhole in particular has no recorded invertebrate species of listed conservation significance, but seven significant invertebrates known from Bundera Sinkhole might occur in the

Tantabiddi region, while two additional significant invertebrates known from nearby Tantabiddi Well might be present. The amphipod shrimp *Grandidierella* sp. nov. is known only from Tantabiddi Sinkhole and while not of listed conservation significance, can be assigned the informal 'locally significant' status (Conservation Significance level 3).

Vegetation and Substrate Associations (VSAs). The project area encompasses eight VSAs which reflect landscape position and soil type. All are widespread in the region.

Patterns of biodiversity. The subterranean environment (VSA 7; represented by a surface expression at Tantabiddi Sinkhole) supports a rich and distinctive stygofauna assemblage. VSA 5 is likely to be richest in fauna species due to the soil type, structural complexity of vegetation and presence of termite mounds. Other VSAs may have fewer species but differences in soil and vegetation type mean that there will be difference in species composition between VSAs. For example, the heavy soils of VSA 4 are likely to support different invertebrates and reptiles from adjacent VSAs with sandier soils.

Key ecological processes. The ecological processes that currently have major effects upon the fauna assemblage include hydrology, the presence of feral species, fire, and habitat degradation (due to weeds). Hydrology may be particularly important due to surface drainage patterns and the presence of stygofauna.

4 Discussion - Impact Assessment

Threatening processes have to be considered in the context of fauna values and the nature of the proposed action and are examined below. Context is also important, as the project area is in a largely undisturbed landscape. Impact categories are defined in Table 7. Impact categories are assigned on the assumption of some management.

Based on the desktop review and site inspection, the proposed development can be assessed against a standard suite of threatening processes. This addresses only terrestrial and shoreline impacts. Consequential impacts (such as impacts on marine life from increased numbers of boats and anglers) are not included.

Loss of habitat affecting population survival.

Negligible to Minor

The area of habitat loss is small within the regional context and the environments present are extensive. The development area is outside the known principal nesting areas of sea turtles.

Loss of habitat leading to population fragmentation.

Negligible to Minor

The environments tend to be linear because of the coastal location; for example the white coastal sands (VSAs 2 and 3) form a corridor only 100-200m wide. In theory, the expanded facility could fragment the population of the Priority 4 Keeled Slider *L. planiventralis maryani* which is restricted to these coastal sands, but the population is already fragmented by existing landscape features (such as the tidal creek at the existing boat ramp). Small numbers of lizards should be able to move through the carpark, particularly if areas of the natural landscape are retained within this. For other species, the area of impact is small and unlikely to interfere with movements and no other significant species are known to be confined to this near-coastal strip. The Mulgara were recorded just outside the project area, and were in VSA 5 which is not impacted by development.

Degradation of habitat due to weed invasion leading to population decline.

Minor

This is a concern with several invasive plant species already present (eg. Buffel Grass). The impact of such species is uncertain but may reduce habitat quality. Development and use of the new facility are likely to increase the risk of invasive plant species due to high volumes of tourist traffic coming from other parts of Australia, although this risk already exists and the impact would be very localised. Weed control around the parking area may be required. The issue of weed invasion applies to all public areas along the Ningaloo coast and effective weed control would require a landscape scale approach.

Increased mortality.

Negligible to Minor

The main source of mortality is likely to be roadkill which is linked to traffic volumes, particularly vehicles movements at night. During the site inspection, one Children's Python was found dead on the road between Yardie Caravan Park and Tantabiddi, and there were several Euro skeletons along Yardie Creek Road in the project area. Increased roadkill is a consequence of general increased vehicle movements in the area, rather than specifically related to the upgrade of the Tantabiddi boat ramp, and when common species are affected it is more of an animal welfare issue than a conservation issue.

Species interactions, including predation and competition.Minor

Feral species are present, with the Rabbit and Feral Cat recorded during the site inspection. Rabbits appeared abundant in the near-coastal sands and may be adversely impacting vegetation. Feral Cats could be inadvertently (or even deliberately) encouraged through the provision of food and shelter; they are a known predator of reptiles and small mammals. Foxes may also increase due to human activity. Increased predator activity could put at risk the Brush-tailed Mulgara and possibly even Black-flanked Rock-Wallabies if these were present along the nearby escarpment. Turtle breeding to the north might also be vulnerable to a general increase in Fox (or feral dog) activity in the area. Avoiding an increase in predator activity would require some management of waste and possibly education and signage.

Hydroecology.Minor (with management)

Drainage from the hard surfaces of the parking area may alter local hydroecology and pose a significant potential risk to stygofauna both through changes in where surface water permeates into the ground, and through the risk of contaminants. Increased motor traffic in the area – both vehicular and marine - increases the likelihood of petroleum contamination. Contamination by petroleum products is possible and even a thin oil slick on the pool surfaces would disrupt gaseous surface exchange. Data on lateral flow of dissolved oxygen within the groundwater resulting from tidal fluctuation would provide important information by which to manage any response to pollution events. Chemical control of road verge vegetation may result in contamination of the pools by subsequent run-off and from spray drift, although appropriate seasonal timing may ameliorate the effect of spray drift. It should be possible to manage these impacts through drainage design in the parking area, so that the parking area is effectively bunded and sealed to prevent groundwater contamination. Impact considered Minor assuming effective management.

Fire.Minor

Increased human activity brings with it an increase in the risk of fire. Hummock grasslands are particularly flammable and sensitive to an altered fire regime. The hummock grasslands lie outside the development footprint but are important for a rich reptile assemblage and the apparent presence of the Brush-tailed Mulgara. Fire in hummock grasslands can facilitate the spread of Buffel Grass.

Disturbance: dust, light, noise, vibration and trampling.Minor (with management)

These effects would be very localised. If lighting is present, it needs to be directed away from the coast to avoid affecting turtle hatchlings. Trampling by people moving around the general area may be a concern around Tantabiddi sinkhole, where access may need to be managed. Increased visitation to the site could result in disturbing the pools directly, trampling the surrounding vegetation and resulting in surface erosion and siltation to the sinkholes. However, access to the sinkhole would be an important opportunity for public education on the nature of the landscape, and managed, informed access may be more effective at reducing risk of damage than attempts at exclusion. Exclusion may be necessary during the construction period. Disturbance of wildlife along the coastline was observed several times during the site inspection, with most beaches accessed by people effectively sterilised for wildlife, and with motorised hang-gliders flying along the coast disturbing roosting birds at Mangrove Bay. This sort of disturbance is not directly linked to the Tantabiddi proposal, but shows the need for consideration of impacts of human activities in the broader area.

At Tantabiddi, there appeared to be very little human activity along the adjacent beaches, presumably because people were focussed on boats.

Impacts are generally low, largely because of the small area of the development. Of the threatening processes discussed above, potential impacts on Tantabiddi Sinkhole are of greatest concern, with risks from disturbance and groundwater contamination.

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6 Appendices

6.1 Appendix 1. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation and substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

VSA assessment was made with reference to the key attributes provided by (EPA 2020):

- soil type and characteristics
- extent and type of ground surfaces and landforms
- height, cover and dominant flora within each vegetation stratum
- presence of specific flora or vegetation of known importance to fauna
- evidence of fire history including, where possible, estimates of time since fire
- evidence and degree of other disturbance or threats, e.g. feral species
- presence of microhabitats and significant habitat features, such as coarse woody debris, rocky
- outcrops, tree hollows, water sources and caves
- evidence of potential to support significant fauna
- function of the habitat as a fauna refuge or part of an ecological linkage.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Western Australian Biodiversity Conservation Act 2016* (BC Act). In addition, the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in [Appendix 2](#).

Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN 2012), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The *Wildlife Conservation Act 1950* uses a series of seven Schedules to classify conservation status that largely reflect the IUCN categories (IUCN 2012).

Conservation Significance (CS) 2: Species listed as Priority by DBCA but not listed under State or Commonwealth Acts.

In Western Australia, DBCA has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the *Wildlife Conservation Act 1950* but for which DBCA feels there is cause for concern.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DBCA, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

Marine-listed species

Some conservation significant species may also be listed as 'Marine' under the EPBC Act. This listing protects these species in 'Commonwealth areas' which include "marine areas beyond the coastal waters of each State and the Northern Territory, and includes all of Australia's Exclusive Economic Zone (EEZ)" (DAWE 2020i). The EEZ extends to 200 nautical miles (approximately 350 kilometres) from the coast (DAWE 2020i). This may mean that the 'Marine' listing does not apply to the project/survey area (depending on its location). Therefore, when a species is otherwise protected (under the EPBC Act or BC Act) or priority-listed (by the DBCA) then the Marine listing is also noted but it does not have site-specific relevance. In cases where a species is solely Marine-listed (for a list see DAWE 2020g) and a project/survey area is not within a Commonwealth area then it is treated like all other fauna.

Invertebrates

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined in [Appendix 3](#) are effectively the ecological processes that can be altered to result in impacts upon fauna.

6.2 Appendix 2. Categories used in the assessment of conservation status.

IUCN (International Union for the Conservation of Nature) categories, as outlined by IUCN (2012), and as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the *Western Australian Biodiversity Conservation Act 2016*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (Ex)	Taxa known to survive only in captivity.
Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (E)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (V)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the *WA Biodiversity Conservation Act 2016*

Schedule 1 (S1)	Critically Endangered fauna.
Schedule 2 (S2)	Endangered fauna
Schedule 3 (S3)	Vulnerable Migratory species listed under international treaties.
Schedule 4 (S4)	Presumed extinct fauna
Schedule 5 (S5)	Migratory birds under international agreement
Schedule 6 (S6)	Conservation dependant fauna
Schedule 7 (S7)	Other specially protected fauna

WA DBCA Priority species (species not listed under the *WA Biodiversity Conservation Act 2016*, but for which there is some concern).

Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
	Taxa in need of monitoring.
Priority 4 (P4)	Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).
Priority 5 (P5)	

6.3 Appendix 3. Explanation of threatening processes.

Potential impacts of proposed developments upon fauna values can be related to threatening processes. This is recognised in the literature and under the EPBC Act, in which threatening processes are listed (see [Appendix 4Appendix 4](#)). Processes that may impact fauna values are discussed below. Rather than being independent of one another, processes are complex and often interrelated. They are the mechanisms by which fauna can be affected by development. Impacts may be significant if large numbers of species or large proportions of populations are affected.

Note that the terms direct and indirect impacts are used by the DoE (2013), DSEWPaC (2013b) and EPA (2016a), but there is some inconsistency in how these are defined. The federal guidance does not define direct impact but has a very broad definition of indirect, and makes the statement (DoE 2013) *‘Consideration should be given to all adverse impacts that could reasonably be predicted to follow from the action, whether these impacts are within the control of the person proposing to take the action or not. Indirect impacts will be relevant where they are sufficiently close to the proposed action to be said to be a consequence of the action, and they can reasonably be imputed to be within the contemplation of the person proposing to take the action.’* Indirect impacts therefore can even include what the DoE (2013) calls facilitated impacts, which are the result of third party actions triggered by the primary action. In contrast, the EPA (2016a) defines direct impacts to *‘include the removal, fragmentation or modification of habitat, and mortality or displacement of individuals or populations.’* This document then lists as indirect impacts what in many cases are the consequences of the removal, fragmentation or modification of habitat. For example, *‘disruption of the dispersal of individuals required to colonise new areas inhibiting maintenance of genetic diversity between populations’* is a consequence of habitat fragmentation. Impacts of light, noise and even roadkill are defined as indirect but they are clearly the result of the action and in control of the person taking the action. Roadkill is as direct a form of mortality as can be observed, but it is considered as an indirect impact in the context of a development presumably because it is not directly linked to land clearing. The EPA (2016a) makes a strong distinction between removal of vegetation (direct impact) and the consequences of such clearing and other aspects of a development (indirect impacts). It is not obvious how this distinction between direct and indirect impacts is helpful in the EIA process, as the key aim is to ensure that all impacts that result from a project are addressed in this assessment process. Interestingly, Gleeson and Gleeson (2012), in a major review of impacts of development on wildlife, do not use the terms direct or indirect. In the following outlines of threatening processes that can cause impacts, the emphasis is upon interpreting how a threatening process will cause an impact. For example, loss of habitat (threatening process) can lead to population decline and to population fragmentation, which are two distinct impacts, with population decline considered a direct impact and fragmentation an indirect impact by the EPA (2016a).

Loss of habitat affecting population survival

Clearing for a development can lead to habitat loss for a species with a consequent decline in population size. This may be significant if the smaller population has reduced viability. Conservation significant species or species that already occur at low densities may be particularly sensitive to habitat loss affecting population survival.

Loss of habitat leading to population fragmentation

Loss of habitat can affect population movements by limiting movement of individuals throughout the landscape as a result of fragmentation (Soule *et al.* 2004; Gleeson and Gleeson 2012). Obstructions associated with the development, such as roads, pipes and drainage channels, may also affect movement of small, terrestrial species. Fragmented populations may not be sustainable and may be sensitive to effects such as reduced gene flow.

Degradation of habitat due to weed invasion leading to population decline

Weed invasion, such as through introduction by human boots or vehicle tyres, can occur as a result of development and if this alters habitat quality, can lead to effects similar to habitat loss.

Increased mortality

Increased mortality can occur during project operations; for example from roadkill, animals striking infrastructure and entrapment in trenches. Roadkill as a cause of population decline has been documented for several medium-sized mammals in eastern Australia (Dufty 1989; Jones 2000). Increased mortality due to roadkill is often more prevalent in habitats that have been fragmented (Scheick and Jones 1999; Clevenger and Waltho 2000; Jackson and Griffin 2000).

Increased mortality of common species during development is unavoidable and may not be significant for a population. However, the cumulative impacts of increased mortality of conservation significant species or species that already occur at low densities may have a significant impact on the population.

Species interactions, including predation and competition

Changes in species interactions often occur with development. Introduced species, including the feral Cat, Red Fox and Rabbit may have adverse impacts upon native species and development can alter their abundance. In particular, some mammal species are very sensitive to introduced predators and the decline of many mammals in Australia has been linked to predation by the Red Fox, and to a lesser extent the feral Cat (Burbidge and McKenzie 1989). Introduced grazing species, such as the Rabbit, Goat, Camel and domestic livestock, can also degrade habitats and deplete vegetation that may be a food source for other species.

Changes in the abundance of some native species at the expense of others, due to the provision of fresh watering points, can also be a concern. Harrington (2002) found the presence of artificial fresh waterpoints in the semi-arid mallee rangelands to influence the abundance and distribution of certain bird species. Common, water-dependent birds were found to out-compete some less common, water-independent species. Similarly, Read *et al.* (2015) found a decline in some bird species but an increase in others in the vicinity of active mines and concluded this was due to the mine attracting large and aggressive species that displaced other species. Over-abundant native herbivores, such as kangaroos, can also adversely affect less abundant native species through competition and displacement.

Hydroecology

Interruptions of hydroecological processes can have major effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Fauna may be impacted by potential changes to groundwater level and chemistry and

altered flow regime. These changes may alter vegetation across large areas and may lead to habitat degradation or loss. Impacts upon fauna can be widespread and major.

Changes to flow regime across the landscape may alter vegetation and may lead to habitat degradation or loss, affecting fauna. For example, Mulga has a shallow root system and relies on surface sheet flow during flood events. If surface sheet flow is impeded, Mulga can die (Kofoed 1998), which may impact on a range of fauna associated with this vegetation type.

Fire

The role of fire in the Australian environment and its importance to vertebrate fauna has been widely acknowledged (Gill *et al.* 1981; Fox 1982; Letnic *et al.* 2004). It is also one of the factors that has contributed to the decline and local extinction of some mammal and bird species (Burbidge and McKenzie 1989). Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Changes in fire regime, whether to more frequent or less frequent fires, may be significant to some fauna. Impacts of severe fire may be devastating to species already occurring at low densities or to species requiring long unburnt habitats to survive. In terms of conservation management, it is not fire *per se* but the fire regime that is important, with evidence that infrequent, extensive and intense fires adversely affect biodiversity, whereas frequent fires that cover small areas and are variable in both season and intensity can enhance biodiversity. Fire management may be considered the responsibility of managers of large tracts of land, including managers of mining tenements.

Dust, light, noise and vibration

Impacts of dust, light, noise and vibration upon fauna are difficult to predict. Some studies have demonstrated the impact of artificial night lighting on fauna, with lighting affecting fauna behaviour more than noise (Rich and Longcore 2006). Effects can include impacts on predator-prey interactions, changes to mating and nesting behaviour, and increased competition and predation within and between invertebrates, frogs, birds and mammals.

The death of very large numbers of insects has been observed around some remote mine sites and attracts other fauna, notably native and introduced predators (M. Bamford pers. obs). The abundance of some insects can decline due to mortality around lights, although this has previously been recorded in fragmented landscapes where populations are already under stress (Rich and Longcore 2006). Artificial night lighting may also lead to disorientation of migratory birds. Aquatic habitats and open habitats such as grasslands and dunes may be vulnerable to light spill.

6.4 Appendix 4. Ecological and threatening processes identified under legislation and in the literature.

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

Ecological processes relevant to the conservation of biodiversity in Australia (Soule *et al.* 2004):

- Critical species interactions (highly interactive species);
- Long distance biological movement;
- Disturbance at local and regional scales;
- Global climate change;
- Hydroecology;
- Coastal zone fluxes;
- Spatially-dependent evolutionary processes (range expansion and gene flow); and
- Geographic and temporal variation of plant productivity across Australia.

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 20 key threatening processes listed by the federal Department of the Environment (DotE 2014b):

- Competition and land degradation by rabbits.
- Competition and land degradation by unmanaged goats.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*).
- Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South.
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations.
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.
- Invasion of northern Australia by Gamba Grass and other introduced grasses.
- Land clearance.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean.
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.
- Novel biota and their impact on biodiversity.
- Predation by European red fox.
- Predation by exotic rats on Australian offshore islands of less than 1000 km² (100,000 ha).
- Predation by feral cats.
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs.
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*).
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant).

General processes that threaten biodiversity across Australia (The National Land and Water Resources Audit):

- Vegetation clearing;
- Increasing fragmentation, loss of remnants and lack of recruitment;
- Firewood collection;
- Grazing pressure;
- Feral animals;
- Exotic weeds;
- Changed fire regimes;
- Pathogens;
- Changed hydrology—dryland salinity and salt water intrusion;
- Changed hydrology— such as altered flow regimes affecting riparian vegetation; and
- Pollution.

In addition to the above processes, the federal Department of Agriculture, Water and the Environment (DAWE) produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

- Will the proposed action lead to a long-term decrease in the size of a population?
- Will the proposed action reduce the area of occupancy of the species?
- Will the proposed action fragment an existing population?
- Will the proposed action adversely affect habitat critical to the survival of a species?
- Will the proposed action disrupt the breeding cycle of a population?
- Will the proposed action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
- Will the proposed action result in introducing invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?
- Will the proposed action introduce disease that may cause the species to decline?
- Will the proposed action interfere with the recovery of the species?

6.5 Appendix 5. Vertebrate fauna expected to occur in the project area.

The list is derived from the results of database and literature searches, and from previous field surveys conducted in the local area. The sources are: ALA = Atlas of Living Australia database search; NM = NatureMap database; EPBC = EPBC Protected Matters search engine; BCE (2005) = Bancroft and Bamford (2005a);

EPBC Act listings: Cr = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory (see [Appendix 2Appendix 2](#)).

Wildlife Conservation Act 1950 listings: S1 to S7 = Schedules 1 to 7 (see [Appendix 2Appendix 2](#)). CD = conservation dependent.

DBCAs Priority species: P1 to P4 = Priority 1 to 4 (see [Appendix 2Appendix 2](#)).

Int = introduced species. LEx = locally extinct. Ex = species is extinct.

See Section [2.4.42-2.4](#) for explanation of expected occurrence categories.

Fish											
Family	Species	Common name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
MYOBATRACHIDAE	<i>Milyeringa veritas</i>	Blind Cave Gudgeon	X		X				S3 (V)	V	Resident
	<i>Ophisternon candidum</i>	Blind Cave Eel			X				S3 (V)	V	Resident

Frogs											
Family	Species	Common name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
MYOBATRACHIDAE	<i>Pseudophryne douglasi</i>	Douglas's Toadlet		X				X			Resident
	<i>Neobatrachus fulvus</i>	Tawny Frog		X	X			X			Resident
	<i>Neobatrachus sutor</i>	Shoemaker Frog						X			Resident
HYLIDAE	<i>Cyclorana maini</i>	Main's Frog		X	X			X			Resident
	<i>Litoria caerulea</i>	Green Tree Frog		X							Vagrant
Total species expected: 5				Conservation significant species: nil					0	0	

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Reptiles											
Family	Species	Common name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
CHELONIIDAE	<i>Chelonia mydas</i>	Green Turtle		X	X	X			S3 (V)	V,M	Irregular visitor
	<i>Caretta caretta</i>	Loggerhead Turtle				X			S2 (E)	E,M	Irregular visitor
	<i>Eretmochelys imbricata</i>	Hawksbill Turtle				X			S2 (E)	E,M	Irregular visitor
	<i>Natator depressus</i>	Flathead Turtle				X			S3 (V)	V,M	Irregular visitor
	<i>Dermochelys coriacea</i>	Leatherback Turtle				X			S2 (E)	E,M	Vagrant
DIPODACTYLIDAE	<i>Crenadactylus tuberculatus</i>	Cape Range Clawless Gecko		X							Resident
	<i>Diplodactylus capensis</i>	Cape Range Stone Gecko		X	X				P2		Resident
	<i>Diplodactylus bilybara</i>	Western Fat-tailed Gecko		X			X				Resident
	<i>Diplodactylus mitchelli</i>	Pilbara Stone Gecko						X			Resident
	<i>Lucasium stenodactylum</i>	Crowned Gecko		X			X	X			Resident
	<i>Strophurus strophurus</i>	Western Spiny-tailed Gecko		X	X		X	X			Resident
	<i>Strophurus jeanae</i>	Southern Phasmid Gecko		X				X			Resident
	<i>Strophurus elderi</i>	Jewelled Gecko		X	X			X			Resident
	<i>Strophurus ciliaris aberrans</i>	Northern Spiny-tailed Gecko		X	X		X	X			Resident
	<i>Strophurus rankini</i>				X			X			Resident

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Reptiles											
Family	Species	Common name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
CARPHODACTYLIDAE	<i>Nephrurus levis</i>	Three-lined Knob-Tail		X			X	X			Resident
GEKKONIDAE	<i>Gehyra variegata</i>	Tree Dtella		X	X		X				Resident
	<i>Gehyra capensis</i>	North West Cape Gehyra		X			X				Resident
	<i>*Hemidactylus frenatus</i>	House Gecko	X	X							Irregular visitor
	<i>Heteronotia binoei</i>	Bynoe's Gecko		X	X			X			Resident
PYGOPODIDAE	<i>Aprasia rostrata</i>	Ningaloo worm lizard			X		x				Resident
	<i>Lialis burtonis</i>	Burton's Snake-Lizard		X	X		X	X			Resident
	<i>Delma australis</i>			X			X	X			Resident
	<i>Delma nasuta</i>				X		X				Resident
	<i>Delma pax</i>							X			Resident
	<i>Delma tealei</i>	Marble-Faced Delma		X	X						Resident
	<i>Delma tincta</i>			X	X						Resident
	<i>Delma australis</i>										Resident
	<i>Pygopus nigriceps</i>	Hooded Scaly-foot			X		X	X			Resident
SCINCIDAE	<i>Carlia munda</i>				X		X	X			Resident
	<i>Cryptoblepharus plagiocephalus</i>	Snake-Eyed Skink		X	X		X	X			Resident
	<i>Ctentotus duricola</i>						X				Resident
	<i>Ctentotus hanloni</i>				X		X				Resident
	<i>Ctentotus rufescens</i>				X		X				Resident
	<i>Ctenotus robustus</i>	Robust Ctenotus		X							Resident
	<i>Ctenotus saxatilis</i>				X		X	X			Resident
	<i>Ctenotus serventyi</i>							X			Resident

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Reptiles											
Family	Species	Common name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
	<i>Ctenotus pantherinus</i>	Leopard Ctenotus	X	X	X		X	X			Resident
	<i>Ctenotus inornatus</i>	Bar-shouldered Ctenotus		X							Resident
	<i>Ctenotus iapetus</i>	North West Cape Ctenotus		X	X		X	X			Resident
	<i>Ctenotus schomburgkii</i>						X	X			Resident
	<i>Ctenotus grandis</i>	Grand Ctenotus		X	X		X	X			Resident
	<i>Cyclodomorphus melanops</i>	Spinifex Slender Blue-Tongue		X	X		X	X			Resident
	<i>Eremiascincus pallidus</i>	Western Narrow-Banded Skink		X	X						Resident
	<i>Eremiascincus fasciolatus</i>						X	X			Resident
	<i>Eremiascincus isolepis</i>	Northern Bar-lipped Skink		X				X			Resident
	<i>Eremiascincus richardsonii</i>	Broad-banded Sand Swimmer			X			X			Resident
	<i>Lerista planiventralis maryani</i>	Keeled Slider	X	X				X	P1		Resident
	<i>Lerista macropisthopus</i>	Unpatterned Robust Slider		X	X		X	X			Resident
	<i>Lerista lineopunctulata</i>	Dotted-line Robust Slider		X	X		X	X			Resident
	<i>Lerista elegans</i>	Elegant Slider		X	X		X	X			Resident

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Reptiles											
Family	Species	Common name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
	<i>Lerista connivens</i>	Blinking Broad-blazed Slider		X							Resident
	<i>Lerista clara</i>	Sharp-blazed Three-toed Slider		X	X						Resident
	<i>Lerista bipes</i>	North-Western Sandslider		X	X			X			Resident
	<i>Lerista allochira</i>	Cape Range Slider		X	X			X	P3		Resident
	<i>Lerista muelleri</i>						X	X			Resident
	<i>Lerista miopus</i>				X						Resident
	<i>Lerista praepedita</i>						X	X			Resident
	<i>Lerista uniduo</i>						X	X			Resident
	<i>Menetia surda</i>	Western Dwarf Skink		X	X		X	X			Resident
	<i>Menetia greyii</i>	Common Dwarf Skink		X	X		X	X			Resident
	<i>Morethia ruficauda exquisita</i>	Lined Firetail Skink		X	X		X	X			Resident
	<i>Morethia lineocellata</i>				X		X				Resident
	<i>Notoscincus ornatus ornatus</i>				X		X	X			Resident
	<i>Proablepharus reginae</i>	Western Soil-crevice Skink		X							Resident
	<i>Tiliqua multifasciata</i>	Central Bluetongue			X		X	X			Resident
AGAMIDAE	<i>Ctenophorus rubens</i>	Reddening Sand-Dragon		X							Resident
	<i>Ctenophorus reticulatus</i>	Western Netted Dragon		X	X			X			Resident

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Reptiles											
Family	Species	Common name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
	<i>Ctenophorus parviceps</i>	Gnaraloo Heath Dragon		X							Resident
	<i>Ctenophorus nuchalis</i>	Central Netted Dragon		X	X		X				Resident
	<i>Ctenophorus maculatus</i>	Spotted Military Dragon		X							Resident
	<i>Ctenophorus isolepis</i>	Central Military Dragon	X	X	X		X	X			Resident
	<i>Ctenophorus clayi</i>						X	X			Resident
	<i>Ctenophorus femoralis</i>				X		X	X			Resident
	<i>Gowidon longirostris</i>	Long-nosed Dragon	X	X	X		X	X			Resident
	<i>Lophognathus gilberti</i>	Gilbert's Dragon		X	X			X			Resident
	<i>Moloch horridus</i>	Thorny Devil		X			X	X			Resident
	<i>Pogona minor</i>	Dwarf Bearded Dragon		X	X		X	X			Resident
VARANIDAE	<i>Varanus tristis</i>	Black-headed Monitor		X	X			X			Resident
	<i>Varanus gouldii</i>	Gould's Goanna		X			X	X			Resident
	<i>Varanus giganteus</i>	Perentie		X	X		X	X			Resident
	<i>Varanus acanthurus</i>	Ridge-tailed Monitor		X	X		X	X			Resident
	<i>Varanus brevicauda</i>	Short-tailed Pygmy Monitor			X						Resident
	<i>Varanus eremius</i>						X	X			Resident
TYPHLOPIDAE	<i>Anilius ammodytes</i>							X			Resident
	<i>Anilius grypus</i>	Beaked Blind Snake		X				X			Resident

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Reptiles											
Family	Species	Common name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
	<i>Anilius hamatus</i>							X			Resident
	<i>Anilius splendidus</i>							X			Resident
	<i>Anilius</i> sp. 'Cape Range'								P1		Resident
BOIDAE	<i>Antaresia childreni</i>	Children's Python	X	X	X		X	X			Resident
	<i>Antaresia perthensis</i>	Pygmy Python			X			X			Resident
	<i>Aspidites melanocephalus</i>	Black-headed Python			X			X			Resident
ELAPIDAE	<i>Acanthophis wellsei</i>	Pilbara Death Adder		X	X			X			Resident
	<i>Brachyurophis approximans</i>	North-Western Shovel-nosed Snake		X	X			X			Resident
	<i>Demansia calodera</i>	Black-necked Whipsnake		X	X						Resident
	<i>Demansia psammophis cupreiceps</i>				X			X			Resident
	<i>Furina ornata</i>	Orange-naped Snake		X	X			X			Resident
	<i>Pseudechis australis</i>	King Brown Snake		X	X		X	X			Resident
	<i>Pseudonaja modesta</i>	Ringed Brown Snake		X	X			X			Resident
	<i>Pseudonaja mengdeni</i>	Western Brown Snake		X	X						Resident
	<i>Pseudonaja nuchalis</i>	Gwarder						X			Resident
	<i>Simoselaps bertholdi</i>	Jan's Banded Snake		X	X		X	X			Resident
	<i>Simoselaps littoralis</i>	West-coast Banded Snake		X	X			X			Resident
	<i>Suta fasciata</i>	Rosen's Snake		X				X			Resident
	<i>Suta punctulata</i>	Spotted Snake						X			Resident

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Reptiles												
Family	Species	Common name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area	
	<i>Hydrophis ornatus</i>	Ornate Reef Sea snake			X						Irregular visitor	
	<i>Aipysurus apraefrontalis</i>	Short-nosed Seasnake				X			S1 (Cr)	Cr	Irregular visitor	
	<i>Aipysurus duboisii</i>	Dubois Seasnake				X					Irregular visitor	
	<i>Aipysurus eydouxii</i>	Spine-tailed Seasnake				X					Irregular visitor	
	<i>Aipysurus laevis</i>	Olive Seasnake				X					Irregular visitor	
	<i>Astrotia stokesii</i>	Stokes' Seasnake				X					Irregular visitor	
Total species expected: 111 ; One species introduced (House Gecko). Conservation significant species: 10									10	6		

Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
CASUARIIDAE	<i>Dromaius novaehollandiae</i>	Emu		X		X		X	X			Regular visitor
PHASIANIDAE	<i>Synoicus ypsilophora</i>	Brown Quail		X	X	X			X			Regular visitor
	<i>Coturnix pectoralis</i>	Stubble Quail		X								Regular visitor
TURNICIDAE	<i>Turnix velox</i>	Little Button-quail	X	X	X	X		X	X			Resident
DIOMEDEIDAE	<i>Thalassarche carteri</i>	Indian Yellow-nosed Albatross		X								Vagrant
PROCELLARIIDAE	<i>Ardenna pacifica</i>	Wedge-tailed Shearwater		X	X	X						Vagrant

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Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Puffinus huttoni</i>	Hutton's Shearwater		X	X							Vagrant
	<i>Pterodroma mollis</i>	Soft-plumed Petrel				X						Vagrant
OCEANITIDAE	<i>Oceanites oceanicus</i>	Wilson's Storm-Petrel		X	X							Vagrant
PELEICANIDAE	<i>Pelecanus conspicillatus</i>	Australian Pelican		X	X	X						Irregular visitor
SULIDAE	<i>Morus serrator</i>	Australasian Gannet		X								Vagrant
	<i>Sula leucogaster</i>	Brown Booby			X							Vagrant
FREGATIDAE	<i>Fregata ariel</i>	Lesser Frigatebird		X	X		X		X	S5 (M)	M	Irregular visitor
PHAETHONTIDAE	<i>Phaethon rubricauda</i>	Red-tailed Tropicbird		X	X	X				P4		Vagrant
	<i>Phaethon lepturus</i>	White-tailed Tropicbird		X								Vagrant
ANHINGIDAE	<i>Anhinga novaehollandiae</i>	Australasian Darter		X	X							Irregular visitor
PHALACROCORACIDAE	<i>Microcarbo melanoleucos</i>	Little Pied Cormorant		X	X							Regular visitor
	<i>Phalacrocorax carbo</i>	Great Cormorant		X	X							Regular visitor
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant		X	X	X						Regular visitor
	<i>Phalacrocorax varius</i>	Pied Cormorant	X	X	X	X						Regular visitor
PODICIPEDIDAE	<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe		X	X							Irregular visitor
	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe		X	X	X						Irregular visitor

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Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
ANATIDAE	<i>Aythya australis</i>	Hardhead		X	X	X						Vagrant
	<i>Anas superciliosa</i>	Pacific Black Duck		X	X	X						Irregular visitor
	<i>Anas gracilis</i>	Grey Teal	X	X	X	X						Irregular visitor
	<i>Cygnus atratus</i>	Black Swan		X								Irregular visitor
	<i>Chenonetta jubata</i>	Australian Wood Duck		X	X	X						Irregular visitor
RALLIDAE	<i>Hypotaenidia philippensis</i>	Buff-banded Rail		X		X						Irregular visitor
	<i>Fulica atra</i>	Eurasian Coot		X	X	X						Irregular visitor
	<i>Porzana fluminea</i>	Australian Spotted Crake		X	X	X						Irregular visitor
	<i>Tribonyx ventralis</i>	Black-tailed Native-hen		X	X	X						Irregular visitor
ARDEIDAE	<i>Nycticorax caledonicus</i>	Nankeen Night-Heron		X	X	X						Irregular visitor
	<i>Bubulcus ibis</i>	Cattle Egret		X	X	X						Irregular visitor
	<i>Egretta novaehollandiae</i>	White-faced Heron		X		X						Irregular visitor
	<i>Butorides striata</i>	Striated Heron		X								Regular visitor
	<i>Ardea pacifica</i>	White-necked Heron		X								Irregular visitor
	<i>Ardea intermedia</i>	Intermediate Egret		X								Irregular visitor
	<i>Egretta garzetta</i>	Little Egret		X								Irregular visitor

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Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Ardea Modesta</i>	Eastern Great Egret	X	X	X	X						Irregular visitor
	<i>Egretta sacra</i>	Eastern Reef Egret	X	X		X		X	X			Regular visitor
THRESKIORNITHIDAE	<i>Threskiornis spinicollis</i>	Straw-necked Ibis		X	X	X						Irregular visitor
	<i>Platalea regia</i>	Royal Spoonbill		X	X	X						Irregular visitor
	<i>Platalea flavipes</i>	Yellow-billed Spoonbill		X								Irregular visitor
	<i>Threskiornis moluccus</i>	Australian White Ibis		X	X							Irregular visitor
CICONIIDAE	<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork		X		X						Vagrant
OTIDIDAE	<i>Ardeotis australis</i>	Australian Bustard		X	X	X		X	X			Regular visitor
SCOLOPACIDAE	<i>Limosa limosa</i>	Black-tailed Godwit		X	X					S5 (M)	M	Regular visitor
	<i>Limosa lapponica</i>	Bar-tailed Godwit		X	X	X	X		X	S1 (Cr) S5 (M)	Cr, M	Regular visitor
	<i>Numenius madagascariensis</i>	Eastern Curlew		X	X		X		X	S1 (Cr) S5 (M)	Cr, M	Regular visitor
	<i>Calidris ferruginea</i>	Curlew Sandpiper		X			X		X	S1 (Cr) S5 (M)	Cr, M	Regular visitor
	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper		X	X	X	X		X	S5 (M)	M	Regular visitor
	<i>Actitis hypoleucos</i>	Common Sandpiper		X	X	X	X			S5 (M)	M	Regular visitor
	<i>Numenius minutus</i>	Little Curlew		X	X	X				S5 (M)	M	Irregular visitor

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Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Tringa stagnatilis</i>	Marsh Sandpiper		X		X				S5 (M)	M	Regular visitor
	<i>Tringa glareola</i>	Wood Sandpiper		X	X	X				S5 (M)	M	Regular visitor
	<i>Calidris falcinellus</i>	Broad-billed Sandpiper		X						S5 (M)	M	Irregular visitor
	<i>Xenus cinereus</i>	Terek Sandpiper		X						S5 (M)	M	Regular visitor
	<i>Tringa nebularia</i>	Common Greenshank		X	X	X	X		X	S5 (M)	M	Regular visitor
	<i>Calidris subminuta</i>	Long-toed Stint		X	X	X				S5 (M)	M	Vagrant
	<i>Calidris alba</i>	Sanderling		X	X	X				S5 (M)	M	Regular visitor
	<i>Tringa brevipes</i>	Grey-tailed Tattler		X	X	X				S5 (M)	M	Regular visitor
	<i>Numenius phaeopus</i>	Whimbrel		X	X	X				S5 (M)	M	Regular visitor
	<i>Arenaria interpres</i>	Ruddy Turnstone		X	X	X				S5 (M)	M	Regular visitor
	<i>Calidris ruficollis</i>	Red-necked Stint		X	X	X				S5 (M)	M	Regular visitor
	<i>Calidris tenuirostris</i>	Great Knot		X						S1 (Cr) S5 (M)	M	Regular visitor
	<i>Calidris canutus</i>	Red Knot					X			S2 (E) S5 (M)	E, M	Regular visitor
GLAREOLIDADAЕ	<i>Glareola maldivarum</i>	Oriental Pratincole		X	X	X	X		X	S5 (M)	M	Irregular visitor
ROSTRATULIDAE	<i>Rostratula australis</i>	Australian Painted-snipe					X			S2 (E)	E	Vagrant
BURHINIDAE	<i>Burhinus grallarius</i>	Bush Stone-curlew		X	X				X			Regular visitor

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Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Esacus magnirostris</i>	Beach Stone-curlew		X	X							Regular visitor
HAEMATOPODIDAE	<i>Haematopus fuliginosus</i>	Sooty Oystercatcher		X	X	X						Regular visitor
	<i>Haematopus longirostris</i>	Australian Pied Oystercatcher		X	X	X		X	X			Regular visitor
CHARADRIIDAE	<i>Euseyornis melanops</i>	Black-fronted Dotterel		X	X	X						Regular visitor
	<i>Vanellus tricolor</i>	Banded Lapwing		X	X	X						Regular visitor
	<i>Vanellus miles</i>	Masked Lapwing			X							Vagrant
	<i>Erythronyx cinctus</i>	Red-kneed Dotterel		X	X	X						Regular visitor
	<i>Pluvialis fulva</i>	Pacific Golden Plover		X						S5 (M)	M	Regular visitor
	<i>Charadrius australis</i>	Inland Dotterel			X							Irregular visitor
	<i>Charadrius leschenaultii</i>	Greater Sand Plover	X	X	X			X	X	S5 (M)	M	Regular visitor
	<i>Charadrius veredus</i>	Oriental Plover		X			X		X	S5 (M)	M	Irregular visitor
	<i>Pluvialis squatarola</i>	Grey Plover		X	X	X				S5 (M)	M	Regular visitor
	<i>Charadrius mongolus</i>	Lesser Sand Plover		X	X	X				S2 (E) S5 (M)	M,E	Regular visitor
	<i>Charadrius ruficapillus</i>	Red-capped Plover	X	X	X	X						Regular visitor
RECURVIROSTRIDAE	<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet		X								Irregular visitor
	<i>Cladorhynchus leucocephalus</i>	Banded Stilt		X								Irregular visitor

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Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Himantopus leucocephalus</i>	Black-winged Stilt		X		X						Regular visitor
LARIDAE	<i>Gelochelidon macrotarsa</i>	Australian Gull-billed Tern		X								Regular visitor
	<i>Sterna hirundo</i>	Common Tern		X						S5 (M)	M	Regular visitor
	<i>Hydroprogne caspia</i>	Caspian Tern	X	X	X	X		X	X	S5 (M)	M	Regular visitor
	<i>Sternula nereis</i>	Fairy Tern		X	X		X			S3 (V)	V	Regular visitor
	<i>Chlidonias leucopterus</i>	White-winged Black Tern		X	X	X				S5 (M)	M	Regular visitor
	<i>Sternula albifrons</i>	Little Tern		X	X	X				S5 (M)	M	Regular visitor
	<i>Sterna dougallii</i>	Roseate Tern		X	X	X				S5 (M)	M	Regular visitor
	<i>Thalasseus bergii</i>	Crested Tern	X	X	X	X				S5 (M)	M	Regular visitor
	<i>Onychoprion fuscatus</i>	Sooty Tern		X	X							Vagrant
	<i>Onychoprion anaethetus</i>	Bridled Tern		X	X							Regular visitor
	<i>Chlidonias hybrida</i>	Whiskered Tern		X	X							Regular visitor
	<i>Thalasseus bengalensis</i>	Lesser Crested Tern	X	X	X							Regular visitor
	<i>Larus pacificus</i>	Pacific Gull		X	X							Irregular visitor
	<i>Chroicocephalus novaehollandiae</i>	Silver Gull	X	X	X			X	X			Resident
	<i>Anous stolidus</i>	Common Noddy		X	X	X	X		X	S5 (M)	M	Irregular visitor

OFFICIAL

Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
ACCIPITRIDAE	<i>Pandion cristatus</i>	Eastern Osprey	X	X	X	X	X	X	X	S5 (M)	M	Resident
	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	X	X	X	X			X			Resident
	<i>Hieraaetus morphnoides</i>	Little Eagle	X	X	X	X			X			Regular visitor
	<i>Aquila audax</i>	Wedge-tailed Eagle		X	X	X		X	X			Regular visitor
	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk		X	X	X			X			Regular visitor
	<i>Haliastur indus</i>	Brahminy Kite		X	X	X			X			Regular visitor
	<i>Milvus Mrans</i>	Black Kite		X	X	X			X			Irregular visitor
	<i>Haliastur sphenurus</i>	Whistling Kite	X	X	X	X						Resident
	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard		X	X	X			X			Irregular visitor
	<i>Circus assimilis</i>	Spotted Harrier	X	X	X	X		X	X			Regular visitor
	<i>Accipiter fasciatus</i>	Brown Goshawk		X	X	X		X	X			Regular visitor
	<i>Elanus axillaris</i>	Black-shouldered Kite		X	X			X	X			Regular visitor
		Letter-winged Kite										Vagrant
	<i>Lophoictinia isura</i>	Square-tailed Kite		X	X							Irregular visitor
	<i>Circus approximans</i>	Swamp Harrier		X	X							Vagrant
FALCONIDAE	<i>Falco cenchroides</i>	Nankeen Kestrel	X	X	X	X		X	X			Resident
	<i>Falco peregrinus</i>	Peregrine Falcon		X	X	X		X	X	S7		Regular visitor

OFFICIAL

Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Falco longipennis</i>	Australian Hobby		X	X	X			X			Regular visitor
	<i>Falco hypoleucos</i>	Grey Falcon		X			X			V	V	Vagrant
	<i>Falco subniger</i>	Black Falcon			X							Vagrant
	<i>Falco berigora</i>	Brown Falcon		X	X	X		X	X			Regular visitor
COLUMBIDAE	<i>Geophaps plumifera</i>	Spinifex Pigeon		X	X	X		X	X			Regular visitor
	<i>Ocyphaps lophotes</i>	Crested Pigeon	X	X		X		X	X			Regular visitor
	<i>Geopelia cuneata</i>	Diamond Dove		X	X	X			X			Regular visitor
	<i>Geopelia humeralis</i>	Bar-shouldered Dove		X	X	X			X			Regular visitor
	<i>Geopelia placida</i>	Peaceful Dove	X	X	X				X			Regular visitor
	<i>Columba livia</i>	Rock Dove		X	X	X						Irregular visitor
	<i>Streptopelia senegalensis</i>	Laughing Dove		X	X	X	Int					Irregular visitor
	<i>Phaps chalcoptera</i>	Common Bronzewing		X	X	X						Regular visitor
PSITTACIDAE	<i>Pezoporus occidentalis</i>	Night Parrot					X		X	Cr	E	Vagrant
	<i>Cacatua sanguinea</i>	Little Corella	X	X	X	X		X	X			Regular visitor
	<i>Barnardius zonarius</i>	Australian Ringneck	X	X	X	X		X	X			Regular visitor
	<i>Melopsittacus undulatus</i>	Budgerigar		X	X	X		X	X			Regular visitor
CACATUIDAE	<i>Nymphicus hollandicus</i>	Cockatiel		X	X	X			X			Regular visitor

OFFICIAL

Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Eolophus roseicapilla</i>	Galah	X	X	X			X	X			Resident
	<i>Calyptorhynchus banksii</i>	Red-Tailed Black Cockatoo			X							Irregular visitor
CUCULIDAE	<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo		X	X			X	X			Regular visitor
	<i>Heteroscenes pallidus</i>	Pallid Cuckoo	X	X		X			X			Regular visitor
	<i>Chalcites osculans</i>	Black-eared Cuckoo		X	X				X			Regular visitor
CENTROPODIDAE	<i>Centropus phasianinus</i>	Pheasant Coucal		X	X	X						Regular visitor
STRIGIDAE	<i>Ninox connivens</i>	Barking Owl		X		X						Irregular visitor
	<i>Ninox boobook</i>	Southern Boobook		X								Regular visitor
TYTONIDAE	<i>Tyto alba</i>	Barn Owl		X	X				X			Regular visitor
PODARGIDAE	<i>Podargus strigoides</i>	Tawny Frogmouth		X	X	X		X	X			Regular visitor
CAPRIMULGIDAE	<i>Eurostopodus argus</i>	Spotted Nightjar		X	X			X	X			Regular visitor
AEGOTHELIDAE	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar		X		X			X			Regular visitor
APODIDAE	<i>Apus pacificus</i>	Fork-tailed swift							X	S5 (M)	M	Irregular visitor
HALCYONIDAE	<i>Todiramphus sanctus</i>	Sacred Kingfisher		X	X	X		X	X			Regular visitor
	<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher		X		X		X	X			Regular visitor
	<i>Todiramphus chloris</i>	Collared Kingfisher		X	X	X			X			Irregular visitor

OFFICIAL

Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Dacelo leachii</i>	Blue-winged Kookaburra		X								Regular visitor
MEROPIDAE	<i>Merops ornatus</i>	Rainbow Bee-eater		X	X	X						Regular visitor
MALURIDAE	<i>Malurus lamberti</i>	Variiegated Fairy-wren		X	X	X		X	X			Resident
	<i>Malurus leucopterus</i>	White-winged Fairy-wren	X	X	X	X		X	X			Resident
	<i>Stipiturus ruficeps</i>	Rufous-crowned Emu-wren		X	X	X		X	X			Regular visitor
	<i>Amytornis striatus</i>	Striated Grasswren		X	X				X			locally extinct
PARDALOTIDAE	<i>Pardalotus rubricatus</i>	Red-browed Pardalote		X	X	X			X			Regular visitor
	<i>Pardalotus striatus</i>	Striated Pardalote		X	X	X			X			Regular visitor
ACANTHIZIDAE	<i>Gerygone fusca</i>	Western Gerygone		X	X	X			X			Irregular visitor
	<i>Gerygone tenebrosa</i>	Dusky Gerygone		X	X	X						Irregular visitor
	<i>Smicronis brevirostris</i>	Weebill		X	X	X			X			Regular visitor
	<i>Pyrrholaemus brunneus</i>	Redthroat	X	X	X	X			X			Irregular visitor
	<i>Calamanthus campestris</i>	Rufous Fieldwren		X	X	X		X	X			Resident
NEOSITTIDAE	<i>Daphoenositta (Neositta) chrysoptera</i>	Varied Sittella			X							Irregular visitor
MELIPHAGIDAE	<i>Lichmera indistincta</i>	Brown Honeyeater		X	X	X		X	X			Regular visitor
	<i>Certhionyx variegatus</i>	Pied Honeyeater		X	X	X		X	X			Regular visitor

OFFICIAL

Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Gavicalis virescens</i>	Singing Honeyeater	X	X	X	X		X	X			Resident
	<i>Epthianura tricolor</i>	Crimson Chat		X	X	X		X	X			Regular visitor
	<i>Epthianura aurifrons</i>	Orange Chat				X						Irregular visitor
	<i>Epthianura albifrons</i>	White-fronted Chat		X								Vagrant
	<i>Manorina flavigula</i>	Yellow-throated Miner	X	X	X	X		X	X			Regular visitor
	<i>Conopophila whitei</i>	Grey Honeyeater		X	X			X	X			Vagrant
	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater		X	X	X			X			Regular visitor
	<i>Ptilotula keartlandi</i>	Grey-headed Honeyeater		X	X	X			X			Regular visitor
	<i>Ptilotula penicillata</i>	White-plumed Honeyeater	X	X	X				X			Resident
	<i>Ptilotula plumula</i>	Grey-fronted Honeyeater		X	X							Irregular visitor
	<i>Sugomel niger</i>	Black Honeyeater		X					X			Regular visitor
	<i>Purnella albifrons</i>	White-fronted Honeyeater			X							Irregular visitor
PETROICIDAE	<i>Melanodryas cucullata</i>	Hooded Robin		X	X			X	X			Regular visitor
	<i>Peneothello pulverulenta</i>	Mangrove Robin		X		X						Irregular visitor
	<i>Petroica goodenovii</i>	Red-capped Robin		X		X			X			Regular visitor
NECTARINIIDAE	<i>Dicaeum hirundinaceum</i>	Mistletoebird		X	X	X		X	X			Regular visitor

OFFICIAL

Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
POMATOSTOMIDAE	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler		X	X	X			X			Regular visitor
CINCLOSOMATIDAE	<i>Psophodes occidentalis</i>	Chiming Wedgebill		X		X			X			Resident
PACHYCEPHALIDAE	<i>Colluricincla harmonica</i>	Grey Shrike-thrush		X	X	X		X	X			Regular visitor
	<i>Oreoica gutturalis</i>	Crested Bellbird		X	X	X		X	X			Resident
	<i>Pachycephala rufiventris</i>	Rufous Whistler		X	X	X						Resident
	<i>Pachycephala lanioides</i>	White-breasted Whistler		X	X	X						Regular visitor
DICRURIDAE	<i>Rhipidura leucophrys</i>	Willie Wagtail		X	X	X			X			Resident
	<i>Rhipidura fuliginosa</i>	Grey Fantail		X	X	X			X			Irregular visitor
	<i>Rhipidura phasiana</i>	Mangrove Grey Fantail		X	X	X						Irregular visitor
	<i>Grallina cyanoleuca</i>	Magpie-lark	X	X	X	X			X			Resident
CAMPEPHAGIDAE	<i>Lalage tricolor</i>	White-winged Triller		X	X			X	X			Regular visitor
	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		X	X	X		X	X			Regular visitor
ARTAMIDAE	<i>Artamus cinereus</i>	Black-faced Woodswallow		X	X	X		X	X			Resident
	<i>Artamus minor</i>	Little Woodswallow		X	X	X		X	X			Regular visitor
	<i>Artamus personatus</i>	Masked Woodswallow		X	X	X			X			Irregular visitor
	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow		X		X			X			Irregular visitor
	<i>Cracticus nigrogularis</i>	Pied Butcherbird	X	X	X	X		X	X			Resident
	<i>Cracticus torquatus</i>	Grey Butcherbird		X	X	X			X			Resident

OFFICIAL

Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
	<i>Gymnorhina tibicen</i>	Australian Magpie		X	X	X			X			Resident
ALAUDIDAE	<i>Mirafra javanica</i>	Horsfield's Bushlark		X	X	X			X			resident
CORVIDAE	<i>Corvus orru</i>	Torresian Crow	X	X	X	X			X			resident
	<i>Corvus bennetti</i>	Little Crow		X	X	X		X	X			resident
PTILONORHYNCHIDAE	<i>Ptilonorhynchus guttatus</i>	Western Bowerbird		X	X	X			X			Regular visitor
HIRUNDINIDAE	<i>Cheramoeca leucosterna</i>	White-backed Swallow		X	X	X			X			Regular visitor
	<i>Hirundo neoxena</i>	Welcome Swallow	X	X	X	X			X			Regular visitor
	<i>Petrochelidon ariel</i>	Fairy Martin		X	X	X		?	X			Regular visitor
	<i>Petrochelidon nigricans</i>	Tree Martin		X	X	X		?	X			Regular visitor
ZOSTEROPIDAE	<i>Zosterops lateralis</i>	Silvereeye		X	X	X		X	X			Irregular visitor
	<i>Zosterops luteus</i>	Yellow White-eye		X	X	X						regular visitor
MEGALURIDAE	<i>Poodytes carteri</i>	Spinifexbird		X	X	X			X			resident
	<i>Cincloramphus cruralis</i>	Brown Songlark	X	X	X			X	X			regular visitor
	<i>Cincloramphus mathewsi</i>	Rufous Songlark	X	X	X			X	X			regular visitor
	<i>Acrocephalus australis</i>	Australian Reed-Warbler		X								irregular visitor
PASSERIDAE	<i>Emblema pictum</i>	Painted Finch		X	X				X			irregular visitor
	<i>Neochmia ruficauda</i>	Star Finch		X	X							Irregular visitor
	<i>Taeniopygia guttata</i>	Zebra Finch	X	X	X			X	X			Resident

OFFICIAL

Birds												
Family	Common Name	Scientific Name	2021 Site Visit	BA	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Act	Status in Survey Area
MOTACILLIDAE	<i>Anthus novaeseelandiae</i>	Australasian Pipit	X	X	X			X	X			Resident
Total: Expected species 221; 1 Introduced Conservation Significant Species 28										28	17	

Mammals											
Family	Species	Common Name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
TACHYGLOSSIDAE	<i>Tachyglossus aculeatus</i>	Echidna		X			X	X			Resident
DASYURIDAE	<i>Dasykaluta rosamondae</i>	(Little Red) Kaluta		X	X		X	X			Resident
	<i>Antechinomys laniger</i>	Kultarr						X			LEx
	<i>Dasyercus blythi</i>	Brush-tailed Mulgara	X?					X	P4		Resident
	<i>Dasyurus geoffroii</i>	Chuditch						X	S3 (V)	V	LEx
	<i>Dasyurus hallucatus</i>	Northern Quoll				X		X	S2 (E)	E	LEx
	<i>Ningau timealeyi</i>	Pilbara Ningau		X	X			X			Resident
	<i>Planigale sp</i>							X			Resident
	<i>Phascogale calura</i>	Red-tailed Phascogale			X			X	S6 (CD)	V	LEx
	<i>Pseudantechinus macdonnellensis</i>	Fat-Tailed Pseudantechinus		X							Regular visitor
	<i>Sminthopsis longicaudata</i>	Long-tailed Dunnart			X			X	P4		LEx

OFFICIAL

Mammals											
Family	Species	Common Name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
	<i>Sminthopsis ooldea</i>	Ooldea Dunnart						X			LEx
	<i>Sminthopsis macroura</i>	Stripe-faced Dunnart		X	X			X			Resident
	<i>Sminthopsis youngsoni</i>	Lesser Hairy-footed Dunnart					X	X			Resident
PERAMELIDAE	<i>Isodon auratus</i>	Golden Bandicoot						X	S3 (V)	V	LEx
	<i>Perameles bougainville</i>	Western Barred Bandicoot						X	S3 (V)	E	LEx
	<i>Macrotis lagotis</i>	Greater Bilby						X	S3 (V)	V	LEx
POTOROIDAE	<i>Bettongia leueur</i>	Boodie						X	S6 (CD)	Ex	LEx
MACROPODIDAE	<i>Lagorchestes conspicillatus</i>	Spectacled Hare-Wallaby						X	P4		LEx
	<i>Macropus robustus</i>	Euro		X	X		X	X			Resident
	<i>Macropus rufus</i>	Red Kangaroo		X	X		X	X			Regular visitor
	<i>Petrogale lateralis</i>	Black-footed Rock-Wallaby	X	X	X	X		X	S2 (E)	E	Irregular visitor
PHALANGERIDAE	<i>Trichosurus vulpecula</i>	Common Brushtail Possum						X			Irregular visitor
PTEROPODIDAE	<i>Pteropus alecto</i>	Black Flying-Fox		X							Irregular visitor
EMBALLONURIDAE	<i>Taphozous georgianus</i>	Common Sheathtail Bat		X	X			X			Regular visitor
	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat						X			Regular visitor
MOLOSSIDAE	<i>Tadarida australis</i>	White-striped Mastiff Bat						X			Regular visitor
VESPERTILIONIDAE	<i>Chaerephon jobensis</i>	Northern Freetail Bat						X			Regular visitor

OFFICIAL

Mammals											
Family	Species	Common Name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
	<i>Mormopterus beccari</i>	Beccari's Freetail Bat						X			Regular visitor
	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat						X			Resident
	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat						X			Resident
	<i>Vespadelus finlaysoni</i>	Inland Cave Bat		X	X			X			Resident
	<i>Scotorepens greyii</i>	Little Broad-nosed Bat						X			Regular visitor
MURIDAE	<i>Leporillus apicalis</i>	Lesser Stick-nest Rat			X	X		X	S4 (Ex)	Ex	Extinct
	<i>Notomys alexis</i>	Spinifex Hopping Mouse		X	X		X	X			Resident
	<i>Pseudomys chapmani</i>	Pebble Mound Mouse						X			LEx
	<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse		X	X		X	X			Resident
	<i>Notomys longicaudatus</i>	Long-tailed Hopping Mouse						X	S4 (Ex)	Ex	Ex
	<i>Notomys amplus</i>	Short-tailed Hopping Mouse						X	S4 (Ex)	Ex	Extinct
	<i>Pseudomys desertor</i>	Desert Mouse						X			LEx
	<i>Pseudomys fieldi</i>	Djoongari			X			X	S3 (V)	V	LEx
	<i>Pseudomys nanus</i>	Western Chestnut Mouse						X			LEx
	<i>Rattus tunneyi</i>	Pale Field Rat						X			LEx
CANIDAE	<i>Canis lupus dingo</i>	Dingo		X			X?	X			Regular visitor
INTRODUCED MAMMALS	<i>Mus musculus</i>	House Mouse		X	X		X	X			Resident
	<i>Rattus rattus</i>	Black Rat		X	X		X	X			Regular visitor
	<i>Vulpes vulpes</i>	Red Fox					X	X			Resident

Mammals											
Family	Species	Common Name	2021 Site Visit	ALA	NM	EPBC	Learmonth Survey BCE 2005	WAM Faunabase 2005	WA Status	EPBC Status	Status in Survey Area
	<i>Felis catus</i>	Feral Cat					X	X			Resident
	<i>Oryctolagus cuniculus</i>	European Rabbit	X				X	X			Resident
	<i>Capra hircus</i>	Goat	X				X	X			Regular visitor
	<i>Equus caballus</i>	Horse						X			Irregular visitor
Total native species: 44			Introduced mammals: 7		Conservation Significant species: 15				15	8	

6.6 Appendix 6. Species recorded in the field investigations (18-20 April 2021).

Species	2021 Annotations
<i>Ctenophorus isolepis</i> (Central Military Dragon)	Hatchling seen
<i>Ctenopus pantherinus</i> (Leopard Ctenopus)	Hatchling seen
<i>Gemmatrophora longirostris</i> (Long Nosed Dragon)	Adult on beach and ran back into foredune vegetation just north of boat ramp
<i>Himidactylus frenatus</i> (Common House Gecko)	Seen in town
<i>Lerista planiventralis</i> (Keeled Slider)	Tracks everywhere in white sands. One seen at 807090E, 7572790N
<i>Antaresia childreni</i> (Children's Python)	One run over on Yardie Creek Road just before Yardie caravan park near Tantabiddi Boat Ramp
Turtle track	Several months old and weathered. In south of project area at: 806825E, 7692915N
<i>Anas gracilis</i> (Grey Teal)	One on inlet at Tantabiddi Boat Ramp (18/04) and one (same bird?) seen flying over the ocean further south (19/04)
<i>Ocyphaps lophotes</i> (Crested Pigeon)	One seen in project area (18/04) and several south towards Yardie Creek
<i>Geopelia striata</i> (Peaceful Dove)	Few in town
<i>Phalacrocorax varius</i> (Pied Cormorant)	Three on rocks at T-Bone (19/04)
<i>Ardea modesta</i> (Eastern Great Egret)	One on inlet at Tantabiddi Boat Ramp (18/04)
<i>Egretta sacra</i> (Eastern Reef Egret (dark morph))	One on inlet at Tantabiddi Boat Ramp (18/04)
<i>Haliaeetus leucogaster</i> (White-bellied Sea-Eagle)	Pair at Mangrove Bay (19/04)
<i>Pandion cristatus</i> (Eastern Osprey)	Pair regularly in Tantabiddi Boat Ramp area, with nest on tall pole in carpark. Pairs also at South Mandu and T-Bone (19/04)
<i>Hieraaetus morphnoides</i> (Little Eagle)	Three at Mangrove Bay (19/04)
<i>Haliastur sphenurus</i> (Whistling Kite)	One seen over project in afternoon on 18/04 and 19/04
<i>Circus assimilis</i> (Spotted Harrier)	One in east of project area (18/04)
<i>Falco cenchroides</i> (Nankeen Kestrel)	One on Osprey nest at Tantabiddi Boat Ramp (19/04). Also a few seen along Yardie Creek Road to the north
<i>Cacomantis pallidus</i> (Pallid Cuckoo)	One seen and heard at Tantabiddi (19/04)
<i>Turnix velox</i> (Little Button-quail)	Tracks in project area

Species	2021 Annotations
<i>Charadrius leschenaultii</i> (Greater Sand Plover)	One on shore just to south of Tantabiddi; present 18/04 and 19/04
<i>Charadrius ruficapillus</i> (Red-capped Plover)	Two on creek pool at T-Bone (19/04)
<i>Hydroprogne caspia</i> (Caspian Tern)	Eight at South Mandu and two t T-Bone (19/04)
<i>Thalasseus bergii</i> (Crested Tern)	Six at South Mandu, 10 at T-Bone and four on beach just south of Tantabiddi (19/04)
<i>Thalasseus bengalensis</i> (Lesser Crested Tern)	Twelve at South Mandu (19/04)
<i>Chroicocephalus novaehollandiae</i> (Silver Gull)	Up to about 10 flying offshore from Tantabiddi, and occasional birds at boat ramp. Seen occasionally further south in ones and twos
<i>Eolophus roseicapillus</i> (Galah)	Two over project area (18/04) and a few small groups further south (19/04)
<i>Cacatua sanguinea</i> (Little Corella)	Few in town
<i>Barnardius zonarius</i> (Australian Ringneck)	Two seen in town once
<i>Hirundo neoxena</i> (Welcome Swallow)	Several over inlet at Tantabiddi and visiting the sinkhole
<i>Malurus leucopterus</i> (White-winged Fairy-wren)	Parties throughout. Vicki reported a coloured male but all other birds uncoloured. At least four groups in project area at: 807980E, 7573880N; 807390E, 7571900N; 807550E, 7573200N; 808030E, 7573710N
<i>Calamanthus campestris</i> (Rufous Fieldwren)	Few calling throughout the project area; perhaps eight calling birds?
<i>Manorina flavigula</i> (Yellow-throated Miner)	In town and at Visitors' Centre in National Park.
<i>Lichenostomus penicillatus</i> (White-plumed Honeyeater)	In town.
<i>Lichenostomus virescens</i> (Singing Honeyeater)	Eight counted in project area
<i>Grallina cyanoleuca</i> (Magpie-lark)	Few in town
<i>Cincloramphus cruralis</i> (Brown Songlark)	One calling in project area
<i>Cincloramphus mathewsi</i> (Rufous Songlark)	One calling near oval in town
<i>Anthus novaeseelandiae</i> (Australasian Pipit)	At least two pairs in project area and occasionally elsewhere
<i>Corvus orru</i> (Torresian Crow)	Group of three at Yardie Creek (19/04)
<i>Cracticus nigrogularis</i> (Pied Butcherbird)	Pair in project area and few seen along drive to Yardie Creek

Species	2021 Annotations
<i>Taeniopygia guttata</i> (Zebra Finch)	Few in project area. Nest building in Osprey nest at Tantabiddi
<i>Dasyercus blythi</i> (Brush-tailed Mulgara)	What appear to be good tracks of this species, on sandy soil east of existing boat ramp and just outside the project area
Euro	Several old skeletons along Yardie Creek Road
<i>Petrogale lateralis</i> (Black-flanked Rock-Wallaby)	Two in Yardie Creek gorge
<i>Oryctolagus cuniculus</i> (Rabbit)	Appears to be very abundant near the coast
<i>Capra hircus</i> (Goat)	Droppings at Yardie Creek

6.7 Appendix 7. Conservation significant invertebrate fauna species expected to occur in the Pilbara management region (as per DBCA 2019, 2020b), including conservation status and likely residency status in the project area. Species recorded from Tantabiddi Sinkhole (W. Humphreys (pers obs) are indicated (TS). These include some not of conservation significance.

Status codes:

CS1, CS2, CS3 = (summary) levels of conservation significance. See [Appendix 1. Explanation of fauna values.](#)
[Appendix 1](#) for full explanation.

EPBC Act listings: E = Endangered, V = Vulnerable, M = Migratory, Mar = Marine (see [Appendix 2Appendix 2](#)).

Biodiversity Conservation Act 2016 listings: S1 to S7 = Schedules 1 to 7 (see [Appendix 2Appendix 2](#)).

DBCA Priority species: P1 to P4 = Priority 1 to 4 (see [Appendix 2Appendix 2](#)).

Species *immediately* considered as unlikely to occur in the project area are listed in grey font.

Other exclusions (plain black text) followed spatial analysis of current records.

Expected species are highlighted.

Species	Common Name	Status	Expected Occurrence
Polychaete worms			
<i>Sphaerosyllis centroamericana</i>		NA	Recorded (TS). Widespread; known from Eastern Pacific: Mexico, Peru and Galapagos Islands
<i>Prionospio thalanji</i>		CS1 (S1)	Probably absent. Restricted to Bundera Sinkhole
Millipedes			
<i>Antichiropus</i> sp. 'DIP004'	Roy Hill Antichiropus Millipede	CS2 (P1)	Absent. Restricted to Roy Hill area (c. 90 km NE of Newman) and nearby (WAM 2021a). Project area more than 600 km outside of the species' known range.
<i>Antichiropus</i> sp. 'DIP005'	Abydos Antichiropus Millipede	CS2 (P1)	Absent. Restricted to Abydos Plain (near Marble Bar) and nearby (WAM 2021b). Project area more than 600 km outside of the species' known range.

Species	Common Name	Status	Expected Occurrence
<i>Antichiropus</i> sp. 'DIP006'	Area C Antichiropus Millipede	CS2 (P1)	Absent. Restricted to Area C (c. 80 km NW of Newman) and nearby (WAM 2021c). Project area more than 500 km outside of the species' known range.
<i>Antichiropus</i> sp. 'DIP007'	Bond's Antichiropus Millipede	CS2 (P1)	Absent. Restricted to Area C (c. 80 km NW of Newman) and nearby (WAM 2021d). Project area more than 500 km outside of the species' known range.
<i>Antichiropus</i> sp. 'DIP008'	Flinders Antichiropus Millipede	CS2 (P1)	Absent. Restricted to Flinders (c. 100 km NW of Tom Price) and nearby (WAM 2021e). Project area more than 300 km outside of the species' known range.
<i>Antichiropus</i> sp. 'DIP013'	Cloudbreak Antichiropus Millipede	CS2 (P1)	Absent. Restricted to Cloudbreak area (WAM 2021f). Project area more than 500 km outside of the species' known range.
<i>Antichiropus</i> sp. 'DIP029'	Mt Bruce Antichiropus Millipede	CS2 (P1)	Absent. Restricted to Mt Bruce area (near Tom Price) and nearby (WAM 2021g). Project area more than 400 km outside of the species' known range.
<i>Stygiochiropus isolatus</i>	a stygiochiropus millipede (Cape Range)	CS1 (S3)	Probably absent. Restricted to Cameron's Cave and Loop Cave, near the Exmouth townsite, on the Cape Range peninsula (Humphreys and Brooks 2015).
<i>Stygiochiropus peculiaris</i>	Cameron's Cave Millipede	CS1 (S1)	Probably absent. Restricted to Cameron's Cave, near the Exmouth townsite, on the Cape Range peninsula (Shear and Humphreys 1996).
<i>Stygiochiropus sympatricus</i>	a stygiochiropus millipede (Cape Range)	CS1 (S3)	Probably absent. Restricted to a single cave on the north-west of the Cape Range peninsula (Humphreys and Adams 1993; Shear and Humphreys 1996).
<i>Speleostrophus nesiotus</i>	Barrow Island millipede	CS1 (S3)	Absent. Restricted to Barrow Island. Project area more than 100 km outside of the species' known range.
Crustaceans			

Species	Common Name	Status	Expected Occurrence
<i>Kumonga exleyi</i>	Cape Range Remipede	CS1 (V, S1)	Probably absent. Restricted to the Bundera sinkhole, on the south-western coastline of the Cape Range peninsula (Black <i>et al.</i> 2001).
<i>Liagoceradocus branchialis</i>	Cape Range Liagoceradocus Amphipod	CS1 (S2)	Probably absent. Restricted to the Bundera sinkhole, on the south-western coastline of the Cape Range peninsula (Bradbury and Williams 1996).
<i>Liagoceradocus subthalassicus</i>	Barrow Island Liagoceradocus Amphipod	CS1 (S3)	Absent. Restricted to Barrow Island. Project area more than 100 km outside of the species' known range.
<i>Nedsia chevronia</i>	Chevron's Freshwater Amphipod (Barrow Island)	CS2 (P2)	Absent. Restricted to Barrow Island. Project area more than 100 km outside of the species' known range.
<i>Nedsia fragilis</i>	a freshwater amphipod	CS1 (S3)	Absent. Restricted to Barrow Island (Humphreys <i>et al.</i> 2013). Project area more than 100 km outside of the species' known range.
<i>Nedsia humphreysi</i>	a freshwater amphipod	CS1 (S3)	Absent. Restricted to Barrow Island (Humphreys <i>et al.</i> 2013). Project area more than 100 km outside of the species' known range.
<i>Nedsia hurlberti</i>	a freshwater amphipod	CS1 (S3)	Absent. Restricted to Barrow Island (Humphreys <i>et al.</i> 2013). Project area more than 100 km outside of the species' known range.
<i>Nedsia macrosculptilis</i>	a freshwater amphipod	CS1 (S3)	Absent. Restricted to Barrow Island (Humphreys <i>et al.</i> 2013). Project area more than 100 km outside of the species' known range.
<i>Nedsia sculptilis</i>	a freshwater amphipod	CS1 (S3)	Absent. Restricted to Barrow Island (Humphreys <i>et al.</i> 2013). Project area more than 100 km outside of the species' known range.
<i>Nedsia straskraba</i>	a freshwater amphipod	CS1 (S3)	Absent. Restricted to Barrow Island (Humphreys <i>et al.</i> 2013). Project area more than 100 km outside of the species' known range.

Species	Common Name	Status	Expected Occurrence
<i>Nedsia urifimbriata</i>	a freshwater amphipod	CS1 (S3)	Absent. Restricted to Barrow Island (Humphreys <i>et al.</i> 2013). Project area more than 100 km outside of the species' known range.
<i>Speleophria bunderae</i>	a copepod (Bundera Sinkhole)	CS1 (S1)	Probably absent. Restricted to the Bundera sinkhole, on the south-western coastline of the Cape Range peninsula (Jaume <i>et al.</i> 2001).
<i>Stygiocaris lancifera</i>	Lance-beaked Cave Shrimp	CS1 (S3)	Possibly present. Restricted to the "western side" of Cape Range including nearby Tantabiddi Well (Knott 1993; Page <i>et al.</i> 2008).
<i>Stygiocaris stylifera</i>	Spear-beaked Cave Shrimp	CS2 (P4)	Possibly present. Largely restricted to the "eastern side" of Cape Range (with some sympatric sites with <i>S. lancifera</i> on the northwest of the peninsula including Tantabiddi Well), and Barrow Island (Knott 1993; Page <i>et al.</i> 2008)
<i>Stygocyclopia australis</i>	a copepod (Bundera Sinkhole)	CS1 (S1)	Probably absent. Restricted to the Bundera sinkhole, on the south-western coastline of the Cape Range peninsula (Jaume <i>et al.</i> 2001).
<i>Bunderia misophaga</i>	a copepod (Bundera Sinkhole)	CS1 (S1)	Probably absent. Restricted to the Bundera sinkhole, on the south-western coastline of the Cape Range peninsula (Jaume and Humphreys 2001). Project area more than 100 km outside of the species' known range.
<i>Welesina kornickeri</i>	Kornicker's Bundera Sinkhole Ostracod	CS1 (S1)	Probably absent. Restricted to the Bundera sinkhole, on the south-western coastline of the Cape Range peninsula (Iglukowska and Boxshall 2013).
<i>Nitokra humphreysi</i>	Copepod	NS	Recorded (TS). A cosmopolitan genus
<i>Phyllopodopsyllus</i> sp.	Copepod	NS	Recorded (TS). Global temperate to tropical

Species	Common Name	Status	Expected Occurrence
<i>Halicyclops spinifer</i>	Copepod	NS	Recorded (TS). A cosmopolitan genus in brackish water
<i>Phlyctenophora mesembria</i>	Ostracod		Recorded (TS). An Indo-Pacific genus, the species type locality is Yardie Creek
<i>Welesina kornickeri</i>	Ostracod	S1	Known only from Bundera Sinkhole
<i>Grandidierella</i> sp. nov.	Amphipod	CS3	Recorded (TS). Species known only from Tantabiddi Sinkhole. Genus originally described from Madagascar
<i>Bogidomma australis</i>	Barrow Island Bogidomma Amphipod	CS1 (S3)	Absent. Restricted to Barrow Island. Project area more than 100 km outside of the species' known range
<i>Halosbaena tulki</i>	Thermosbaenacean	NS	Genus is highly speciated around Cape Range, through the Pilbara and on Christmas Island (Page <i>et al.</i> 2016).
Arachnids (spiders and allies)			
<i>Bamazomus subsolanus</i>	Eastern Cape Range Bamazomus	CS1 (S2)	Probably absent. Restricted to the "eastern side of Cape Range peninsula" (Harvey 2001). Project area more than 15 km outside of the species' known range.
<i>Bamazomus vespertinus</i>	Western Cape Range Bamazomus	CS1 (S2)	Possibly present. Restricted to the "the western side of Cape Range peninsula" (Harvey 2001).
<i>Draculoides bramstokeri</i>	Barrow Island Draculoides	CS1 (S3)	Absent. Restricted to Barrow Island (Harvey <i>et al.</i> 2008). Project area more than 100 km outside of the species' known range.
<i>Draculoides brooksi</i>	Northern Cape Range Draculoides	CS1 (S2)	Probably absent. Restricted to "the north-eastern portion of Cape Range Peninsula" (Harvey 2001; Harvey <i>et al.</i>

Species	Common Name	Status	Expected Occurrence
			2008). Project area more than 15 km outside of the species' known range.
<i>Draculoides julianneae</i>	western Cape Range Draculoides	CS1 (S2)	Possibly present. Restricted to "the western edge of Cape Range Peninsula" (Harvey 2001; Harvey <i>et al.</i> 2008).
<i>Draculoides mesozeirus</i>	Middle Robe Draculoides	CS1 (S3)	Absent. Restricted to middle of Robe Valley. Project area more than 100 km outside of the species' known range.
<i>Paradraculoides anachoretus</i>	Mesa A paradraculoides	CS1 (S3)	Absent. Restricted to Mesa A and nearby (Harvey <i>et al.</i> 2008). Project area more than 200 km outside of the species' known range.
<i>Paradraculoides bythius</i>	Mesa B/C paradraculoides	CS1 (S3)	Absent. Restricted to Mesa B/C and nearby (Harvey <i>et al.</i> 2008). Project area more than 200 km outside of the species' known range.
<i>Paradraculoides gnophicola</i>	Mesa G paradraculoides	CS1 (S3)	Absent. Restricted to Mesa G and nearby (Harvey <i>et al.</i> 2008). Project area more than 200 km outside of the species' known range.
<i>Paradraculoides kryptus</i>	Mesa K paradraculoides	CS1 (S3)	Absent. Restricted to Mesa K and nearby (Harvey <i>et al.</i> 2008). Project area more than 200 km outside of the species' known range.
<i>Indohya damocles</i>	Cameron's Cave Pseudoscorpion	CS1 (S1)	Probably absent. Restricted to Cameron's Cave, near the Exmouth townsite, on the Cape Range peninsula (Harvey and Volschenk 2007)
<i>Tyrannochthonius</i> sp. 'Mesa A' (WAM T81480)	a <i>Tyrannochthonius</i> pseudoscorpion (Mesa A)	CS2 (P1)	Absent. Restricted to Mesa A and nearby. Project area more than 200 km outside of the species' known range.
<i>Ideoblothrus linnaei</i>	Linnaeus' Pseudoscorpion (Mesa A)	CS2 (P1)	Absent. Restricted to Mesa A and nearby. Project area more than 200 km outside of the species' known range.
<i>Ideoblothrus</i> sp. 'Mesa A' (WAM T81374)	an <i>Ideoblothrus</i> pseudoscorpion (Mesa A)	CS2 (P1)	Absent. Restricted to Mesa A and nearby. Project area more than 200 km outside of the species' known range.

Species	Common Name	Status	Expected Occurrence
<i>Lagynochthonius asema</i>	Mesa A Lagynochthonius Pseudoscorpion	CS2 (P1)	Absent. Restricted to Mesa A and nearby. Project area more than 200 km outside of the species' known range.
Insects			
<i>Antipodogomphus hodgkini</i>	Pilbara Dragonfly	CS2 (P3)	Absent. Restricted to the "the Millstream area of Western Australia" (Hawking 1999; Theischinger and Hawking 2012).
<i>Nocticola flabella</i>	Cape Range Blind Cockroach, Cape Range Delicate Cockroach	CS2 (P4)	Possibly present. Restricted to "Cape Range" and known from only two locations in the central range (Roth 1991, W. Humphires pers. obs).
<i>Nososticta pilbara</i>	Pilbara threadtail	CS2 (P2)	Absent. Restricted to "only the oasis of permanent waters, fed by the Millstream aquifer, along the Fortescue River in the Pilbara region of Western Australia" (Watson and Theischinger 1984; Hawking 1999).
Molluscs			
<i>Dupucharopa millestriata</i>	Depuch Island charopid land snail	CS2 (P2)	Absent. Restricted to Depuch Island (and nearby islands?). Project area more than 400 km outside of the species' known range.