Eneabba Phase 3 Project:

Basic Vertebrate Fauna Survey and Cockatoo Habitat Survey 2021

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Executive Summary

Introduction

Iluka Resources Limited (Iluka) operate a mineral sands mine near Eneabba, Western Australia. Iluka propose to develop a processing facility as part of the Eneabba Phase 3 Project. To provide baseline data on the fauna and fauna habitats in the project area, Iluka commissioned Western Wildlife to undertake a basic vertebrate fauna survey and targeted cockatoo habitat survey.

The key objectives of the fauna survey were to:

- Identify and describe the fauna habitats present.
- Identify any potential foraging, roosting and/or breeding habitat for Carnaby's Cockatoo.
- List the vertebrate fauna that were recorded and/or have the potential to occur.
- Identify species of conservation significance, or habitats of particular importance for fauna, that may occur.

This report details the findings of the fauna survey conducted in July 2021.

Methods

The fauna survey was undertaken in accordance with *Technical guidance: terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020) and relevant State and Federal Guidelines on surveying conservation significant fauna.

The field survey was carried out on the 12th - 13th July 2021, and included:

- Fauna habitat identification and assessment.
- Targeted survey for Carnaby's Cockatoo habitat.
- Keeping opportunistic records of all vertebrate fauna observed.

Species of conservation significance were classified as: **Threatened** if listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or *Biodiversity Conservation Act 2016* (BC Act); **Migratory** if listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened; **Specially Protected** if listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act; **Priority** if listed as Priority by DBCA and **Locally Significant** if considered by the author to potentially be of local significance.

Results and Discussion

Six habitats were identified in the study area: Kwongan heath (uplands), Kwongan heath (lowlands), minor drainages, rehabilitation (shrublands and heaths), planted eucalypts and farmland. The habitats of the study area are widespread in the region, and the native habitats are likely to support a substantially intact faunal assemblage, typical of the assemblage found in Kwongan heaths of the region. Rehabilitation areas (shrublands and heaths) are likely to support a smaller subset of the faunal assemblage, but still have value as fauna habitat. Farmland is only likely to support a few, generalist species.

The predicted faunal assemblage includes up to 10 frogs, 60 reptiles, 118 birds and 26 mammals (19 native and seven introduced). The observed faunal assemblage included two frogs, one reptile, 32 birds and five mammals (three native and two introduced), and this is unlikely to be complete. The faunal assemblage is likely to relatively intact and typical of woodlands in the region. A total of seven vertebrate and eight invertebrate fauna species of conservation significance have the potential to occur in the study area:

Threatened species

Three threatened species potentially occur in the study area (two vertebrate and one invertebrate), of which one was recorded:

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) - EPBC Act (Endangered), BC Act (Endangered)
- Malleefowl (*Leipoa ocellata*) - EPBC Act (Vulnerable), BC Act (Vulnerable)
- Shield-backed Trapdoor Spider (*Idiosoma nigrum*) - EPBC Act (Vulnerable), BC Act (Vulnerable)

Carnaby's Cockatoo was recorded roosting and foraging in the study area. Thirty birds were present at an overnight roost and foraging signs were observed on *Banksia* spp. in both the upland Kwongan heath and the shrublands in the rehabilitation areas. No breeding habitat is present, and no breeding habitat is known to occur within 12km of the study area. The birds present are likely to be a flock of over-wintering foraging birds that breed elsewhere in the wheatbelt. Foraging habitat in the non-breeding range and the night roost are considered habitat critical to the survival of the species. The presence of foraging signs in the rehabilitated areas indicates that re-establishment of foraging habitat is possible.

The study area is unlikely to provide important habitat for the Malleefowl and the Shield-backed Trapdoor Spider is unlikely to occur due to changes in its taxonomic status.

Migratory Species

One vertebrate Migratory species potentially occurs in the study area:

- Fork-tailed Swift (*Apus pacificus*) - EPBC Act (Migratory), BC Act (Migratory)

The Fork-tailed Swift is thought to be almost entirely aerial when visiting Australia, so the study area is not likely to provide important habitat for this species.

Specially Protected species

One vertebrate Specially Protected species potentially occurs in the study area:

- Peregrine Falcon (*Falco peregrinus*) – BC Act (other specially protected fauna)

The Peregrine Falcon is likely to occur as a foraging visitor, but the study area is unlikely to be important for this species as its population is large and secure, and its favoured breeding habitat is absent.

Priority species

Nine Priority species potentially occur in the study area (three vertebrate and six invertebrate):

- Woma (*Aspidites ramsayi*) – Priority 1
- Black-striped Snake (*Neelaps calonotos*) - Priority 3
- Western Brush Wallaby (*Notamacropus irma*) - Priority 4
- Kwongan Heath Shield-backed Trapdoor Spider (*Idiosoma kwongan*) – Priority 1
- Thorny Bush Katydid (*Hemisaga vepreculae*) - Priority 2
- Springtime Corroboree Stick Katydid (*Phasmodes jeeba*) - Priority 2
- Graceful Sun-moth (*Synemon gratiosa*) - Priority 4
- Woolybush Bee (*Hylaeus globuliferus*) - Priority 3
- An earwig fly (*Austromerope poultoni*) - Priority 2

The Black-striped Snake is likely to occur in the Kwongan heaths, but the study area is unlikely to support the Woma (locally extinct) or provide important habitat for the Western Brush Wallaby. Many of the Priority invertebrates are poorly known, hampering an accurate assessment of their likely status in the study area, however, some potentially occur in the study area.

Locally significant species

One locally significant species is likely to occur:

- a millipede (*Antichiropus sulcatus*) – probable short-range endemic

This millipede considered likely to occur in the study area and is a probable short-range endemic (SRE) species. It is unlikely that *Antichiropus sulcatus* is the only SRE invertebrate present, however, the small size of the study area is unlikely to overlap the entire range of any SRE species.

Table of Contents

Tables, Figures and Plates

1. Introduction

Iluka Resources Limited (Iluka) operate a mineral sands mine near Eneabba, Western Australia, extracting material from a monazite-rich mineral stockpile for processing and sale. Iluka propose to further develop a processing facility as part of the Eneabba Phase 3 Project – Eneabba Rare Earth Refinery (ERER). To provide baseline data on the fauna and fauna habitats in the project area, Iluka commissioned Western Wildlife to undertake a basic vertebrate fauna survey. A targeted survey for Carnaby's Cockatoo (*Calyptorhynchus latirostris*) was also commissioned, as this species is listed as Threatened and known to occur in the region.

The key objectives of the fauna survey were to:

- Identify and describe the fauna habitats present.
- Identify any potential foraging, roosting and/or breeding habitat for Carnaby's Cockatoo.
- List the vertebrate fauna that were recorded and/or have the potential to occur.
- Identify species of conservation significance, or habitats of particular importance for fauna, that may occur.

This report details the findings of the fauna survey conducted in July 2021.

1.1 Study Area

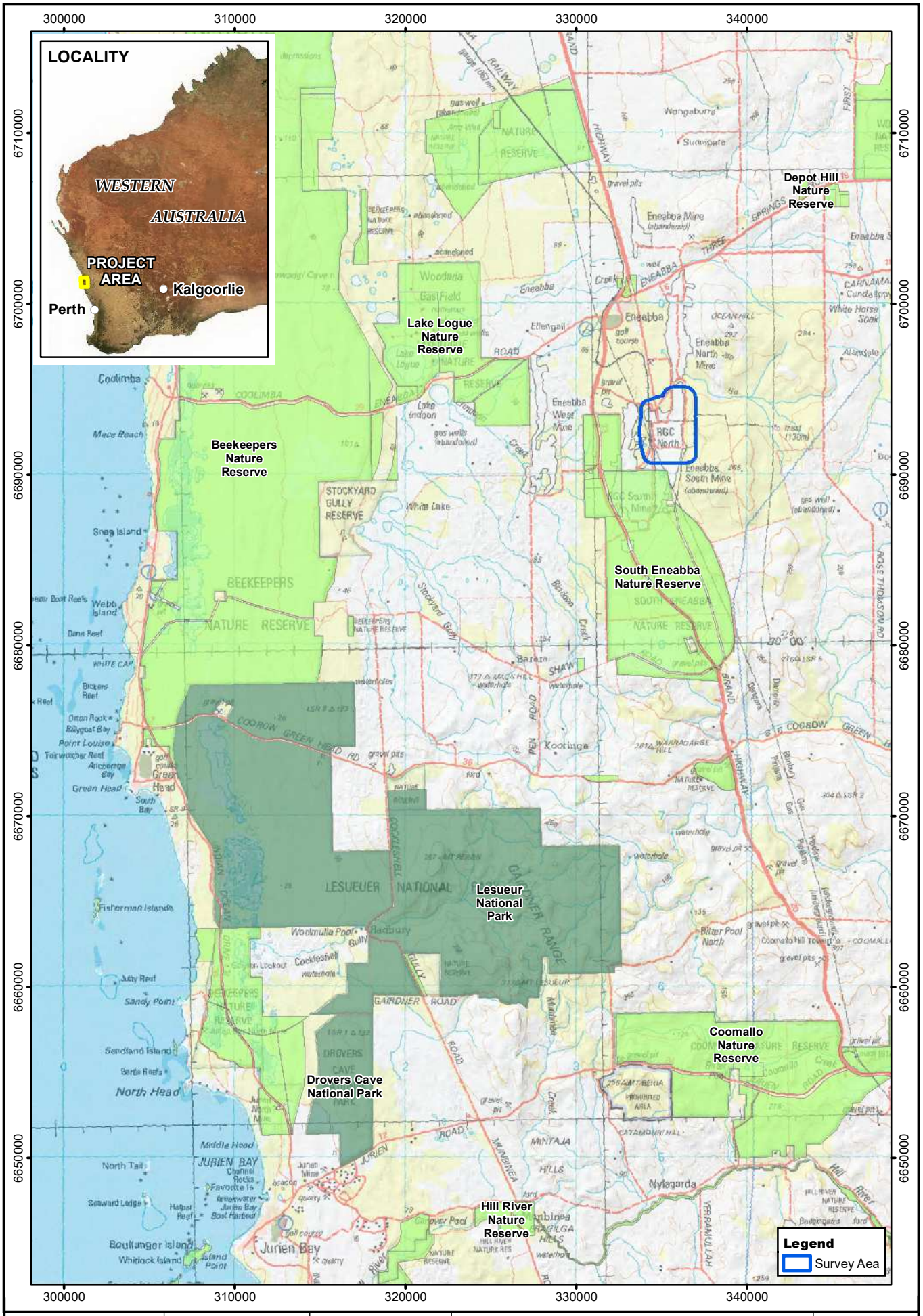
The ERER is located in the Shire of Carnamah, about 5km south of Eneabba. A 500m buffer was placed around the 687ha proposed development envelope to give a study area totalling 1,303.1ha. The study area includes cleared areas, rehabilitation areas of various ages, topsoil stockpiles and native vegetation.

1.2 Regional Context

1.2.1 IBRA Bioregion

The Interim Biogeographic Regionalisation for Australia (IBRA) classifies the land surface of Australia into 89 Bioregions and 419 subregions, each defined by a set of environmental influences that impact the occurrence of flora and fauna and their interaction with the physical environment (DoEE 2018).

The study area falls within the Lesueur Sandplain Subregion of the Geraldton Sandplains Bioregion. The subregion has a Mediterranean climate, and the primary land-use is dryland agriculture (69.34%), with smaller areas of conservation (17.6%) and Unallocated Crown Land (UCL) and Crown reserves (12.5%) (Desmond and Chant 2001). The vegetation in the subregion is dominated by endemic-rich shrub-heaths on a mosaic of sandplains, lateritic mesas, coastal sands and limestones, with heath on laterised sandplains on the north-eastern edges of the subregion (Desmond and Chant 2001).



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Date: July 2021 Rev: A	Author: J. Wilcox			

1.2.2 Botanical Province

The Botanical Provinces are determined by vegetation mapping (Beard 1980) and broadly correspond to climactic regions; the Southwest (Bassian) Province experiencing warm dry summers and cool wet winters, the Northern Province experiencing warm wet summers and cool dry winters and the Eremaean Province experiencing low, irregular rainfall. The study area is in Southwest Province.

1.2.3 Parks and Reserves

There are no reserves in the study area. The closest is South Eneabba Nature Reserve, 500m south of the study area. There are several large nature reserves on the west coast, about 10 - 15 km west of the study area. These include Beekeepers Nature Reserve, Lake Logue Nature Reserve, Stockyard Gully Reserve and several unnamed Nature Reserves (Figure 1). To the east are Wotto Nature Reserve, Tathra National Park and Alexander Morrison National Park.

1.2.4 Land Systems

Land systems are broad descriptions of landform, geology and soils. The study area intersects two land systems (Figure 2), which are characterised as follows:

- **Eneabba Plain System** – level to gently undulating sandplain to the north-west and south-west of Eneabba. Pale deep sands, grey shallow to deep sandy duplexes, moderately deep sandy gravels, and yellow deep sands common. Banksia woodlands and heathlands.
- **Yerramullah System** – subdued, dissected lateritic plateau, undulating low hills and rises on laterised weathered sandstone. Pale deep sand, sandy gravels and yellow deep sand. Banksia woodlands on lower slopes/depressions, heathlands elsewhere.

1.2.5 Vegetation

The vegetation in the study area is relatively diverse. The following floristic community types (FCTs) have been identified in the study area by Woodman Environmental Consulting (2012) and are shown in Figure 3:

- Open Low Woodland to Open Low Scrub of *Eucalyptus pleurocarpa* and/or *Eucalyptus todtiana* over mixed shrubs dominated by *Banksia spp*. and *Hakea spp*. over sedges on grey to brown sands with very occasional laterite influence on lower to mid slopes (FCT 1a)
- Open Woodland to Scrub of *Eucalyptus spp*. and/or *Banksia spp*., with occasional *Xylomelum angustifolium*, over mixed shrubs dominated by myrtaceous spp., *Banksia spp*., and Jacksonia spp. on grey sand on mid to upper slopes (FCT 1b).

- Low Woodland of *Banksia attenuata* and occasional *Banksia menziesii* and Xylomelum angustifolium, over Low Scrub of mixed species including *Banksia leptophylla* var. *leptophylla*, *Banksia candolleana*, *Melaleuca leuropoma* and *Hibbertia hypericoides* on brown or grey sand on upper slopes (FCT 2a).

- Scrub of *Banksia attenuata*, with emergent *Eucalyptus todtiana* or *Eucalyptus pleurocarpa*, over Low Scrub dominated by *Banksia spp*. on predominantly yellow sands on mid and upper slopes (FCT 2b).

- Open Low Woodland to Heath of *Banksia spp*. over mixed shrubs commonly including *Melaleuca leuropoma*, *Eremaea beaufortioides* and *Scholtzia laxiflora* on grey or yellow sand on lower to mid slopes (FCT 3).

- Low Scrub of mixed species including *Beaufortia elegans* and *Banksia spp*., with occasional Low Woodland of *Eucalyptus pleurocarpa*, over *Xanthorrhoea spp* and sedges on soil types ranging from white-grey sands to grey sand with lateritic gravel on mid and upper slopes (FTC 6a)

- Shrublands and Heaths, with occasional Low Woodland of *Eucalyptus pleurocarpa*. Common species include *Allocasuarina microstachya*, *Melaleuca leuropoma*, *Melaleuca trichophylla*, and *Verticordia spp*. over sedges on grey-brown sands, sandy clays and or gravel on flats, swales and lower-slopes (FCT 6b).

- Open Low Woodland of *Eucalyptus pleurocarpa* to species rich Low Heath generally dominated by *Banksia spp*., *Daviesia spp*., *Lambertia multiflora* var. *multiflora* and *Xanthorrhoea drummondii* on grey sands with a moderate to heavy laterite component (FCT 7).

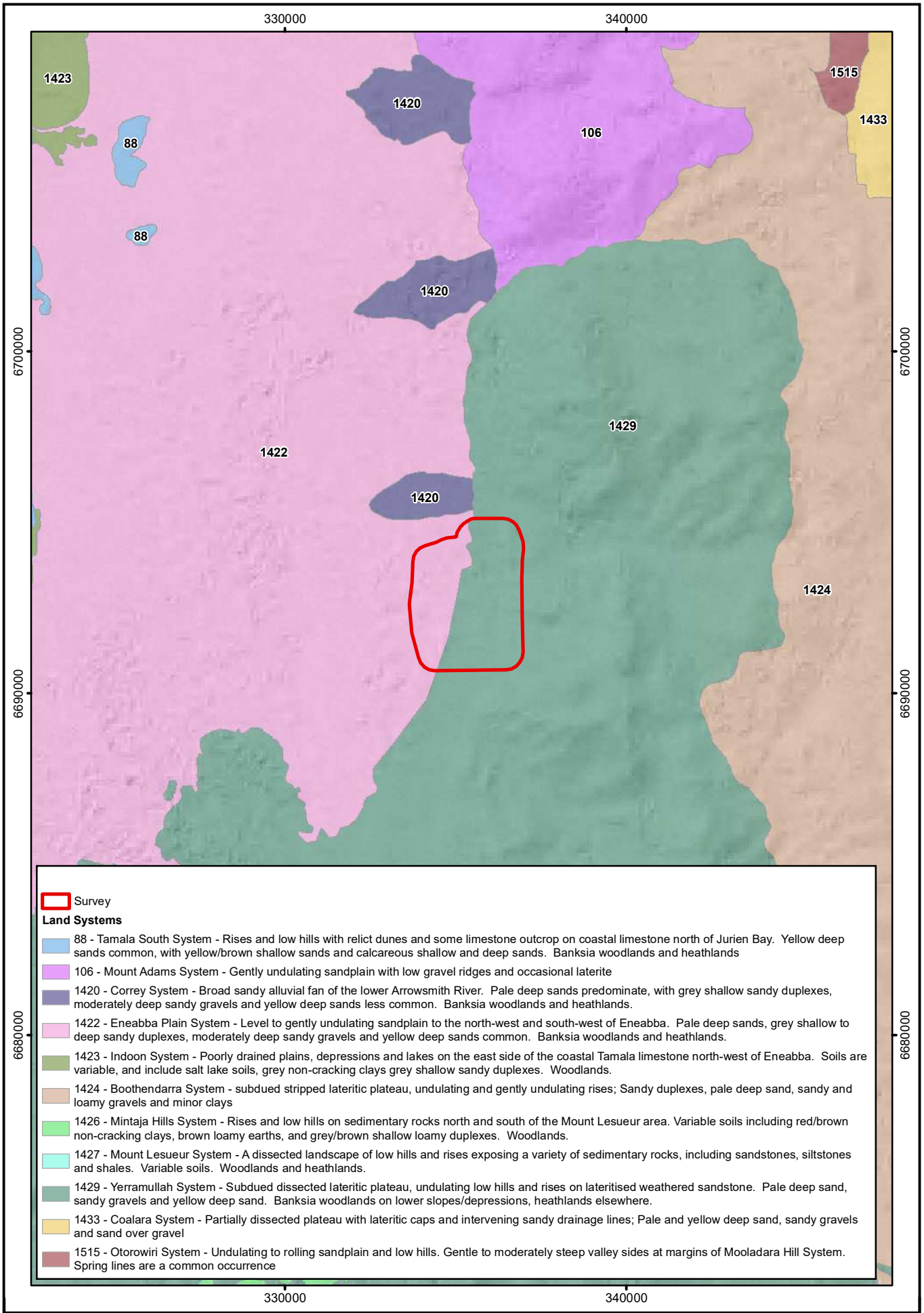
- Low Woodland of *Eucalyptus accedens* over Open Low Scrub dominated by *Baeckea spp* and *Melaleuca spp*. on sandy gravels or sandy clay on flats and lower slopes (FCT 14)

- Thicket dominated by *Melaleuca viminea* subsp. *viminea*, with occasional *Eucalyptus loxophleba* subsp. *loxophleba* or *Eucalyptus camaldulensis* in clay flats (FCT 18)

- Low Woodland of *Melaleuca preissiana* over a sparse, often disturbed shrub layer of species including *Tecticornia pergranulata* subsp. *pergranulata* and *Rhagodia preissii* subsp. *obovata* on grey sandy clay in depressions and seasonally inundated basins (FCT 22).

- Degraded vegetation on private property.

In addition, part of the study area consists of rehabilitation in various ages, between 1981 and 2021 (Figure 4).



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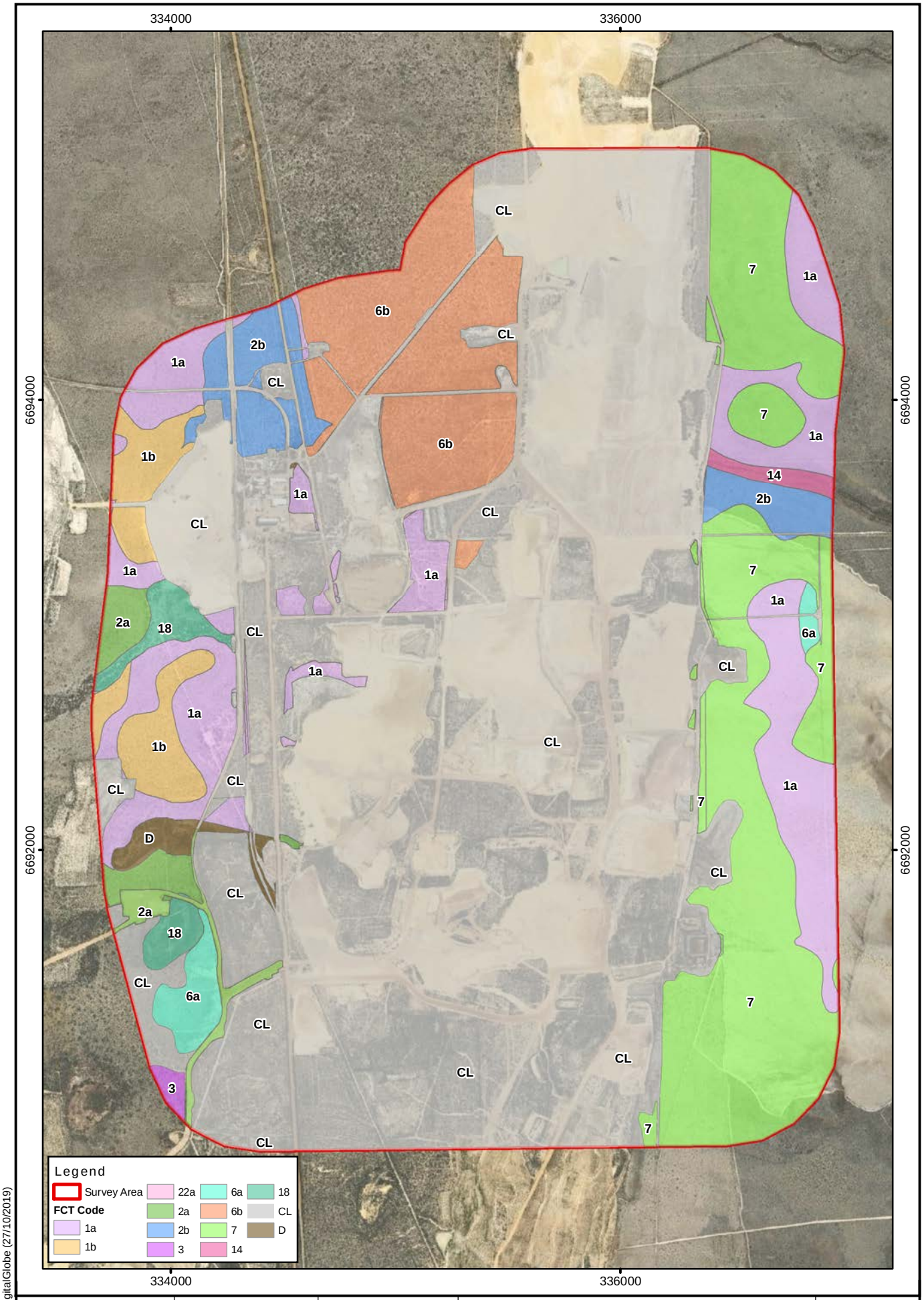
Eneabba Phase 3 Project
Land Systems

Figure: **2**



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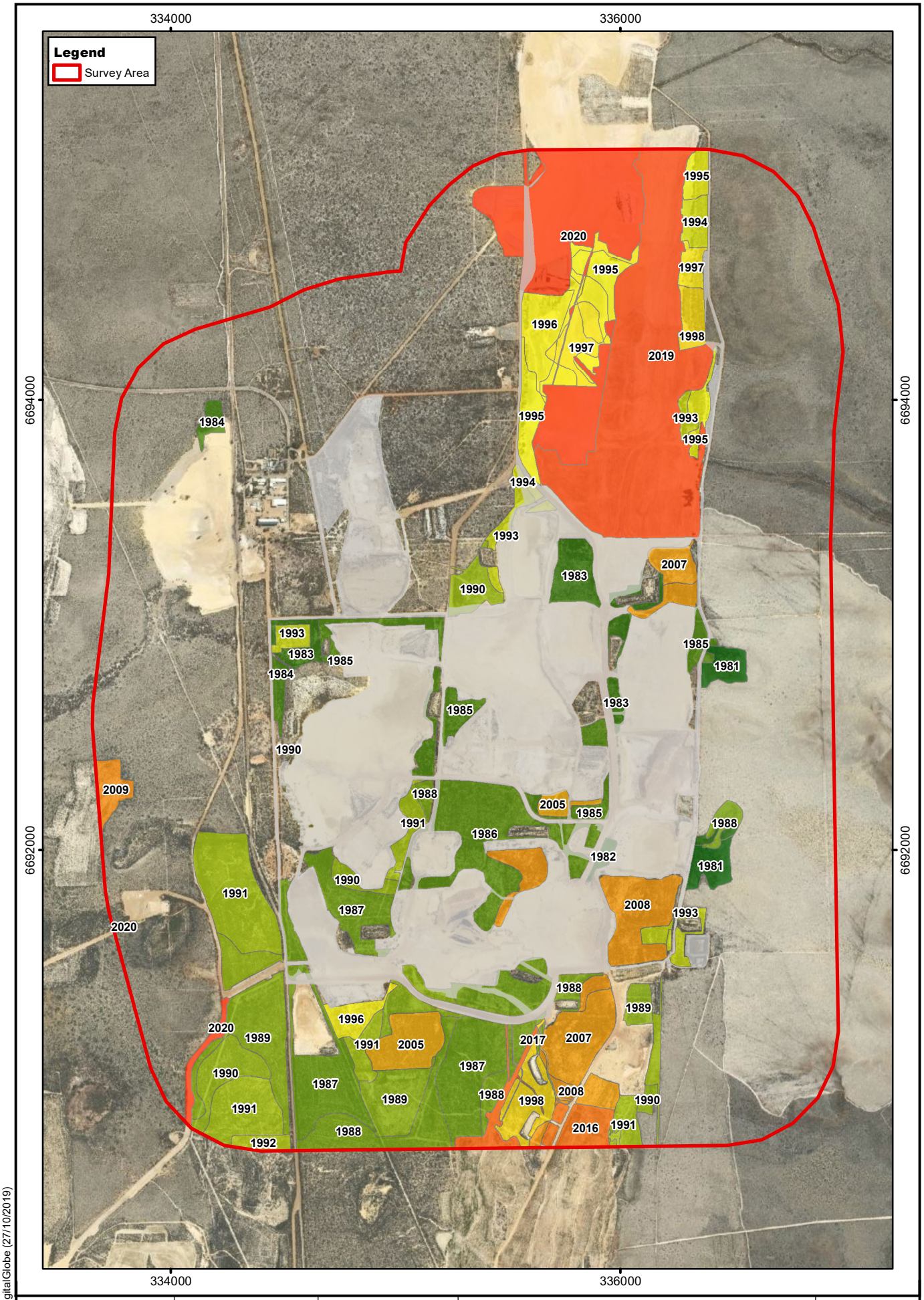
Western Wildlife

Eneabba Phase 3 Project
Vegetation

Figure: **3**



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Date: October 2021 | Rev: A	Author: J. Wilcox			

1.3 Climate and Weather

The long-term climate statistics were drawn from the Eneabba weather station (site number 008225), about 5km north of the Study Area. The mean monthly maximum and minimum temperatures and rainfall for this weather station is presented in Figure 5. The data indicate that the highest rainfall falls in winter and the highest temperatures occur in the summer months.

The average annual rainfall for Eneabba is 489.6mm, averaged over the period 1964 - 2017 (Bureau of Meteorology 2021). As this weather station closed in 2017, the annual rainfall for recent years was drawn from the DPIRD automatic weather station located 4.5km east of Eneabba and was below average in both 2020 (364.8mm) and 2019 (287.4mm) (DPIRD 2021). Weather during survey was cool at 18 – 20°C (DPIRD 2021), with showers and variable winds.

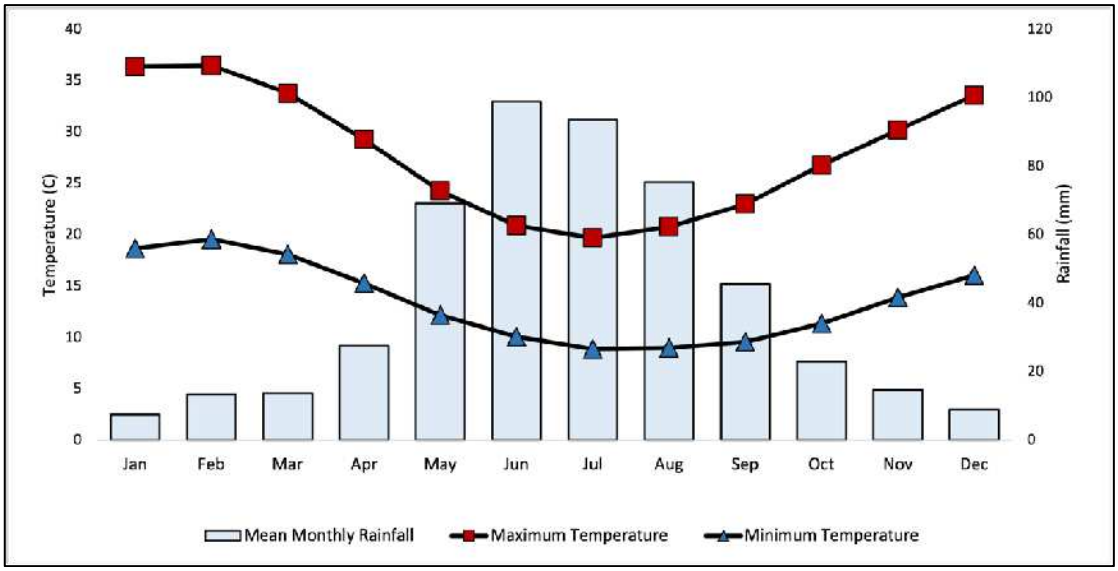


Figure 5. Monthly Climate Statistics for Eneabba (Bureau of Meteorology 2021).

2. Methods

2.1 Overview

A basic vertebrate fauna survey with a targeted Carnaby's Cockatoo habitat survey was undertaken. The fauna survey included a search of publicly available literature and databases (a desktop study), and a brief site visit. The data collected in the field serve to put the desktop study into context, as well as allowing for the identification of fauna habitats and likely fauna assemblages of the site. A basic fauna survey was sufficient to characterise the fauna habitats, vertebrate faunal assemblage and the likely conservation significant fauna using the study area.

2.2 Guidance and Licencing

The survey was conducted with reference to the following documents:

- Technical guidance: terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020)
- EPBC Act Referral Guidelines for three threatened black cockatoos: Carnaby's Cockatoo, Baudin's Cockatoo and Forest Red-tailed Black-Cockatoo (DSEWPaC 2012).

As the survey was observational only, no DBCA license was required.

2.3 Personnel

Ms Jenny Wilcox (*BSc.Biol./Env.Sci., Hons.Biol.*) and Dr Wes Bancroft (*PhD. Zool*.) undertook the fieldwork and Jenny Wilcox prepared this report. Both zoologists have over 20 years' experience with fauna surveys in Western Australia and have previously conducted cockatoo habitat surveys.

2.4 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum checklists, as updated November 2020. In the text, common names are used where appropriate, and all scientific names are given in species lists. Where a species lacks a common name, they are referred to by their scientific name.

2.5 Literature Review

Lists of fauna expected to occur in the Study Area were produced using information from several sources. These included publications that provide information on general patterns of distribution of frogs (Tyler *et al*. 2000), reptiles (Wilson and Swan 2017, Storr *et al*. 1983, 1990, 1999 and 2002), birds (Barrett *et al*. 2003; Johnstone and Storr 1998 and 2004) and mammals (Churchill 2008, Menkhorst and Knight 2011; Van Dyck and Strahan 2008).

The databases in Table 1 were searched for fauna records in and around the study area. Some species may occur on database results that are not likely to be present in the study area, usually due either to lack of suitable habitat or the study area being outside the known range of the species (i.e., erroneous records or records of vagrants). Some records may be historical, with the species known to be locally or regionally extinct. These species are generally not included in lists of expected fauna unless some discussion is thought to be necessary. In all cases the extent of the database search was larger than the extent of the Study Area to pick up records of species in the wider area that may also occur in the Study Area.

Table 1. Databases used in the preparation of Appendices 1 - 4.

Database	Type of records held	Area searched
WA Museum Specimen Databases for reptiles frogs, birds and mammals (NatureMap: DBCA 2007-)	Records of specimens held in the Western Australian Museum. Includes historical records.	20km radius around a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).
Fauna Survey Returns Database (NatureMap: DBCA 2007-)	Records collected from fauna surveys carried out in Western Australia. Includes observational and trapping data.	20km radius around a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).
DBCA's Threatened and Priority Fauna Database (DBCA 2021)	Information and records on Threatened and Priority species in Western Australia.	30km radius around a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).
Birds Australia Atlas Database (NatureMap: DBCA 2007-)	Records of bird observations in Australia, 1998-2009.	20km radius around a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).
Birdata (NatureMap: DBCA 2007-)	Records of bird observations in Australia, 2010-2018.	20km radius around a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).
Atlas of Living Australia (ALA) Database	Records of fauna from several sources including museum specimen records and observations from members of the public.	20km radius around a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).
Index of Biodiversity Surveys for Assessments (IBSA) Database	Fauna survey reports and data in Western Australia.	Geraldton Sandplains IBRA Bioregion.
EPBC Act Protected Matters Search Tool	Information and modelled distributions for matters protected under the EPBC Act, including threatened species and ecological communities, migratory species and marine species.	5km radius around a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).
Black-cockatoo breeding sites (buffered to 2km) (Birdlife Australia 2019)	Sites where Black-Cockatoos (generally Carnaby's) are confirmed to be breeding. Breeding is inferred based on surveys which have recorded either birds entering/leaving the nest or the inside of the nest has been viewed with eggs or chicks. These records are of breeding attempts, but not necessarily of successful fledging. The first surveys were in 2003, with some nests surveyed a single time and others revisited once a year. Most records are in the peak breeding season of Carnaby's (September to January).	at least 12km surrounding a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).
Carnaby's Cockatoo confirmed breeding areas within the Swan Coastal Plain and Jarrah Forest IBRA Regions. (Glossop *et al*. 2011)	Confirmed breeding areas of the Carnaby's Black Cockatoo (CBC) within the Swan Coastal Plain and the Jarrah Forest IBRA regions. Confirmed sites are identified where chicks or eggs of CBC have been observed.	at least 12km surrounding a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).

Table 1. (cont.)

Database	Type of records held	Area searched
Black-cockatoo roosting sites (buffered to 1km) (Birdlife Australia 2020)	Data from The Great Cocky Count which takes place annually in early to mid-April. This event records birds as they fly in to night roosts on a single day and has taken place since 2010. Three species are recorded: Carnaby's and Baudin's (white-tailed) and Forest Red-tailed Black-Cockatoos. In the Perth-Peel Coastal Plain all white-tailed are assumed to be Carnaby's. In other areas the roosts could include either species or both, so a generic 'white-tailed' term is used.	at least 12km surrounding a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).
Carnaby's Cockatoo confirmed roosting areas within the Swan Coastal Plain and Jarrah Forest IBRA Regions. (Glossop *et al*. 2011)	Describes the currently known and confirmed night roost areas for Carnaby's Black Cockatoo in the South - West of Western Australia.	at least 12km surrounding a point in the center of the Survey Area (-29.8878º S, 115.2954º"E).

The following surveys have been completed in the vicinity of the Study Area, and have been used to inform the literature review:

- ***Vertebrate Survey of Reserve 31030, Eneabba, Western Australia*** **(Dunlop 1981).** This survey was undertaken in the South Eneabba Nature Reserve in October and December 1981. Survey methods included pitfall trapping, hand searching, bird surveys and mist-netting for birds and bats. A total of 39 birds, 20 reptiles and nine mammals were recorded. Carnaby's Cockatoo (*Calyptorhynchus latirostris*) was the only conservation significant species recorded.

- ***An Ecological Study of Heathlands of the Leeman Area, Western Australia*** **(Foulds and McMillan 1982).** A survey of invertebrate and vertebrate fauna on an east-west transect through Reserve 22521 and Reserve 24496 (Beekeeper's Nature Reserve), south of the town of Leeman, about 26km southwest of the survey area.

- ***Fauna Review; Eneabba*** **(Bancroft and Bamford 2006).** A basic fauna survey was undertaken on one day in October 2005. The literature review included database searches and reviews of invertebrate and vertebrate fauna reports from 1980 – 2000. The literature review identified 288 potentially occurring vertebrate species, 12 frogs, 59 reptiles, 190 birds and 27 mammals. Thirty species of conservation significance were identified, although the status of some of these have been downgraded since the date of this report.

- ***Assessment of Significant Habitat for Carnaby's Cockatoo*** **Calyptorhynchus latirostris** ***in the Eneabba region (*****Johnstone and Kirkby 2007*****).*** This survey aimed to identify any foraging, breeding or roosting habitat within the future mining area at the Eneabba Operations, with data collected September 2006, April 2007, July 2007, and August 2007. No breeding habitat was found in the vicinity of Eneabba. Important roost sites were identified at the Eneabba townsite with a satellite roost on Woodada Road. Important foraging areas were identified in reserves to the north and west of the operations area, in remnant bushland, road verges and in farmland where birds foraged on wild melons (*Citrullus lanatus*). Vegetation at the Eneabba operations (IPL South, South Tails and IPL North) were also identified as providing foraging habitat. It was considered that staged clearing in these areas would not have a significant impact on Carnaby's Cockatoo.

- ***Fauna Values of Proposed Future Mining Areas in the Eneabba Region*** **(Bamford 2007a).** This basic fauna survey was undertaken across three days in September 2007. The survey involved fauna habitat assessment, opportunistic observations, active searching for reptiles and short range endemic invertebrates at 23 sites, spot-lighting and bat call detection. The list of potentially occurring species was the same as presented in Bancroft and Bamford (2006), with one frog, 16 reptile, 49 bird and seven mammals recorded on the survey.

- ***Survey for the Shield-backed Trapdoor Spider Idiosoma nigrum in Iluka lease areas at Eneabba*** **(Bamford 2007b).** This targeted survey was undertaken on two days in December 2006, at nine sites across the Eneabba Operations. No *Idiosoma nigrum* were detected and it was concluded that this species is unlikely to occur.

- ***Fauna Investigations of Iluka's Proposed Eneabba Future Mining Operations with a focus on IPL North and IPL South Deposits*** **(Bamford 2009).** A basic fauna survey was undertaken on two days in November 2008, also including searching for foraging signs of Carnaby's Cockatoo, searching for the katydid Phasmodes jeeba, searching for burrows of Shield-backed Trapdoor Spider (*Idiosoma nigrum*) and searching for short range endemic invertebrates. A total of 264 potentially occurring vertebrate species were identified: three freshwater fish, 12 frogs, 60 reptiles, 160 birds and 29 mammals, of which 10 frogs, 35 reptiles, 101 birds and 18 mammals were recorded on this or previous surveys. Twenty-eight species of conservation significance were identified, although the status of some of these have been downgraded since the date of this report. Of the conservation significant species, Carnaby's Cockatoo (*Calyptorhynchus latirostris*) was reported to occur as a non-breeding species. No other conservation significant species were recorded, but four invertebrates were considered potentially occurring: a scorpionfly (*Austromerope poultoni*) a katydid (*Phasmodes jeeba*), a millipede (*Antichiropus* Eneabba 1) and the Shield-backed Trapdoor Spider (*Idiosoma nigrum*).

- ***Impact of Mulch Harvesting on Fauna at Iluka's Eneabba Operation*** **(Everard *et al*. 2010).** Fauna recorded in this survey, as reported in Everard and Bamford (2013).

- ***Carnaby's Cockatoo Habitat Assessment IPL North Eneabba Region* (Johnstone and Kirkby 2013).** This survey includes a review of known Carnaby's Cockatoo records in the region, site visits to search for evidence of cockatoo foraging and mapping of potential foraging habitat. It was determined that a flock of about 300 birds winter in the Eneabba area, and foraging signs were recorded throughout the region between Eneabba townsite and south of the current survey area. Foraging was recorded on *Banksia sessilis*, *Banksia kippistiana*, *Banksia attenuata*, *Banksia menziesii*, *Banksia prionotes*, *Banksia leptophylla*, *Banksia hookeriana*, *Banksia sphaerocarpa*, *Lambertia multiflora*, *Hakea spp*., *Eucalyptus caesia*, *Corymbia calophylla*, *Xanthorrhoea sp*. and *Pinus sp*. Breeding habitat was not present around Eneabba, but occurs regionally at Moora, between Moora and Watheroo, at Watheroo, near Marchagee, Marchagee Track, Coorow, Dookanooka Reserve, Dandaragan, the Dandaragan – Gingin road, Cataby, Green Head Road, Coomallo Creek and Minyulo.
- ***Iluka Resources Limited IPL North Project Area Fauna Assessment* (Everard and Bamford 2013).** This survey was undertaken across two days in September 2012 and was supported with an extensive desktop assessment. The survey included habitat assessment, targeted searches for conservation significant fauna and opportunistic observations of fauna. The literature review identified 211 potentially occurring fauna: nine frog, 56 reptile, 120 bird and 26 mammal species. Recorded on the survey were one frog, four reptile, 34 bird and five mammal species. No species currently listed as observation significant were recorded on the survey.

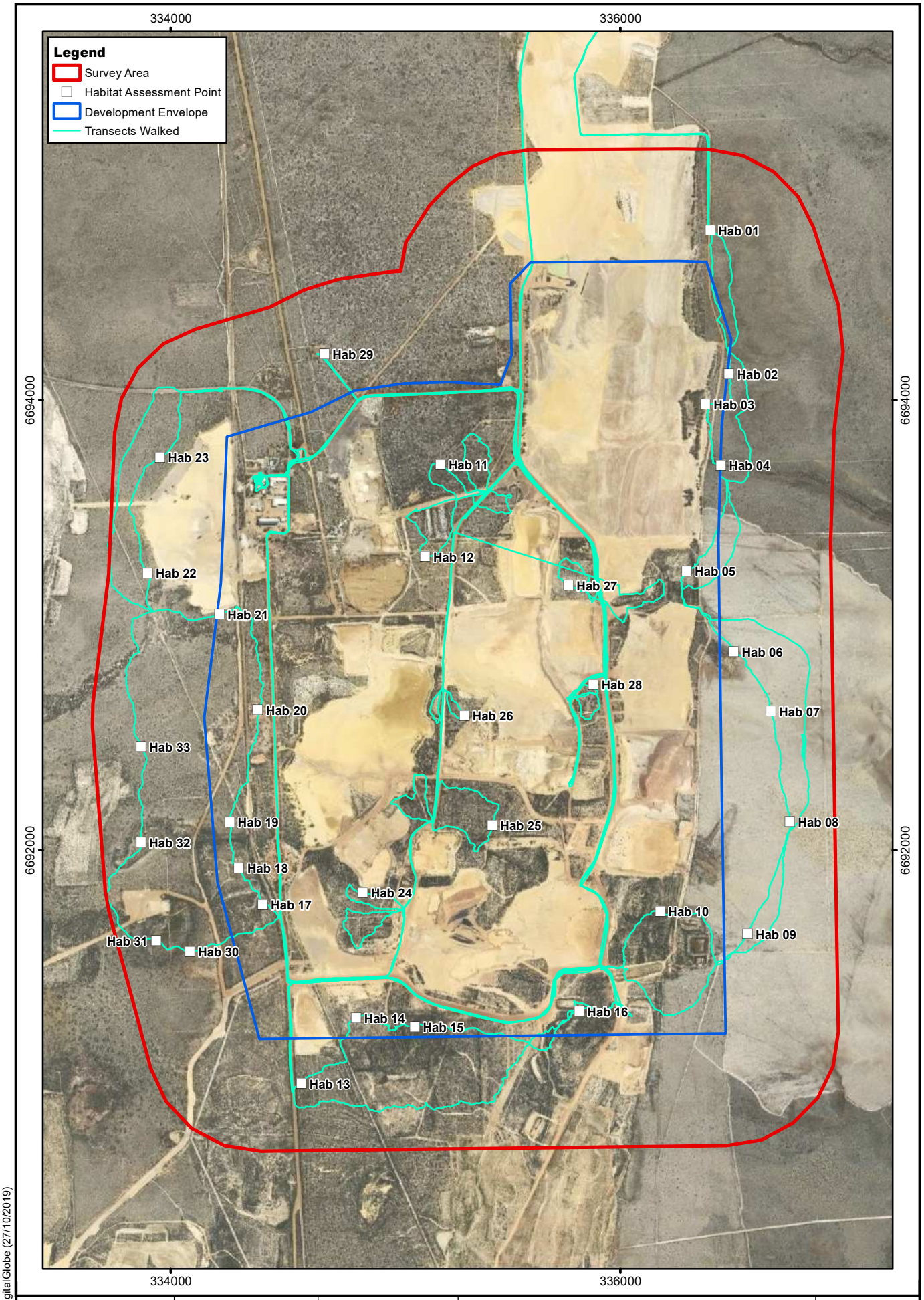
2.6 Field Survey

2.6.1 Basic Fauna Survey

The field survey was carried 12th - 13th July 2021. The study area was surveyed by vehicle and on foot. The areas traversed are shown in Figure 6.

The field study component of a basic fauna survey is primarily to identify the fauna habitats present in the study area. Habitats were assessed as the site was traversed, and assessment points undertaken at 33 locations (Figure 6).

In addition, all vertebrate fauna encountered during the field survey were recorded. The fauna species recorded are usually conspicuous species such as birds, large mammals and diurnal reptiles. The presence of other species may be inferred from evidence such as tracks, burrows, scats or evidence of foraging. Particular attention was paid to searching for evidence of conservation significant species, or habitats likely to support conservation significant species.



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MGA94 (Zone 50)

Western Wildlife

Eneabba Phase 3 Project
Survey Effort

Figure: **6**

2.6.2 Targeted Carnaby's Cockatoo Habitat Survey

A survey for Carnaby's Cockatoo habitat was undertaken across the study area, focussing on the identification of potential foraging, roosting or breeding habitat.

Foraging habitat was identified as vegetation including known food plants for Carnaby's Cockatoo, such as *Banksia spp*., *Hakea spp*., *Eucalyptus spp*., or introduced *Pinus spp*. Vegetation was classified into the following values:

- **Nil** – vegetation contains no food plants likely to sustain Carnaby's Cockatoo, e.g., cleared areas.
- **Low** – vegetation contains occasional food plants, e.g., scattered trees, farmland with weeds known to support foraging.
- **Moderate** – vegetation contains a moderate proportion of important food plants, e.g., vegetation types are known to be important for supporting Carnaby's Cockatoo (such as Banksia shrublands and woodlands) that are in degraded condition, or vegetation types with a moderate proportion of food plant species.
- **High** – vegetation contains a large proportion of important food plants, e.g., vegetation types are known to be important for supporting Carnaby's Cockatoo (such as Banksia shrublands and woodlands) that are in good condition.

Breeding habitat was identified as tree species known to support breeding by Carnaby's Cockatoo, with a diameter at breast height (DBH) of at least 30cm.

Roosting habitat is usually in tall trees, often near water. Vegetation types that may support roosting were identified during the basic survey.

2.7 Habitat Assessment and Mapping

Habitat mapping was undertaken using landform descriptions and vegetation mapping, (created by Woodman Environmental Consulting in 2010 and provided by Iluka Resources Limited), observations made by fauna personnel in the field and interpretation of aerial photography. Important elements of each habitat likely to be important for fauna were identified. Habitat elements may include, but are not limited to, rocky crevices, caves, tree hollows, tree crevices, leaf litter or sands suitable for burrowing.

2.8 Assessment of Conservation Significance

2.8.1 Legislative Protection for Fauna

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the Commonwealth Government's primary piece of environmental legislation. Listed under Part 3 of the EPBC Act are 'Matters of National Environmental Significance' (MNES); these include threatened species, threatened ecological communities and migratory species. Threatened fauna species are assessed against categories based on International Union for Conservation of Nature (IUCN) criteria.

The migratory species listed under the EPBC Act are those recognised under international agreements. These agreements are the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), or species listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) for which Australia is a range state.

Matters of National Environmental Significance (MNES) include the following categories:

- **Extinct in the wild (EW)**: 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 (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.
- **Migratory (Mi):** Taxa listed under international agreements to which Australia is a party.

Reports on the conservation status of most vertebrate fauna species have been produced by the federal Department of Agriculture, Water and the Environment (DAWE) in the form of Action Plans. An Action Plan is a review of the conservation status of a taxonomic group against IUCN categories. Action Plans have been prepared for amphibians (Tyler 1998), reptiles (Cogger *et al*. 1993), birds (Garnett *et al*. 2011) and mammals (Woinarski *et al*. 2014). These publications also use categories similar to those used by the EPBC Act. The information presented in some of the earlier Action Plans may be out of date due to changes since publication.

The *Biodiversity Conservation Act 2016* (BC Act) is State legislation that aims to conserve and protect biodiversity and biodiversity components in Western Australia, including threatened fauna. It is administered by the Department of Biodiversity, Conservation and Attractions (DBCA). In addition to threatened fauna, the BC Act has scope to protect threatened ecological communities and important habitats.

Fauna species are listed under the BC Act as threatened species using IUCN categories, or as specially protected species, as described below.

Threatened Species:

- **Extinct in the wild (EW)**: 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 (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.

Specially Protected Species:

- **Migratory (Mi)**: A subset of the migratory fauna that are known to visit Western Australia that are protected under the international agreements or treaties, excluding species that are listed as Threatened species.
- **Conservation dependent fauna (CD):** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened
- **Other specially protected species (OS):** fauna in need of special protection to ensure their conservation.

The BC Act supersedes the *Western Australian Wildlife Conservation Act 1950* (WC Act).

Priority species are not listed under State or Commonwealth Acts. In Western Australia, DBCA maintains a list of Priority Fauna made up of species that are possibly Threatened but do not meet adequacy of survey requirements or are otherwise data deficient. There are four levels of Priority as defined by DBCA, as listed below.

- **Priority 1:** Poorly known species (on threatened lands)
- **Priority 2:** Poorly known species in few locations (some on conservation lands)
- **Priority 3:** Poorly known species in several locations (some on conservation lands)
- **Priority 4:** Rare, near threatened and other species in need of monitoring

2.8.2 Levels of Conservation Significance in this report

Five levels of conservation significance are used within this report to indicate the level of significance of fauna species, according to the following criteria:

- **Threatened (T):** Taxa listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the EPBC Act and/or BC Act. These species are grouped as they are all species considered to be at risk of extinction, are often rare and are likely to be subject to on-going threatening processes.
- **Migratory (Mi):** Taxa listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened. These species are grouped as they are not necessarily rare but may be dependent on specific habitats for a portion of their life-cycle. For these species, loss of important foraging, breeding or stop-over sites may have a disproportionately large impact on populations.
- **Specially Protected (SP):** Taxa listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act. These species are not necessarily rare but may be dependent on on-going conservation to ensure their protection.
- **Priority (P):** Taxa listed as Priority by DBCA. These species are grouped as they are either conservation dependent or data deficient and in need of further survey.
- **Locally Significant (LS):** Locally significant taxa are not listed under State or Commonwealth Acts or in publications on threatened fauna or as Priority species by DBCA but are considered by the author to potentially be of local significance because they are at the limit of their distribution in the area, they have a very restricted range or they occur in breeding colonies (e.g., some waterbirds). This level of significance has no legislative recognition and is based on interpretation of information on the species patterns of distribution. For example, the Government of Western Australia (2000) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Bush Forever. Recognition of such species is consistent with the aim of preserving regional biodiversity.

2.9 Likelihood of Occurrence

Fauna of conservation significance were assessed and ranked for their likelihood of occurrence in the study area, according to the criteria in Table 2.

Table 2. Criteria for assessing likelihood of occurrence.

Likelihood	Criteria
Unlikely	• The study area is outside the current known distribution of the species as presented in the literature. • No suitable habitat was identified as being present during the field survey. • For some species, individuals may occur occasionally as vagrants, especially if suitable habitat is located nearby, but the study area itself would not support the species. • May include species generally accepted as being locally extinct.
Possible	• The study area is within or just outside the current known distribution of the species, as presented in the literature. • Any habitat present is either limited in extent or of marginal quality at best. • No recent or nearby records of the species on databases. • The species is generally known to be less common in the vicinity of the study area (e.g., for inland sites, where the species usually occurs on the coast).
Potential	• The study area is within the current known distribution of the species, as presented in the literature. • Habitat of reasonable quality was identified as being present during the field survey. • There are some recent and/or nearby records of the species of databases.
Likely	• The study area is well within the current known distribution of the species, as presented in the literature. • Habitat of good quality was identified as being present during the field survey. • Many recent and nearby records of the species on databases.
Known to occur	• The species was positively identified in the study area during this field survey or recorded as occurring in the study area on previous recent field surveys. • Note that for a species 'known to occur', the habitat may still be marginal and therefore the population may be small, or the species may visit the site irregularly.

3. Survey Limitations

Various factors can limit the effectiveness of a fauna survey. Pursuant to EPA Technical Guidance (EPA 2020), these factors have been identified and their potential to impact on the effectiveness of the surveys has been assessed in Table 3 below. All fauna surveys have limitations, and not all fauna species present on the site are likely to be sampled during a survey. Fauna may not be recorded because they are rare, they are difficult to trap or observe, or because they are only present on the site for part of the year.

Table 3. Fauna survey limitations.

Potential Limitation	Extent of limitation for the fauna survey	
Availability of data and information	Not limiting	Several fauna studies have been undertaken in the vicinity of the project area, including trapping surveys, so there is a relatively large amount of local data available.
Competency /experience of the team carrying out the survey	Not limiting	Both zoologists have 21 years' experience with fauna surveys in Western Australia. Both have previously undertaken surveys in the bioregion and have undertaken targeted surveys for Carnaby's Cockatoo habitat throughout the south-west.
Scope of survey (e.g., faunal groups excluded from the survey)	Not limiting	As a basic survey, fauna observations were restricted mainly to diurnal species such as birds and secondary signs. This limited the number of species that could be recorded as part of this survey, but this is ameliorated by the fauna data available for the region.
Timing, weather and season	Not limiting	A basic fauna survey can be undertaken at any time of the year, as the primary purpose is habitat assessment. The survey was undertaken in July, when Carnaby's Cockatoo was present as a winter visitor to the region, allowing for direct observations and observations of fresh foraging signs.
Disturbance that may have affected the results	Not limiting	Although parts of the study area were recently burnt, unburnt habitat was available to sample.
Proportion of fauna identified, recorded and/or collected.	Not limiting	Only a small proportion of the fauna were recorded during this survey, however, a complete sample was not the purpose of the survey. There is a relatively large amount of contextual information available from the local area.
The adequacy of the survey intensity and proportion of survey achieved (e.g., extent to which the area was surveyed)	Not limiting	Sufficient time was allowed to survey all habitats. A representative proportion of all habitats was able to be accessed and surveyed.
Remoteness and/or access problems	Not limiting	Entire Study Area accessible on foot.
Problems with data and analysis, including sampling biases	Not limiting	No complex analyses were undertaken, and no problems were noted.

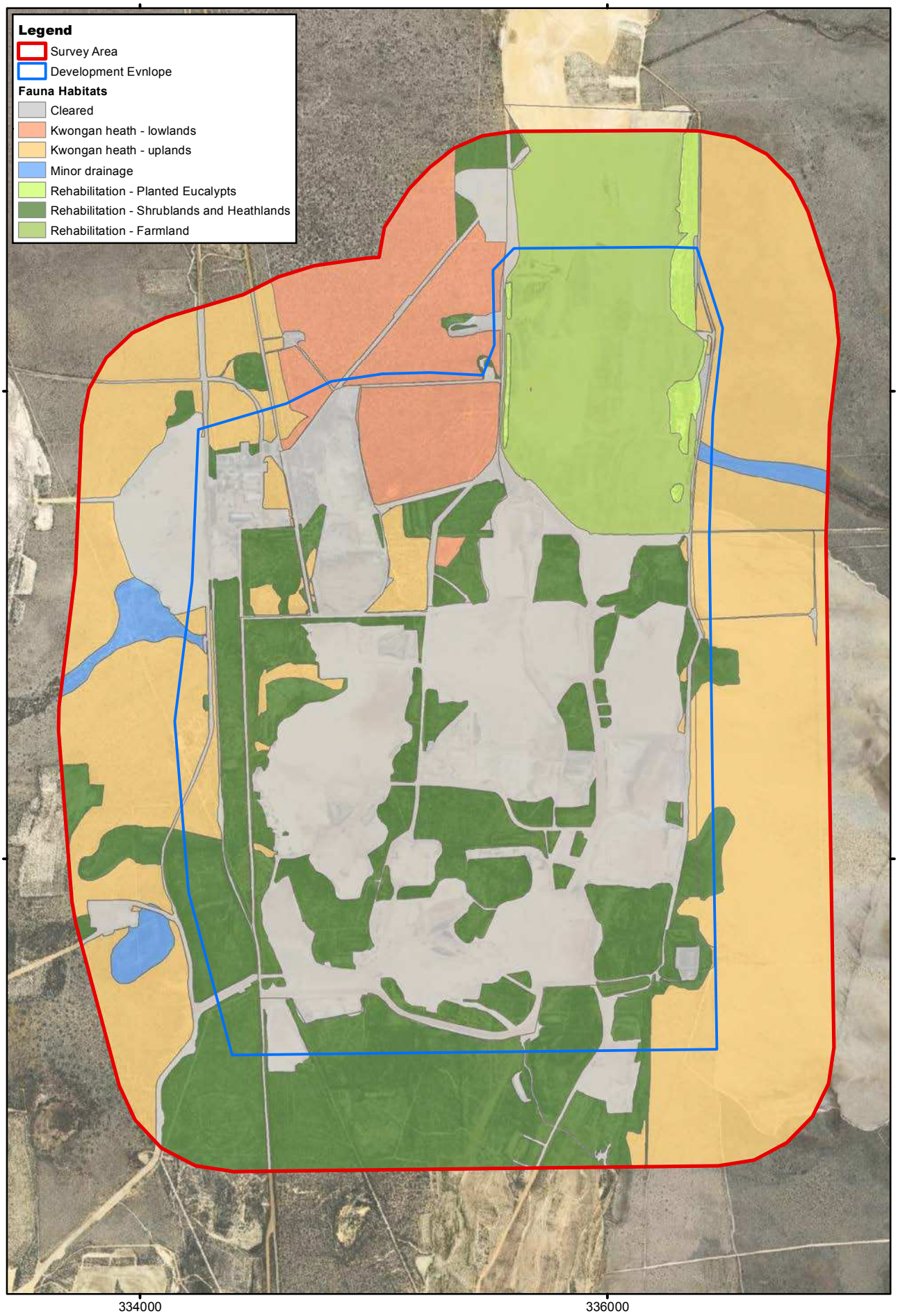
4. Fauna Habitat

4.1 Habitats of the Study Area

Six fauna habitats, plus cleared areas, were identified in the study area (Table 4, Figure 7). Habitat assessment photo points are shown in Figure 6 and Appendix 5. The native habitats are widespread in the IBRA subregion.

Table 4. Fauna habitats in the study area.

Habitat	Key Habitat Elements	Total Area (ha)
Kwongan heath - uplands	• Likely to support a substantially intact faunal assemblage. • Foraging habitat for Carnaby's Cockatoo (*Banksia spp* and *Hakea spp*.) • Nectar resource for honeyeaters and Honey Possum • Emergent eucalypts provide crevices for arboreal reptiles. • Nesting habitat for small birds.	392.2
Kwongan heath - lowlands	• Likely to support a substantially intact faunal assemblage. • Nectar resource for honeyeaters and Honey Possum • Emergent eucalypts provide crevices for arboreal reptiles. • Nesting habitat for small birds.	87.0
Minor drainages	• Habitat for frogs • Nesting habitat for small birds.	17.9
Rehabilitation – shrublands and heaths	• Foraging habitat for Carnaby's Cockatoo (*Banksia spp* and *Hakea spp*.) • Nectar resource for honeyeaters and Honey Possum • Nesting habitat for small birds.	311.3
Rehabilitation – planted eucalypts	• Eucalypts provide crevices for arboreal reptiles. • Roosting and nesting sites for some birds.	11.8
Rehabilitation – farmland	• Foraging habitat for Emu, kangaroos and aerially foraging birds.	121.2
Cleared	• None noted	361.8
	Total:	**1303.1**



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Scale: 1:22,500
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Western Wildlife

Eneabba Phase 3 Project
Fauna Habitats

Figure: **7**

4.1.1 Kwongan Heath - Uplands

Kwongan heath is a floristically diverse low heath or shrubland dominated by sclerophyllous plants, particularly from the families Myrtaceae and Proteaceae (Plates 1 – 5). It occurs on the sandplains and lateritic low rises that comprise the majority of the survey area. The habitat contains a mix of shrub species, sometimes with emergent low eucalypts or Woody Pear (*Xylomelum angustifolium*). The upland Kwongan heath is likely to support a relatively intact faunal assemblage, lacking only those species locally extinct in the bioregion (mainly critical weight-range mammals). This habitat contains variable amounts of important Carnaby's Cockatoo food-plants, such as *Banksia sessilis*, *Banksia kippistiana* and *Banksia attenuata*.

Plate 1. Kwongan heath.

Plate 2. Recently burnt kwongan heath on a low laterite rise.

Plate 3. Kwongan heath with patch of *Banksia sessilis*.

Plate 4. Kwongan heath with emergent eucalypts and *Banksia spp*.

Plate 5. Kwongan heath.

4.1.2 Kwongan Heath - Lowlands

This habitat is structurally similar to the upland Kwongan Heath, but is dominated by *Allocasuarina microstachya*, *Melaleuca spp*. and *Verticordia spp*., lacking the *Banksia spp*. found in other areas (Plate 6). It occurs on sandy and sandy-clay flats and low-lying areas. It is also likely to support an intact faunal assemblage, but it lacks important food-plants for Carnaby's Cockatoo.

Plate 6. Kwongan heath dominated by *Allocasuarina sp*.

4.1.3 Minor Drainages

Minor drainages occur in low-lying areas and are vegetated with a *Melaleuca* shrubland (Plates 7 and 8). This habitat may support frogs, but in most years is unlikely to hold water for long and does not provide habitat for more aquatic species such as freshwater fish, waterbirds and turtles.

Plate 7. Minor drainage on eastern edge of survey area.

Plate 8. Minor drainage on western edge of the survey area.

4.1.4 Rehabilitation – Shrublands and Heaths

The rehabilitation varied in age, structure and plant species composition, but overall tends to be a shrubland or heathland with emergent Eucalypts (Plates 9 - 12). Many areas include important food plants for Carnaby's Cockatoo, including *Banksia spp*., but some areas were entirely myrtaceous and lacked food plants for cockatoos. Rehabilitation areas are likely to support some native fauna, particularly birds and larger native mammals such as kangaroos and the Echidna. Reptiles are likely to be slower to colonise these areas.

Plate 9. Rehabilitation.

Plate 10. Rehabilitation.

Plate 11. Rehabilitation.

Plate 12. Rehabilitation with numerous seedling *Banksia sessilis*.

4.1.5 Rehabilitation – Planted Eucalypts

Stands of planted eucalypts occur around the farmland. These areas have little understory to no understory vegetation (Plate 13). Planted eucalypts are likely to support a small group of native fauna, including birds that feed in eucalypt foliage and flowers, arboreal reptiles and larger mammals such as kangaroos.

Plate 13. Rehabilitation with planted eucalypts.

4.1.6 Rehabilitation - Farmland

Farmland is unlikely to support more than a few generalist fauna species (Plate 14).

Plate 14. Rehabilitation - farmland.

4.2 Important Habitats

All habitats have some importance in that they support native fauna, however, habitats may be of particular importance if they:

- support very diverse or unique faunal assemblages
- are restricted or rare in the region (and thus the associated faunal assemblages are restricted or rare)
- are refugia (e.g., from drought or fire)
- provide ecological linkage
- support conservation significant fauna

The habitats in the study area are common and widespread in the IBRA subregion and the faunal assemblages present are likely to be relatively diverse, but typical of the region. Rehabilitation areas are likely to support a similar, but smaller, subset of the species that occur in the Kwongan heaths. Although all vegetation has some value as ecological linkage, the habitats in the study area are unlikely to be part of a significant ecological linkage. There is native vegetation to the west, south and east of the study area, and a large proportion of the proposed development envelope is currently cleared (Figure 7).

The key value noted for both the upland Kwongan heaths and the shrublands in rehabilitation areas is in providing foraging habitat for Carnaby's Cockatoo (*Calyptorhynchus latirostris*).

5. Vertebrate Fauna

5.1 Vertebrate Fauna Assemblage

The results of the literature review and the field survey were combined to form lists of the vertebrate fauna potentially occurring in the study area. The lists of frogs, reptiles, birds and mammals that potentially occur in the study area are presented in Appendices 1 – 4 and are summarised below in Table 5.

Table 5. Summary of vertebrate fauna potentially occurring in the study area.

Taxon	Total species	Introduced species	Recorded on this survey	Conservation significant species				
				Threatened	Migratory	Specially Protected	Priority	Locally Significant
Amphibians	10	0	2	-	-	-	-	-
Reptiles	60	0	1	-	-	-	2	-
Birds	118	3	32	2	1	1	-	-
Mammals	26	7	5	-	-	-	1	-
Totals:	**214**	**10**	**40**	**2**	**1**	**1**	**3**	**0**

The faunal assemblage of the study area is likely to be largely intact, as it is situated in a region of continuous habitat where habitat loss and fragmentation are minimal. The assemblage is dominated by species with a southwestern distribution, but also includes Eremaean species on the western edge of their range.

The predicted faunal assemblages and fauna of conservation significance are discussed in the sections below.

5.1.1 Amphibians

There are ten species of frog that have the potential to occur in the study area of which two (Bleating Frog - *Crinia pseudinsignifera* and Crawling Toadlet - *Pseudophryne guentheri*) were observed calling during the 2021 site visit (Appendix 1). Nine of the ten species were recorded in previous studies around Eneabba (Appendix 1). In general, the frog species that occur in the study area are common and widely distributed in either the southwest or arid regions.

The frogs that potentially occur fall into roughly three groups. The first are those species that rely on permanent waters or at least permanently damp habitats (i.e. tree frogs). These species are unlikely to occur in areas of dry Kwongan heath but are likely to occur within the wider area and in man-made habitats such as farm dams and tanks. The second are burrowing frogs (e.g. the Moaning Frog, *Heleioporus eyrei*). These species require water to breed, and depending on the species, will breeding in seasonal creeks, salinity banks, gravel pits and other seasonally wet areas. During the non-breeding season, these species range away from water and be found in terrestrial habitats where they forage and/or aestivate underground. These species may breed in the study area where water collects, though no significant frog breeding habitat appears to be present. The Turtle Frog is the sole member of the third group. The Turtle Frog does not require free water to breed as the tadpoles develop into frogs within the egg. This species potentially occurs in sandy soils across the study area.

5.1.2 Reptiles

There are 60 species of reptile that have the potential to occur in the study area (Appendix 2). Only one reptile species was observed in the study area, Gould's Goanna (*Varanus gouldii*), although this is not unexpected during a brief site visit during winter. A total of 36 species have been recorded in previous studies in the vicinity of Eneabba (Appendix 2). The reptile assemblage is likely to be largely intact.

Many of the reptiles present have broad habitat preferences and therefore potentially occur throughout the study area. Species that favour more wooded habitats are likely to favour the areas of emergent *Eucalyptus spp.* including the Black-tailed Monitor (*Varanus tristis*) and Fence Skink (*Cryptoblepharus buchananii*). The rehabilitation areas are likely to support a similar, but much smaller, subset of the species present in the Kwongan heaths.

5.1.3 Birds

There are 118 species of bird that have the potential to occur in the study area, of which 32 were recorded opportunistically during the 2021 site visit (Appendix 3). A total of 87 species have been recorded on previous surveys in the vicinity of Eneabba (Appendix 3).

The bird assemblage is relatively diverse, with the floristically rich Kwongan heaths supporting a variety of nectar-feeding honeyeaters and small insectivores. When seeding, the scattered *Eucalyptus todtiana* and shrubs such as *Banksia*, *Hakea*, *Acacia* and *Allocasuarina* spp. provide food for granivorous species such as parrots, pigeons and cockatoos. Birds of prey forage over the low vegetation, roosting or nesting in the taller trees, particularly in the planted eucalypts in the rehabilitation areas. Species that rely on eucalypts, such as the Weebill (*Smicrornis brevirostris*) are also likely to favour the planted eucalypts.

Many species are likely to breed in the study area, constructing nests in shrubs in densely vegetated areas in most habitats. No nest hollows were observed, but there is likely to be some small hollows present in the low eucalypts and possibly in the planted eucalypts.

Waterbirds, such as ducks, herons, egrets and ibis occur in the region and may occur nearby on farm dams, wetlands or rivers. No waterbirds have been listed in Appendix 3, as there is no significant waterbird habitat present in the study area, however, these species may occur as vagrants from time to time.

5.1.4 Mammals

There are 26 species of mammal that have the potential to occur in the study area, of which 19 are native and seven introduced (Appendix 4). Five species of mammal were recorded opportunistically during the site visit, three native species (Echidna - *Tachyglossus aculeata*, Western Grey Kangaroo - *Macropus fuliginosus* and Euro - *Osphranter robustus*) and two introduced (Fox – *Vulpes vulpes* and Rabbit – *Oryctolagus cuniculus*)(Appendix 4). A total of 15 species have been recorded in previous studies in the vicinity of Eneabba (Appendix 4). Many species of critical weight range mammal are locally extinct in the region, including the Boodie (*Bettongia lesueur ogilbyi*), Tammar Wallaby (*Notamacropus eugenii*) and Quenda (*Isoodon fusciventer*).

Previous surveys in the area involving trapping have recorded the Honey Possum (*Tarsipes rostratus*), White-tailed Dunnart (*Sminthopsis granulipes*) and Ash-Grey Mouse (*Pseudomys albocinereus*) (Appendix 4). These are likely to be common across the floristically diverse kwongan heathlands of the study area, and connectivity of habitat is important for these small mammals. The Honey Possum relies on a diverse array of shrubs to cater for its nectarivorous habits and the dense heathland provides shelter from predators.

Several of the mammals listed in Appendix 4 are insectivorous bats. These species are likely to forage over the study area at night. Most species roost in tree hollows or crevices and may roost in the emergent eucalypts in the Kwongan heathlands or in other sheltered locations such as grasstree skirts.

5.2 Vertebrate Fauna of Conservation Significance

There are seven vertebrate fauna of conservation significance that potentially occur in the study area: two Threatened, one Migratory, one Specially Protected and three Priority species (Table 6). No locally significant species were identified, as it is considered that most species are widespread in the shrublands and heathlands of the region. Each species is summarised in Table 6 and discussed in the sections below. The results of the DBCA Threatened and Priority Fauna Database extract are shown on Figure 8 and the EPBC Protected Matters Search Tool extract is shown in Appendix 6.

Several conservation significant species listed on database searches in the area have been omitted from the listed of potential fauna in Appendices 1 – 4 and the discussion below. This includes the following species:

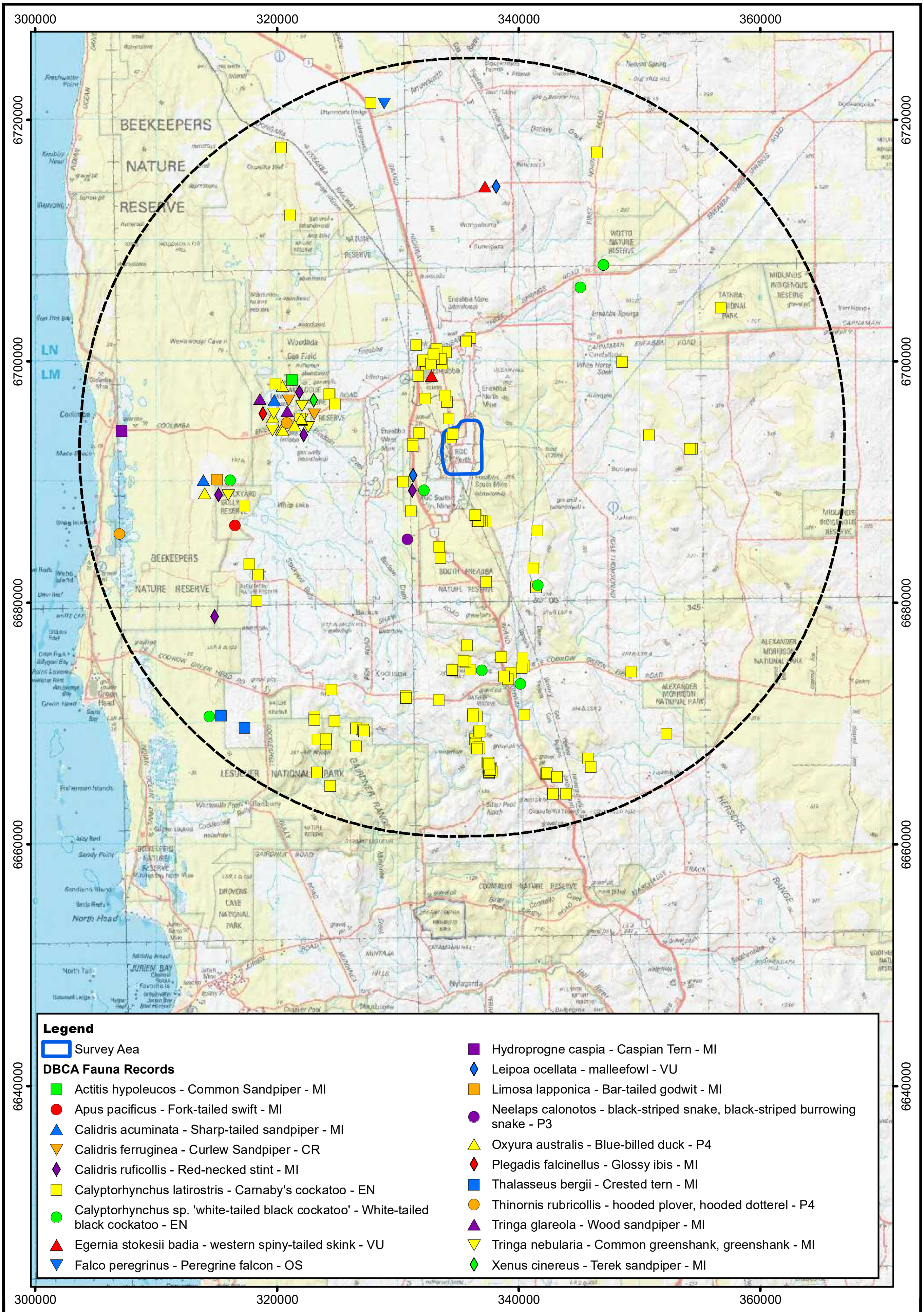
- The Dibbler (*Parantechinus apicalis* - En); although recorded nearby on databases (Appendix 6), is not known from the mainland in this region, occurring only on islands off Jurien Bay.
- The Western Spiny-tailed Skink (*Egernia stokesii badia* - En); although recorded in the region it occurs in York Gum woodlands that are absent from the study area.
- The Chuditch (*Dasyurus geoffroii* - Vu) is locally extinct in the region.
- The following bird species require wetland or coastal habitats that are absent from the study area:
    - Common Sandpiper (*Actitis hypoleucos*) - Mi
    - Sharp-tailed Sandpiper (*Calidris acuminata*) - Mi
    - Curlew Sandpiper (*Calidris ferruginea*) – Mi/Cr
    - Red-necked Stint (*Calidris ruficollis*) - Mi
    - Caspian Tern (*Hydroprogne caspia*) - Mi
    - Bar-tailed Godwit (*Limosa lapponica*) - Mi
    - Blue-billed Duck (*Oxyura australis*) – P4
    - Glossy Ibis (*Plegadis falcinellus*) - Mi
    - Crested Tern (*Thalasseus bergii*) - Mi
    - Hooded Plover (*Thinornis rubricollis*) – P4
    - Wood Sandpiper (*Tringa glareola*) - Mi
    - Common Greenshank (*Tringa nebularia*) - Mi
    - Terek Sandpiper (*Xenus cinereus*) - Mi

Table 6. Summary of conservation significant vertebrate fauna in the study area.

Species	Conservation Status				Likelihood of occurrence	Explanation of likelihood of occurrence
	EPBC Act	BC Act	DBCA Priority	Locally Significant		
Calyptorhynchus latirostris **Carnaby's Cockatoo**	En	En			Known to occur	Night roost and foraging signs recorded in the study area.
Leipoa ocellata **Malleefowl**	Vu	Vu			Possible	Records within 30km, but shrubland habitat in study area generally too low.
Apus pacificus **Fork-tailed Swift**	Mi	Mi			Potential	May occur but only as an aerial species overflying the study area.
Falco peregrinus **Peregrine Falcon**		OS			Potential	May forage in the study area but no breeding habitat present.
Aspidites ramsayi **Woma** (southwest pop^{n})			P1		Unlikely	Likely to be locally extinct.
Neelaps calonotos **Black-striped Snake**			P3		Likely	Nearby record to the south and suitable habitat present in study area.
Macropus irma **Western Brush Wallaby**			P4		Possible	No nearby records, but within the known range of the species.

5.2.1 Threatened Fauna

There are two Threatened vertebrate species that potentially occur in the study area (Table 6). Threatened species are those that are considered in danger of extinction as their populations have declined and/or are still declining, and their total population size is small and/or fragmented or geographically restricted. Sites that support these species may be important for their long-term conservation, particularly if the site supports a resident or breeding population.



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Eneabba Phase 3 Project
DBCA Threatened and Priority vertebrate fauna records

Figure: 8

Carnaby's Cockatoo – *Calyptorhynchus latirostris*

Carnaby's Cockatoo is listed as Endangered under the BC Act and EPBC Act.

Carnaby's Cockatoo is endemic to the southwest of Western Australia, occurring mostly in the wheatbelt but also on the Swan Coastal Plain and wetter southwest (Johnstone and Storr 1998). The population size is estimated to be 40,000 birds (or possibly between 10,000 – 60,000) (Garnett *et al*. 2011). There are many records of this species within 20km on DBCA'S Threatened and Priority Fauna Database (Figure 8).

Carnaby's Cockatoo nests in large eucalypt hollows, usually in smooth-barked species such as Salmon Gum or Wandoo, though they may nest in any suitably sized hollow (DSEWPaC 2012, DPAW 2013). The breeding season is July to December, and for breeding to be successful, birds rely on the presence of foraging habitat within 12km of the breeding site (DPAW 2013). During the non-breeding season, birds generally move west or south towards the coast, foraging in proteaceous shrublands and woodlands. Key threats for this species include loss of breeding habitat, loss of feeding habitat in close proximity to breeding habitat, loss of non-breeding season foraging habitat and night-roost sites, clearing for mining and extraction activities and illegal shooting (DPAW 2013). Carnaby's Cockatoo has been recorded on multiple occasions within 30 km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 8).

- **Breeding habitat.** Carnaby's Black-Cockatoo is known to breed in the region, with the nearest breeding records 18 - 20km south of the study area (Figure 9). No potential breeding habitat is present in the study area, and Johnstone and Kirkby (2007, 2013) found no evidence of potential breeding habitat in the vicinity of Eneabba.

- **Roosting habitat**. Carnaby's Cockatoo usually roost in tall trees, often in riparian habitats (DSEWPaC 2012). Thirty Carnaby's Cockatoo were recorded roosting overnight in exotic eucalypts and pines planted at the Iluka administration building (Figure 10, Plate 15). The nearest known roost sites are 10km south in farmland (Figure 9) and 5km north at Eneabba (Johnstone and Kirby 2013). Most of the remainder of the study area is unsuitable for roosting, except for small stands of planted eucalypts.

- **Foraging habitat**. The study area contains 939.82ha of foraging habitat for Carnaby's Black-Cockatoo, in Kwongan heath uplands supporting *Hakea* spp. and *Banksia* spp. and in revegetation areas with a similar range of food-plants. Evidence of foraging activity was recorded across the study area, mostly on *Banksia sessilis*, but also on *Banksia attenuata*, *Banksia kippistiana*, *Lambertia multiflora* and other species of *Banksia* and *Hakea* (Figure 10, Plates 16 and 17). The foraging value of the vegetation in the Kwongan heath uplands and rehabilitation areas was categorised as moderate – high as the occurrence of food plants is patchy in both habitats. The recently burnt area was classified as moderate, as although food-plants are present, they are not currently providing high value foraging habitat.

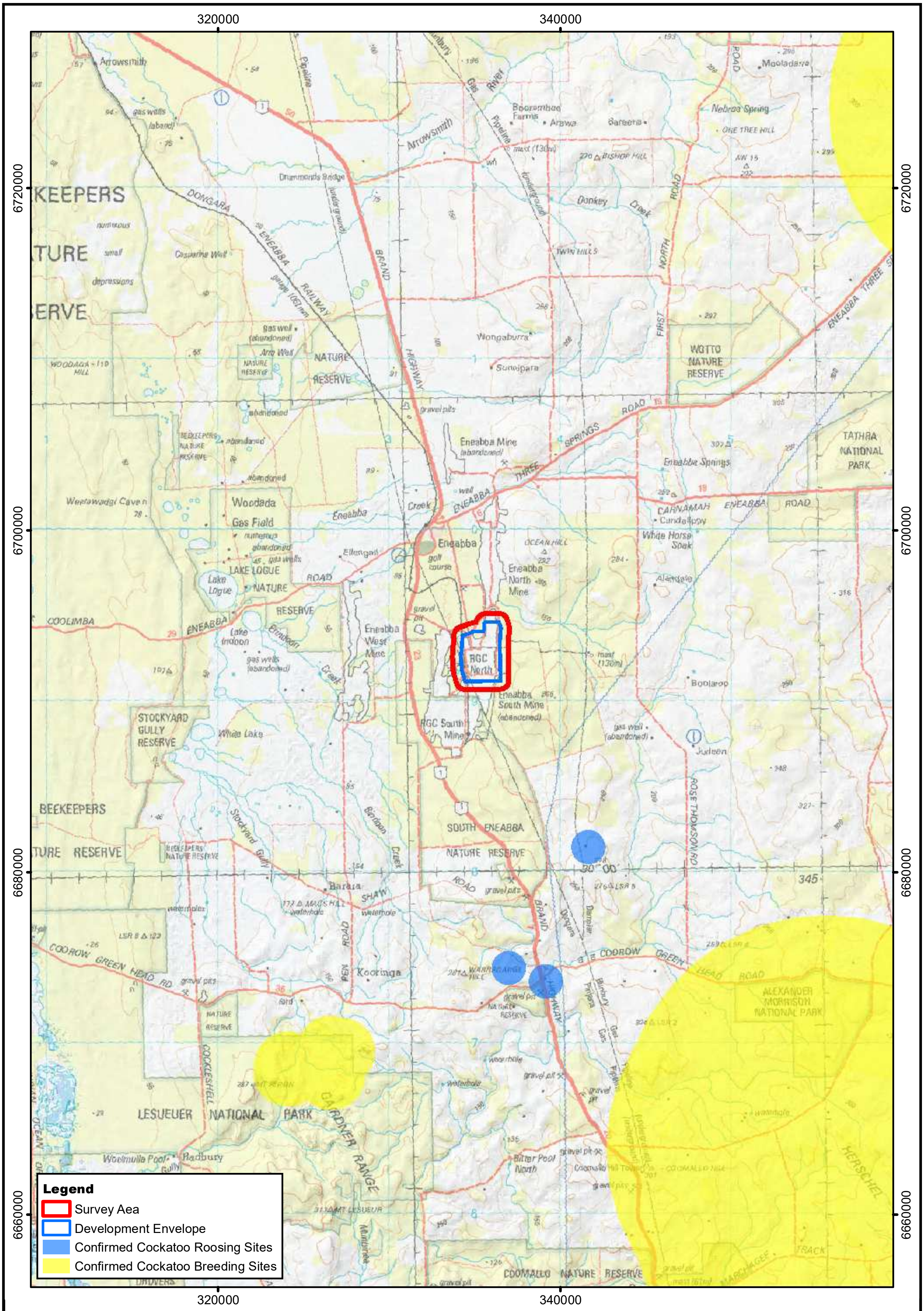
Vegetation that provides food resources in the non-breeding season, as well as the night roosts and water sources that allow birds to take advantage of these resources, can be considered habitat critical to the survival of Carnaby's Cockatoo (DPAW 2013).

Plate 15. Carnaby's Cockatoo roosting at the administration building, July 2021.

Plate 16. Evidence of cockatoo foraging on *Banksia attenuata*.

Plate 17. Evidence of cockatoo foraging on *Banksia sessilis*.

Plate 18. Evidence of cockatoo foraging on *Banksia kippistiana*.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RGC South Mine
Eneabba North Mine
Eneabba South Mine
Eneabba West Mine
Eneabba Mine
SOUTH ENEABBA NATURE RESERVE
LESUEUER NATIONAL PARK
TATHRA NATIONAL PARK
WOTTO NATURE RESERVE
STOCKYARD GULLY RESERVE
LAKE LOGUE NATURE RESERVE
ALEXANDER MORRISON NATIONAL PARK
COOMALLO NATURE RESERVE
BRAND HIGHWAY
Arrowsmith
Woodada Gas Field
Koorimga
Badbury
Judeen
Boolaroo
Candellppy
Sunnipara
Wongaburra
Barasra
Nebroo Spring
Mooladarra

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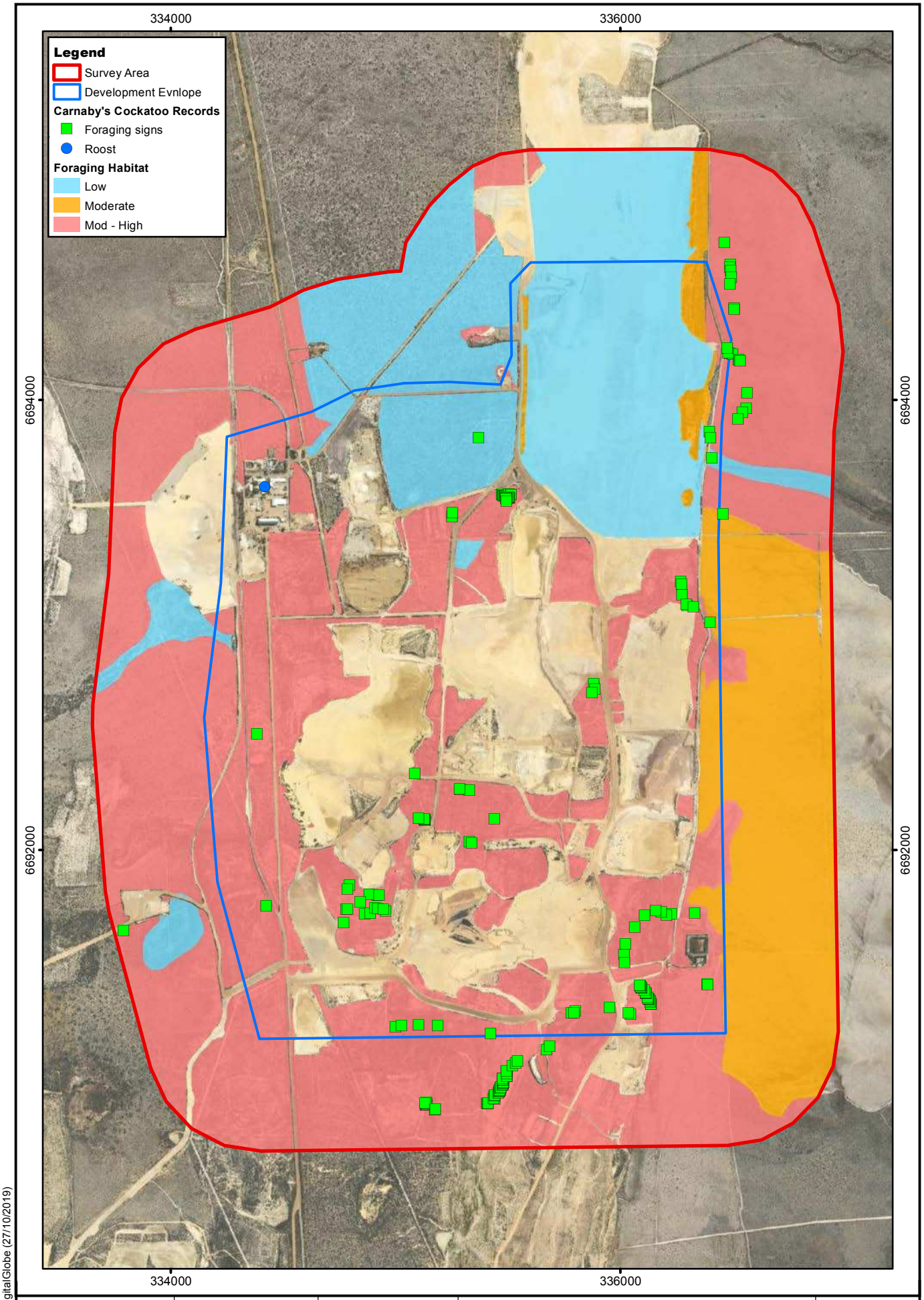

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Western Wildlife

Eneabba Phase 3 Project
Carnaby's Cockatoo Survey records

Figure: **10**

Malleefowl – Leipoa ocellata

The Malleefowl is listed as Vulnerable under the BC Act and EPBC Act.

The Malleefowl is a large ground-dwelling bird inhabits mallee woodlands and *Acacia* shrublands that have a dense layer of leaf litter (Johnstone and Storr 1998). It is thought never to have been common in the vicinity of the study area, with higher density populations occurring to the east of a line between Kalbarri and Wongan Hills (Abbott, 2008). Since European settlement, this range has contracted further (Abbott 2008, Benshemesh 2007).

There are two records of this species within 30km of the study area on the DBCA Threatened and Priority Fauna Database. Both records are relatively recent (2010 and 2014). Although some of the Kwongan heaths in the study area may be suitable habitat for foraging Malleefowl, much of the vegetation present is too low and sparse to support breeding and no nesting mounds were recorded during the field survey. The Malleefowl possibly occurs in the study area as occasional dispersing individuals, as this species is highly mobile. However, the study area is unlikely to provide important habitat for the Malleefowl.

5.2.2 Migratory Fauna

There is one Migratory vertebrate species that potentially occurs in the study area (Table 6). Migratory species are not always present at a site, but a particular site may have significance as a seasonal or ephemeral foraging, breeding or shelter area. Impacts to these sites may then impact the population both within the site and further afield.

Fork-tailed Swift – *Apus pacificus*

The Fork-tailed Swift is listed as Migratory under the BC Act and EPBC Act.

The Fork-tailed Swift is a non-breeding visitor to Australia between September and April (Boehm 1962, Johnstone and Storr 1998). While it can be common in the north, it is generally scarce in southwest Australia (Johnstone and Storr 1998). The bird is primarily observed foraging for insects in proximity to cyclonic weather (Boehm 1962). Although a migratory species, the Fork-tailed Swift has a large range and a large population that appears to be stable (BirdLife International 2021). There is a single record of this species within 30km on DBCA's Threatened and Priority Fauna Database, from Stockyard Gully Cave in 2009 (Figure 8). Although it is likely to occur periodically, in Western Australia the Fork-tailed Swift is a largely an aerial species and study area is not likely to be of particular importance to the species.

5.2.3 Specially Protected Fauna

There is one specially protected vertebrate species that potentially occurs in the study area (Table 6). The populations of Specially Protected species are large enough that they are not considered to be Threatened. However, they require on-going conservation intervention (i.e., Conservation Dependent) or be specially protected in order to prevent them from becoming Threatened.

Peregrine Falcon – *Falco peregrinus*

The Peregrine Falcon is listed as Other Specially Protected Fauna under the BC Act.

The Peregrine Falcon is a widespread bird of prey that globally has a very large range and a very large population that appears to be secure (BirdLife International 2021). In Western Australia the population is secure, though this species may experience reductions at a local level due to human disturbance at nesting sites (Debus 1998). The Peregrine Falcon nests mainly on ledges on cliffs or rocky outcrops, and it may also use tall trees (Johnstone and Storr 1998). This species often takes advantage of man-made structures such as abandoned open pits or quarries. There is a single record of this species within 30km of the study area on the DBCA Threatened and Priority Fauna Database (Figure 8), from the Western Flora Caravan Park in 2002. The Peregrine Falcon may forage in the study area, but its favoured breeding habitat is absent.

5.2.4 Priority Fauna

There are three Priority vertebrate fauna species that potentially occur in the study area (Table 6). Priority 1, 2 or 3 species need further survey effort, as insufficient data exist to adequately determine their status. Many Priority 1, 2 and 3 species are known from only a few records in a limited number of locations, thus determining their status in the study area may be problematic. Priority 4 species are considered to require regular monitoring, as although they are adequately known, they are either rare, near threatened or recently removed from the threatened list.

Woma – *Aspidites ramsayi*

The Woma is listed as Priority 1 by DBCA.

The Woma has severely declined in the wheatbelt, with the last confirmed record in 1989 at Watheroo (Bush *et al*. 2007). There are no records of this species within 30km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 8). The Woma favours sandplain habitats. Although habitats in the study area appear suitable and it may once have occurred in the region, it is considered highly likely to be locally extinct in the vicinity of the study area.

Black-striped Snake – *Neelaps calonotos*

The Black-striped Snake is listed as Priority 3 by DBCA.

This small fossorial snake has a coastal distribution from Dongara south to Mandurah. It inhabits coastal dunes and sandplains that support heath or *Banksia* woodland (Bush *et al*. 2007). The Black-striped Snake is active at night, spending most of its time in the leaf litter or soil. There is a single record of this species within 30km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 8). The record is relatively recent, from Warradarge (south of the survey area). This species is likely to occur on the sandy soils in the Kwongan heaths of the study area, though it is probably absent from the more lateritic uplands.

Western Brush Wallaby – *Notamacropus irma*

The Western Brush Wallaby is listed as Priority 4 by DBCA.

The Western Brush Wallaby is endemic to the southwest of Western Australia and occurs in open forests or woodlands (Van Dyck and Strahan 2008). There are no records of this species within 30km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 8), however, the study area is within its known range. The Western Brush Wallaby possibly occurs in the more wooded parts of the study area, from where it may shelter under trees or larger shrubs during the day, ranging out onto shorter vegetation to forage at night. The lack of records suggest that this distinctive species is uncommon in the region.

6. Invertebrate Fauna

This report is primarily concerned with vertebrate fauna and no comprehensive literature review was undertaken for this group. The invertebrate fauna of the study area are more species rich and abundant than the vertebrate fauna, but cataloguing their occurrence was outside the scope of this survey. However, a few invertebrates of conservation significance were recorded within 30km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 11, DBCA 2021) or are known to occur in the region.

6.1 Invertebrates of Conservation Significance

There are eight invertebrates of conservation significance recorded within 30km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 11) or otherwise known to occur in the region. Note that this may not represent all the conservation significant invertebrates in the region, as invertebrates are typically understudied and not often subject to opportunistic reporting by the general public. Determining the likelihood of occurrence for most species is hampered by lack of contextual data, with most species represented by very few records in the region and their habitat preferences poorly understood.

Table 7. Summary of conservation significant invertebrate fauna in the study area.

Species	Conservation Status				Likelihood of occurrence	Explanation of likelihood of occurrence
	EPBC Act	BC Act	DBCA Priority	Locally Significant		
Idiosoma nigrum **Shield-backed Trapdoor Spider**	Vu	En			Unlikely	Recent taxonomic changes mean that this species is no longer considered to occur in the area.
Idiosoma kwongan **Kwongan Heath Shield-backed Trapdoor Spider**			P1		Possible	Although not found in previous targeted surveys for this species, it's not possible to exclude this species as it's so poorly known.
Hemisaga vepreculae **A katydid**			P2		Potential	Recorded within 30km, suitable habitat probably present in the study area. Poorly known species.
Phasmodes jeeba **A katydid**			P2		Potential	Recorded within 30km, suitable habitat probably present in the study area. Poorly known species.
Synemon gratiosa **Graceful Sun-moth**			P4		Unlikely	Not recorded in the vicinity of the study area, this species is likely to prefer near-coastal habitats.
Hylaeus globuliferus **Woolybush Bee**			P3		Potential	Recorded nearby. Although the habitats of the study area generally lack woolybush except for small patches in the rehabilitation, this species also forages on other plants.
Austromerope poultoni **An earwig fly**			P2		Possible	Poorly known from a single nearby record, its habitat requirements are not well understood.
Antichiropus sulcatus **a millipede**				LS	Likely	This species has been recorded from the South Eneabba Nature Reserve and may occur in moist situations.

Shield-backed Trapdoor Spider – *Idiosoma nigrum*

The Shield-backed Trapdoor Spider is listed as Endangered under the BC Act and Vulnerable under the EPBC Act.

A recent review of the *Idiosoma* genus has resulted in *Idiosoma nigrum* being split into several newly recognized species (Rix *et al*. 2018). The species that retains the name *Idiosoma nigrum* occurs in the central and central-western wheatbelt, west to about Bolgart, New Norcia, Walebing and Bindi Bindi. Therefore, it is unlikely that this species occurs in the vicinity of the study area, and any records of this species in the local area are likely attributable to newly described species *Idiosoma kwongan*.

Kwongan Heath Shield-backed Trapdoor Spider – *Idiosoma kwongan*

The Kwongan Heath Shield-backed Trapdoor Spider is listed as Priority 1 by DBCA.

As stated above, the recent review of the *Idiosoma* genus has resulted in *Idiosoma nigrum* being split into several newly recognized species, of which *Idiosoma kwongan* is one (Rix *et al*. 2018). This species appears to be restricted to a small area between Eneabba, Green Head and Lesueur National Park (Rix *et al*. 2018). Known from few records, the status of this species in the vicinity of the study area is difficult to determine. Searches for shield-back trapdoor spiders in 2006 failed to record any sign of this species (Bamford 2007b), however, it possibly occurs in areas of Kwongan heath. It is likely to be absent from areas of rehabilitation due to ground disturbance.

Thorny Bush Katydid - *Hemisaga vepreculae*

The Thorny Bush Katydid is listed as Priority 2 by DBCA.

This species is a green flightless predatory species endemic to Western Australia (Rentz 2010). There is a single record of this species within 30km of the study area on DBCA's Threatened and Priority Fauna Database, northwest of Eneabba in 1980 (Figure 11, DBCA 2021). The Thorny Bush Katydid potentially occurs in the Kwongan heaths of the study area.

Earwig Fly – *Austromerope poultoni*

The earwig fly is listed as Priority 2 by DBCA.

This earwig fly occurs mainly in the Jarrah Forest south of Perth (Abbott *et al*. 2007). There is a single record of this species at Eneabba in 1998. The record at Eneabba represented a 240km range extension when it was made (Abbott *et al*. 2007). This species of earwig fly may possibly occur in the study area, but the lack of records makes it difficult to accurately ascertain its status in the region. If present it is likely to favour moist situations, possibly occurring in association with minor drainages or low-lying areas.

Springtime Corroboree Stick Katydid – *Phasmodes jeeba*

The Springtime Corroboree Stick Katydid is listed as Priority 3 by DBCA.

This katydid is a species of 'stick katydid' that occurs in coastal sandplain heaths and is endemic to Western Australia (Rentz 2010). Stick katydids feed on flowers and pollen, with the adults present in flowering vegetation through spring, feeding during the night and sheltering in vegetation during the day (Rentz 2010). There is a single record of this species within 30km of the study area on DBCA's Threatened and Priority Fauna Database, at Mt Adams in 1984 (Figure 11, DBCA 2021). The Springtime Corroboree Stick Katydid potentially occurs in the Kwongan heaths of the study area.

Woolybush Bee – *Hylaeus globuliferus*

The Woolybush Bee is listed as Priority 3 by DBCA.

The Woolybush Bee is known from records on the west coast (from about Bunbury north to Arrowsmith) and scattered records in the southeast wheatbelt (Padil, 2017). It is often recorded in association with Woolybush (*Adenanthos cygnorum*), with additional records on species of *Grevillea* and *Banksia* (Padil, 2017). There are two records of this species within 30km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 11). Both records are from 1996, one from Arrowsmith and one from Tathra National Park, Eneabba (DBCA 2021). The Woolybush Bee possibly occurs in the kwongan heaths of the study area, but the habitats generally lack Woolybush as a dominant species. Some small patches of Woolybush occur in the rehabilitation areas.

Graceful Sun-moth – *Synemon gratiosa*

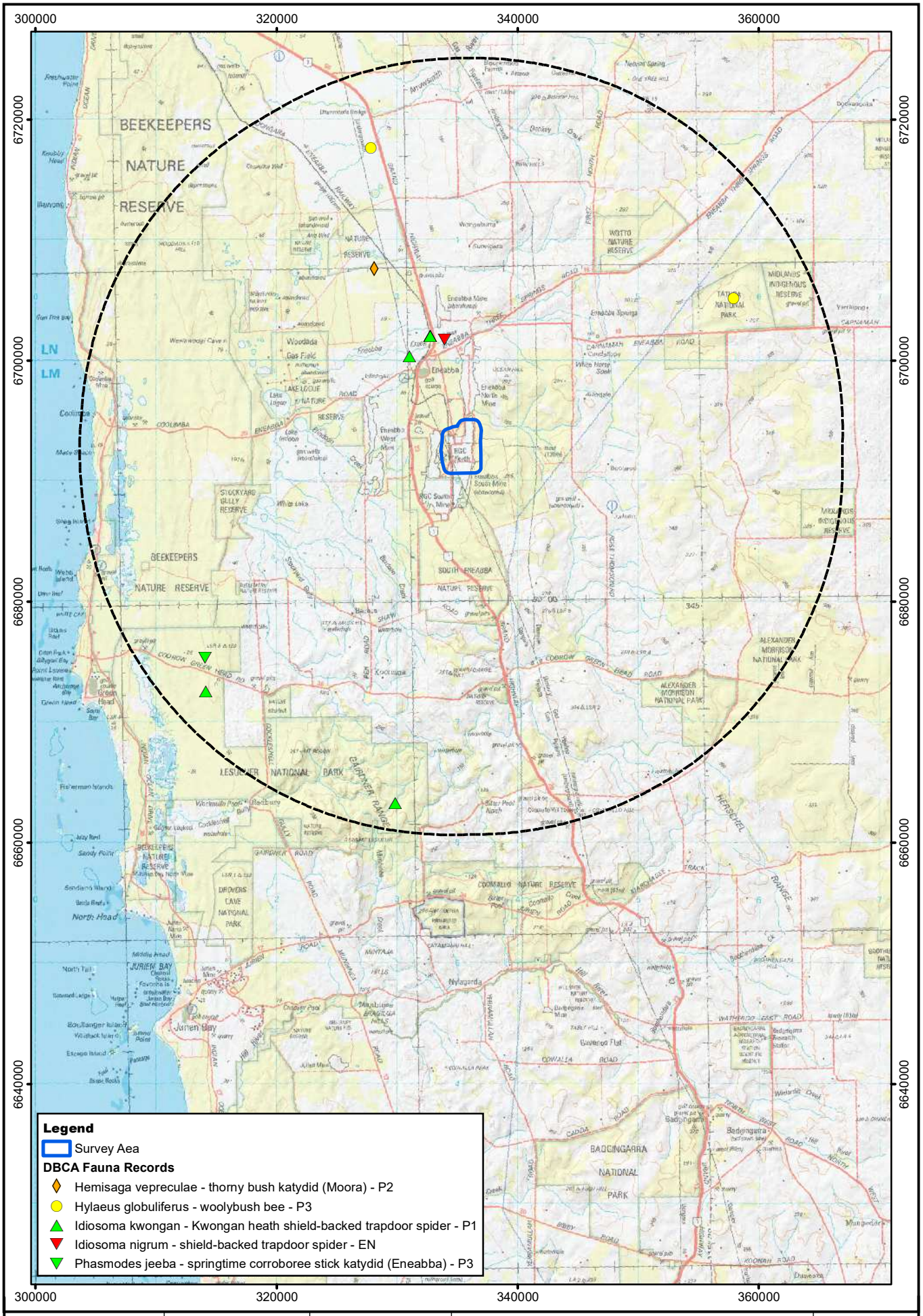
The Graceful Sun-moth is listed as Priority 4 by DBCA.

The Graceful Sunmoth occurs in coastal heaths and *Banksia* woodlands in a coastal strip from Kalbarri south to Binningup (TSSC 2013a). The larval stage of this species feeds on native sedges *Lomandra hermaphrodita* and *Lomandra maritima*, and populations of the sun-moth occur where these plants occur. The life-cycle is thought to take two years, with the adult sun-moths flying between mid-February and late March (TSSC 2013a). Although known from the region, there are no records of this species within 30km of the study area on DBCA's Threatened and Priority Fauna Database (DBCA 2021). The Graceful Sun-moth is unlikely to occur in the study area, instead favouring coastal heaths with *Lomandra maritima*.

A Millipede – *Antichiropus sulcatus*

This millipede has no formal conservation listing but is likely to be a short-range endemic (SRE) invertebrate.

Formerly known as *Antichiropus* 'Eneabba 1', this species was described in 2013 (Carr *et al*. 2013). It is known from the vicinity of the Eneabba Operation and has been collected in native vegetation and rehabilitation sites. It has also been collected from Cooljarloo Mine and near Mt Lesueur to the south and Adams Road to the north. Specimens labelled as from Guildford are considered erroneous, and the distribution of this species is only in the vicinity of Eneabba. As with other species in this genus, this millipede is considered an SRE as it has a very small distribution, has limited capability for dispersal and is limited to small periods of above-ground activity, when conditions are sufficiently moist to allow foraging and mating (Carr *et al*. 2013). As this species has previously been recorded at the Eneabba Operations, it is likely to occur in damp situations.



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7. Conclusions

The habitats of the study area are widespread in the region, and the native habitats are likely to support a substantially intact faunal assemblage, typical of the assemblage found in Kwongan heaths of the region. Shrublands in rehabilitation areas are likely to support a smaller subset of the faunal assemblage, but still has value as fauna habitat.

Of seven conservation significant vertebrates identified as potentially occurring in the region, one is considered unlikely to occur as its though to be locally extinct in the region (Woma – *Aspidites ramsayi*). Two species may possibly occur, although the study area is unlikely to provide important habitat for them and the lack of records of these distinctive species suggest they are uncommon (Malleefowl – *Leipoa ocellata* and Western Brush Wallaby - *Notamacropus irma*). Two species are known from the region and potentially occur, although the habitats of the study area are unlikely to be important for them and their populations are considered large and secure (Peregrine Falcon – *Falco peregrinus*, Fork-tailed Swift – *Apus pacificus*). One species is likely to occur in the sandy soils of the Kwongan heaths and has been recently recorded nearby (Black-striped Snake – *Neelaps calonotos*).

Carnaby's Cockatoo (*Calyptorhynchus latirostris*) was recorded roosting and foraging in the study area. Thirty birds were present at an overnight roost and foraging signs were observed on *Banksia* spp. in both the upland Kwongan heath and the shrublands in the rehabilitation areas. No breeding habitat is present, and no breeding habitat is known to occur within 12km of the study area. The birds present are likely to be a flock of over-wintering foraging birds that breed elsewhere in the wheatbelt. The study area provides 939.82ha of foraging habitat, of which 226ha is low value, 144.75ha is of moderate value and 569.08ha is of moderate-high value. This non-breeding foraging resource and nearby night roost can be considered habitat critical to the survival of the species. Loss of foraging habitat may be a significant impact on this EPBC-listed Threatened species, however, the results of this survey demonstrate that Carnaby's Cockatoo will forage in rehabilitation areas provided suitable food plants are present. Where rehabilitation of cleared lands includes a high proportion of cockatoo food plants such as *Banksia spp*., they are likely to provide foraging habitat for the species, assuming the rehabilitated vegetation is self-sustaining in the long-term.

Of eight conservation significant invertebrates identified as potentially occurring in the region, two are considered unlikely to occur due to taxonomic change (Shield-backed Trapdoor Spider - *Idiosoma nigrum*) or lack of suitable habitat (Graceful Sun-moth – *Synemon gratiosa*). Two species possibly occur, one that has been surveyed for in the past but not found (Kwongan Shield-backed Trapdoor Spider - *Idiosoma kwongan*) and one that favours moist situations (Earwig Fly - *Austromerope poultoni*), however, both are poorly known. Three species potentially occur in Kwongan heath, also all poorly known (Woolybush Bee – *Hylaeus globuliferus*, Springtime Corroboree Stick Katydid – *Phasmodes jeeba* and Thorny Bush Katydid – *Hemisaga vepreculae*). In general, the lack of records of these species makes their status in the study area and the broader region difficult to ascertain. However, any of these species that occurs in the study area are also likely to occur in neighboring heaths.

A millipede, *Antichiropus sulcatus*, is considered likely to occur in the study area and is a probable short-range endemic (SRE) species. It is likely to occur in moist situations and only be active during damp conditions. It is unlikely that *Antichiropus sulcatus* is the only SRE invertebrate present, however, the small size of the study area is unlikely to overlap the entire range of any SRE species. Any SRE species that occurs in the study area is also likely to occur in heaths in neighboring areas.

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Appendix 1. Amphibians potentially occurring in the study area.

Study area = species recorded in the study area during the 2021 fauna survey.
Previous studies = records from the following studies in the vicinity of the survey area:

- a – Fauna recorded at South Eneabba Nature Reserve in 1981 (Dunlop 1981)
- b – Vertebrate fauna recorded at rehabilitation sites at Eneabba Operations (McMillan *et al*. 1992)
- c – Fauna recorded in rehabilitation and sandplains (McNee *et al*. 1995)
- d – Fauna recorded in rehabilitation areas at Eneabba Operations (HGM 1998)
- e – Baseline fauna survey at IPL Central and IBL North at Eneabba Operations (HGM 2001)
- f – Fauna recorded at Eneabba Operations in 2007 (Bamford 2007a)
- g – Fauna recorded at Eneabba Operations in 2009 (Bamford 2009)
- h – Fauna recorded at Eneabba Operations 2010 (Everard et al. 2010)
- i - Fauna recorded at Eneabba Operations 2013 (Everard and Bamford 2013)

ALA = species recorded in the area on the Atlas of Living Australia (see Table 1).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DBCA Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Appendix 1 - Frogs								
Species	Conservation Status	Records						
		Study area	Previous studies	ALA	WAM	FSDB	TF	EPBC
Hylidae (tree frogs and water-holding frogs)								
Slender Tree Frog *Litoria adelaidensis*				+				
Motorbike Frog *Litoria moorei*			b e	+	+			
Limnodynastidae (ground frogs)								
Western Spotted Frog *Heleioporus albopunctatus*			c e h	+	+	+		
Moaning Frog *Heleioporus eyrei*			b c d e h	+	+	+		
Sand Frog *Heleioporus psammophilus*			e h	+		+		
Banjo Frog / Pobblebonk *Limnodynastes dorsalis*			b c d e	+				
Humming Frog *Neobatrachus pelabatoides*			b c f					
Myobatrachidae (ground frogs)								
Turtle Frog *Myobatrachus gouldii*			b c e i			+		
Bleating Froglet *Crinia pseudinsignifera*		+	d	+	+			
Crawling Toadlet *Pseudophryne guentheri*		+	c e	+	+			
Number of frog species:		**10 (2 recorded)**						

Appendix 2. Reptiles potentially occurring in the study area.

Study area = species recorded in the study area during the 2021 fauna survey.
Previous studies = records from the following studies in the vicinity of the survey area:

- a – Fauna recorded at South Eneabba Nature Reserve in 1981 (Dunlop 1981)
- b – Vertebrate fauna recorded at rehabilitation sites at Eneabba Operations (McMillan *et al*. 1992)
- c – Fauna recorded in rehabilitation and sandplains (McNee *et al*. 1995)
- d – Fauna recorded in rehabilitation areas at Eneabba Operations (HGM 1998)
- e – Baseline fauna survey at IPL Central and IBL North at Eneabba Operations (HGM 2001)
- f – Fauna recorded at Eneabba Opertations in 2007 (Bamford 2007a)
- g – Fauna recorded at Eneabba Operations in 2009 (Bamford 2009)
- h – Fauna recorded at Eneabba Operations 2010 (Everard et al. 2010)
- i - Fauna recorded at Eneabba Operations 2013 (Everard and Bamford 2013)

ALA = species recorded in the area on the Atlas of Living Australia (see Table 1).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DBCA Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Appendix 2 - Reptiles										
Species		Conservation Status	Records							
			Study area	Previous studies	ALA	WAM	FSDB	TF	EPBC
Carphodactylidae (knob-tailed geckoes)									
Barking Gecko	*Underwoodisaurus milii*					+			
Diplodactylidae (geckoes)									
Clawless Gecko	*Crenadactylus ocellatus*			g f	+				
Wheatbelt Stone Gecko	*Diplodactylus granariensis*			d					
Ornate Gecko	*Diplodactylus ornatus*				+	+			
Spotted Sandplian Gecko	*Diplodactylus polyophthalmus*			a	+	+			
White-spotted Ground-gecko	*Lucasium alboguttatum*				+	+			
Soft Spiny-tailed Gecko	*Strophurus spinigerus*			a b c d e h	+	+	+		
Gekkonidae (geckoes)									
Marbled Gecko	*Christinus marmoratus*				+				
Varieagted Dtella	*Gehyra variegata*			b f	+	+			
Pygopodidae (legless lizards)									
Sand-plain Worm-lizard	*Aprasia repens*			a f	+	+			
Javelin Legless Lizard	*Delma concinna*			a					
Fraser's Legless Lizard	*Delma fraseri*			b		+			
Gray's Legless Lizard	*Delma grayii*			d	+	+			
Burton's Legless Lizard	*Lialis burtonis*			a c f h	+	+	+		
Keeled Legless Lizard	*Pletholax gracilis*			h		+	+		
Common Scaley-foot	*Pygopus lepidopodus*			d f		+			
Agamidae (dragon lizards)									
Southern Heath Dragon	*Ctenophorus adelaidensis*			a b c e f g h	+	+	+		
Spotted Military Dragon	*Ctenophorus maculatus*			a c d f g h	+	+			
Thorny Devil	*Moloch horridus*			a					
Bearded Dragon	*Pogona minor*			a c d e f g h	+	+	+		
Scincidae (skink lizards)									

Appendix 2 - Reptiles									
Species		Conservation Status	Records						
			Study area	Previous studies	ALA	WAM	FSDB	TF	EPBC
Fence Skink	*Cryptoblepharus buchananii*			a b	+	+			
Limestone Ctenotus	*Ctenotus australis*				+	+			
West Coast Ctenotus	*Ctenotus fallens*			a c d e f g h i		+	+		
South-western Odd-striped Ctenotus	*Ctenotus impar*			a b	+	+			
Leopard Ctenotus	*Ctenotus pantherinus*			a b c d e h	+	+	+		
	Ctenotus schomburgkii			a c	+	+			
Western Slender Blue-tongue	*Cyclodomorphus celatus*			f	+	+			
Broad-banded Sand Swimmer	*Eremiascincus richardsonii*								
Bold-striped Slider	*Lerista christinae*			b d	+	+			
	Lerista distinguenda								
	Lerista elegans				+	+			
	Lerista lineopunctulata				+	+			
	Lerista praepedita			a b c e f g h i	+	+	+		
Bull Skink	*Liopholis multiscutata*				+	+			
Dwarf Skink	*Menetia greyii*			a d e f h i	+	+	+		
	Morethia lineoocellata								
	Morethia obscura			a	+	+			
Western Bluetongue	*Tiliqua occipitalis*			a d					
Bobtail	*Tiliqua rugosa*			a b c d e f g h	+	+			
Varanidae (monitors & goannas)									
Gould's Goanna	*Varanus gouldii*		+	a f g					
Black-tailed Monitor	*Varanus tristis*			d e					
Typhlopidae (blind snakes)									
Southern Blind Snake	*Anilios australis*								
Prong-snouted Blind Snake	*Anilios bituberculatus*								
	Anilios hamatus								
	Anilios waitii					+			
Boidae (pythons)									
Stimpson's Python	*Antaresia stimsoni*				+				
Woma (southwest population)	*Aspidites ramsayi*	P							
Carpet Python	*Morelia spilota*								
Elapidae (front-fanged snakes)									
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolatus*								
Southern Shovel-nosed Snake	*Brachyurophis semifasciatus*								
Yellow-faced Whipsnake	*Demansia reticulata*			f					
Bardick	*Echiopsis curta*			c g	+	+			
Black-naped Snake	*Neelaps bimaculatus*								
Black-striped Snake	*Neelaps calonotos*	P						+	
Gould's Hooded Snake	*Parasuta gouldii*			b c		+			
Mulga Snake	*Pseudechis australis*			e h	+	+			

Appendix 2 - Reptiles										
Species		Conservation Status	Records							
			Study area	Previous studies	ALA	WAM	FSDB	TF	EPBC
Ringed Brown Snake	*Pseudonaja modesta*								
Western Brown Snake / Gwardar	*Pseudonaja mengdeni*			**e f g i**	**+**	**+**	**+**		
Jan's Banded Snake	*Simoselaps bertholdi*					**+**			
West Coast Banded Snake	*Simoselaps littoralis*			**c**	**+**	**+**			
Number of reptile species:			**60 (1 recorded)**							

Appendix 3. Birds potentially occurring in the study area.

Study area = (+) species recorded in the study area during the 2021 fauna survey.
Previous studies = records from the following studies in the vicinity of the survey area:

- a – Fauna recorded at South Eneabba Nature Reserve in 1981 (Dunlop 1981)
- b – Vertebrate fauna recorded at rehabilitation sites at Eneabba Operations (McMillan *et al*. 1992)
- c – Fauna recorded in rehabilitation and sandplains (McNee *et al*. 1995)
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- f – Fauna recorded at Eneabba Operations in 2007 (Bamford 2007a)
- g – Fauna recorded at Eneabba Operations in 2009 (Bamford 2009)
- h – Fauna recorded at Eneabba Operations 2010 (Everard et al. 2010)
- i - Fauna recorded at Eneabba Operations 2013 (Everard and Bamford 2013)

BA = species recorded in the area on the Birds Australia Atlas Database (see Table 1).
Birdata = species recorded in the area on the Birdata Database (see Table 1).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DBCA Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Appendix 3 - Birds												
Species		Conservation Status	Records									
			Study area	Previous studies	ALA	BA	Birdata	WAM	FSDB	TF	EPBC
Dromaiidae (emu)											
Emu	*Dromaius novaehollandiae*		+	**d e f h i**	+	+			+		
Megapodiidae (mound-builders)											
Malleefowl	*Leipoa ocellata*	T									+
Phasianidae (quails)											
Stubble Quail	*Coturnix pectoralis*			**g h**							
Accipitridae (osprey, hawks, eagles and harriers)											
Black-shouldered Kite	*Elanus caeruleus*			**a d**	+	+					
Square-tailed Kite	*Hamirostra isura*				+						
Whistling Kite	*Haliastur sphenurus*				+	+					
Brown Goshawk	*Accipiter fasciatus*			**d e f h**	+	+	+				
Collared Sparrowhawk	*Accipiter cirrocephalus*			**d h**	+	+	+				
Little Eagle	*Aquila morphnoides*			**e f**	+	+	+				
Wedge-tailed Eagle	*Aquila audax*			**a d e f g i**	+	+			+		
Spotted Harrier	*Circus assimilis*			**i**	+	+			+		
Rallidae (crakes, rails, coots & allies)											
Black-tailed Native Hen	*Gallinula ventralis*				+						
Turnicidae (button-quails)											
Painted Button-quail	*Turnix varius*		+	**a d**							
Little Button-quail	*Turnix velox*			**d e i**	+	+			+		
Charadriidae (plovers, dotterels and lapwings)											
Banded Lapwing	*Vanellus tricolor*			**g**	+	+					
Columbidae (pigeons and doves)											
Domestic Pigeon	*Columa livia*	Int.		**d**	+	+					+
Common Bronzewing	*Phaps chalcoptera*		+	**a d e f h**	+	+	+				

Appendix 3 - Birds												
Species		Conservation Status	Records									
			Study area	Previous studies	ALA	BA	Birdata	WAM	FSDB	TF	EPBC
Brush Bronzewing	*Phaps elegans*			**d i**	+	+			+		
Crested Pigeon	*Ocyphaps lophotes*		+	**d e f g h i**	+	+	+		+		
Laughing Turtle-dove	*Spilopelia senegalensis*	Int.			+						
Cuculidae (cuckoos)											
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		+	**f**	+	+	+				
Pallid Cuckoo	*Cacomantis pallidus*			**f i**	+	+			+		
Black-eared Cuckoo	*Chrysococcyx osculans*				+						
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*			**e f g h i**	+				+		
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*			**f**	+						
Strigidae (hawk owls)											
Boobook Owl	*Ninox boobook*			**h**	+	+		+			
Tytonidae (barn owls)											
Barn Owl	*Tyto alba*			**f**							
Podargidae (frogmouths)											
Tawny Frogmouth	*Podargus strigoides*				+	+					
Aegothelidae (owlet-nightjars)											
Australian Owlet-Nightjar	*Aegotheles cristatus*										
Apodidae (swifts)											
Fork-tailed Swift	*Apus pacificus*	Mi				+					+
Alcedinidae (kingfishers)											
Laughing Kookaburra	*Dacelo novaeguineae*	Int.			+	+	+				
Red-backed Kingfisher	*Todiramphus pyrropygia*			**d e i**	+	+			+		
Sacred Kingfisher	*Todiramphus sanctus*			**a**	+	+					
Meropidae (bee-eaters)											
Rainbow Bee-eater	*Merops ornatus*			**a d e g h**	+	+	+	+			
Falconidae (falcons)											
Brown Falcon	*Falco berigora*			**a d e f g h**	+	+	+				
Australian Kestrel	*Falco cenchroides*		+	**a d e f h i**	+	+	+		+		
Australian Hobby	*Falco longipennis*				+	+			+		
Peregrine Falcon	*Falco peregrinus*	Sp		**f**	+						
Cacatuidae (cockatoos)											
Galah	*Cacatua roseicapilla*		+	**a d e f g h i**		+			+		
Major Mitchell's Cockatoo	*Cacatua leadbeateri*										
Western Long-billed Corella	*Cacatua pastinator*			**d h**	+	+	+				
Little Corella	*Cacatua sanguinea*				+	+	+				
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*				+		+				
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	T	+	**a d h**	+	+	+	+			+
Cockatiel	*Nymphicus hollandicus*			**e**	+	+					
Psittacidae (parrots, lorikeets & rosellas)											
Budgerigar	*Melopsittacus undulatus*			**i**	+	+			+		

Appendix 3 - Birds												
Species		Conservation Status	Records									
			Study area	Previous studies	ALA	BA	Birdata	WAM	FSDB	TF	EPBC
Elegant Parrot	*Neophema elegans*		+								
Mulga Parrot	*Platycercus varius*				+						
Australian Ringneck	*Platycercus zonarius*		+	d e f g h	+	+					
Regent Parrot	*Polytelis anthopeplus*				+						
Maluridae (fairy-wrens, grasswrens and emu-wrens)											
Variegated Fairy-wren	*Malurus lamberti*		+	a d e f g	+	+	+	+			
White-winged Fairy-wren	*Malurus leucopterus*		+	a d f g h i	+	+	+	+	+		
Blue-breasted Fairy-wren	*Malurus pulcherrimus*			d	+	+	+				
Splendid Fairy-wren	*Malurus splendens*		+	d g	+	+	+				
Southern Emu-wren	*Stipiturus malachurus*			d e h	+	+			+		
Meliphagidae (honeyeaters and chats)											
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*			a	+	+					
Western Spinebill	*Acanthorhynchus superciliosus*				+						
Red Wattlebird	*Anthochaera carunculata*			e f h i	+	+	+		+		
Western Wattlebird	*Anthochaera lunulata*				+	+					
Pied Honeyeater	*Certhionyx vareigatus*				+						
Tawny-crowned Honeyeater	*Glyciphila melanops*		+	a d e f g h i	+	+	+		+		
Brown Honeyeater	*Lichmera indistincta*		+	a d e f g i	+	+	+		+		
Singing Honeyeater	*Gavicalis virescens*		+	d e f g h i	+	+	+		+		
Yellow-throated Miner	*Manorina flavigula*			d i	+	+			+		
Brown-headed Honeyeater	*Melithreptus brevirostris*			a	+	+					
White-cheeked Honeyeater	*Phylidonyris niger*		+	a d e f g h i	+	+	+		+		
New Holland Honeyeater	*Phylidonyris novaehollandiae*			a d	+	+					
White-fronted Honeyeater	*Purnella albifrons*			d	+						
White-fronted Chat	*Epthianura albifrons*			d f h	+	+	+				
Crimson Chat	*Epthianura tricolor*			a	+						
Pardalotidae (pardalotes)											
Spotted Pardalote	*Pardalotus punctatus*			f							
Striated Pardalote	*Pardalotus striatus*		+	a d e f g	+	+	+				
Acanthizidae (thornbills, gerygones & allies)											
Inland Thornbill	*Acanthiza apicalis*				+	+					
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		+	e f g	+	+	+		+		
Western Thornbill	*Acanthiza inornata*			a	+	+					
Chestnut-rumped Thornbill	*Acanthiza uropygialis*				+	+					
Southern Whiteface	*Aphelocephala leucopsis*										
Rufous Fieldwren	*Calamanthus campestris*		+	a d e f g h i	+	+			+		
Western Gerygone	*Gerygone fusca*			e f g	+	+	+				
Redthroat	*Pyrrholaemus brunneus*				+	+					
White-browed Scrubwren	*Sericornis frontatus*		+	d e f g	+	+	+	+			
Weebill	*Smicrornis brevirostris*			e d e h i	+	+	+		+		

Appendix 3 - Birds											
Species		Conservation Status	Records								
			Study area	Previous studies	ALA	BA	Birdata	WAM	FSDB	TF	EPBC
Pomatostomidae (babblers)											
White-browed Babbler	*Pomatostomus superciliosus*			i	+	+			+		
Artamidae (woodswallows)											
Masked Woodswallow	*Artamus personatus*										
Black-faced Woodswallow	*Artamus cinereus*		+	a d e f g h	+	+			+		
Dusky Woodswallow	*Artamus cyanopterus*				+	+	+				
Cracticidae (magpies, butcherbirds & currawongs)											
Grey Butcherbird	*Cracticus torquatus*			f g	+	+	+				
Pied Butcherbird	*Cracticus nigrogularis*		+	e g i	+	+	+		+		
Australian Magpie	*Cracticus tibicen*		+	e h	+	+	+				
Grey Currawong	*Strepera versicolor*			f	+	+					
Campephagidae (cuckoo-shrikes and trillers)											
Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*			a d e f g h i	+	+	+		+		
White-winged Triller	*Lalage tricolor*			a g h	+				+		
Neosittidae (sittellas)											
Varied Sittella	*Daphoenositta chrysoptera*										
Oreoicidae (crested bellbird)											
Crested Bellbird	*Oreoica gutteralis*					+					
Pachycephalidae (shrike-tits, whistlers and allies)											
Western Golden Whistler	*Pachycephala occidentalis*			f	+	+					
Rufous Whistler	*Pachycephala rufiventris*			a d e f g h	+	+	+				
Grey Shrike-thrush	*Colluricincla harmonica*		+	d e f g h i	+	+	+		+		
Rhipiduridae (fantails)											
Willie Wagtail	*Rhipidura leucophrys*		+	a d e f g h i		+	+		+		
Grey Fantail	*Rhipidura albiscapa*			e g		+	+				
Monarchidae (flycatchers, monarchs & magpie-lark)											
Magpie-lark	*Grallina cyanoleuca*		+	d e f g h i	+	+	+		+		
Corvidae (ravens and crows)											
Australian Raven	*Corvus coronoides*		+	a d e f g h i	+	+	+	+	+		
Little Crow	*Corvus bennetti*			d f	+		+				
Petroicidae (robins)											
White-breasted Robin	*Eopsaltria georgiana*			d	+	+		+			
Western Yellow Robin	*Eopsaltria australis griseogularis*										
Jacky Winter	*Microeca fascinans*				+	+					
Hooded Robin	*Melanodryas cucullata*			a f	+						
Red-capped Robin	*Petroica goodenovii*			a d f g	+	+	+	+			
Hirundinidae (swallows and martins)											
White-backed Swallow	*Cheramoeca leucosterna*		+	a d e i	+	+	+		+		
Welcome Swallow	*Hirundo neoxena*		+	a d e g h i	+	+	+		+		
Tree Martin	*Petrochelidon nigricans*		+	d e g h	+	+	+		+		

Appendix 3 - Birds											
Species	Conservation Status	Records									
		Study area	Previous studies	ALA	BA	Birdata	WAM	FSDB	TF	EPBC
Fairy Martin *Petrochelidon ariel*			**d e**	+	+					
Acrocephalidae (reed-warblers)										
Australian Reed Warbler *Acrocephalus australis*				+	+	+				
Locustellidae (grassbirds, songlarks & old world warblers)										
Rufous Songlark *Megalurus mathewsi*			**g h i**	+	+	+		+		
Brown Songlark *Megalurus cruralis*			**a e**	+	+	+				
Zosteropidae (white-eyes)										
Silvereye *Zosterops lateralis*			**d e f g**	+	+	+				
Dicaeidae (flowerpeckers)										
Mistletoebird *Dicaeum hirundinaceum*			**f**	+	+	+				
Estrildidae (grassfinches and allies)										
Zebra Finch *Taeniopygia guttata*			**g i**	+	+			+		
Motacillidae (pipits and wagtails)										
Australian Pipit *Anthus australis*		+	**a d e f h i**	+				+		
# bird species expected in the study area:		**118 (32 recorded)**								

Appendix 4. Mammals potentially occurring in the study area.

Study area = species recorded in the study area during the 2021 fauna survey.
Previous studies = records from the following studies in the vicinity of the survey area:

- a – Fauna recorded at South Eneabba Nature Reserve in 1981 (Dunlop 1981)
- b – Vertebrate fauna recorded at rehabilitation sites at Eneabba Operations (McMillan *et al*. 1992)
- c – Fauna recorded in rehabilitation and sandplains (McNee *et al*. 1995)
- d – Fauna recorded in rehabilitation areas at Eneabba Operations (HGM 1998)
- e – Baseline fauna survey at IPL Central and IBL North at Eneabba Operations (HGM 2001)
- f – Fauna recorded at Eneabba Operations in 2007 (Bamford 2007a)
- g – Fauna recorded at Eneabba Operations in 2009 (Bamford 2009)
- h – Fauna recorded at Eneabba Operations 2010 (Everard et al. 2010)
- i - Fauna recorded at Eneabba Operations 2013 (Everard and Bamford 2013)

ALA = species recorded in the area on the Atlas of Living Australia (see Table 1).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DBCA Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Appendix 4 - Mammals									
Species		Conservation Status	Records						
			Study area	Previous studies	ALA	WAM	FSDB	TF	EPBC
Tachyglossidae (echidnas)									
Echidna	*Tachyglossus aculeatus*		+	a e f g i	+		+		
Dasyuridae (dasyurid marsupials)									
Fat-tailed Dunnart	*Sminthopsis crassicaudata*								
Little Long-tailed Dunnart	*Sminthopsis dolichura*				+	+			
White-tailed Dunnart	*Sminthopsis granulipes*			d e h	+	+			
Grey-bellied Dunnart	*Sminthopsis griseoventer*			h					
Tarsipedidae (honey possum)									
Honey Possum	*Tarsipes rostratus*			a b d e	+	+	+		
Macropodidae (kangaroos and wallabies)									
Western Grey Kangaroo	*Macropus fuliginosus*		+	a e f i	+	+	+		
Western Brush Wallaby	*Macropus irma*	P							
Euro	*Macropus robustus*		+		+	+			
Molossidae (freetail bats)									
South-western Freetail Bat	*Ozimops kitcheneri*								
White-striped Freetail Bat	*Tadarida australis*			e h					
Vespertilionidae (ordinary bats)									
Gould's Wattled Bat	*Chalinolobus gouldii*			a	+	+			
Chocolate Wattled Bat	*Chalinolobus morio*				+	+			
Greater Long-eared Bat	*Nyctophilus major*								
Southern Forest Bat	*Vespadelus regulus*					+			
Inland Broad-nosed Bat	*Scotorepens balstoni*								
Lesser Long-eared Bat	*Nyctophilus geoffroyi*			a h	+	+			
Muridae (rats and mice)									
House Mouse	*Mus musculus*	Int.		a b d e h	+	+	+		+
Western Bush Rat	*Rattus fuscipes*				+	+			

Appendix 4 - Mammals									
Species		Conservation Status	Records						
			Study area	Previous studies	ALA	WAM	FSDB	TF	EPBC
Black Rat	*Rattus rattus*	Int.							
Ash-grey Mouse	*Pseudomys albocinereus*			**a b d e h**	**+**	**+**			
Canidae (dogs and foxes)									
Fox	*Vulpes vulpes*	Int.	**+**	**a e f g h i**			**+**		**+**
Dog	*Canis familiaris familiaris*	Int.		**e**	**+**				**+**
Felidae (cats)									
Feral/House Cat	*Felis catus*	Int.		**e f g h**					**+**
Leporidae (rabbits & hares)									
Rabbit	*Oryctolagus cuniculus*	Int.	**+**	**a e f g h i**			**+**		**+**
Bovidae (horned ruminants)									
Goat	*Capra hircus*	Int.		**f**					**+**
Number of mammal species:			**26 (5 recorded)**						

Appendix 5. Habitat assessment.

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 01 Kwongan Heathland - uplands Low heath with Banksia spp., on grey sand and laterite.	
Hab 02 Kwongan Heathland - uplands Low heath with Banksia spp., on pale grey sand.	
Hab 03 Rehabilitation – Planted Eucalypts Rehabilitation with planted eucalypts.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 04 Minor Drainage Minor drainage, unlikely to hold water. Melaleuca shrubland with occasional Eucalypts on yellow sand.	
Hab 05 Rehabilitation – Shrublands and Heaths Rehabilitation with mixed tall shrubs including Acacia, Melaleuca and Calothamnus with occasional Banksia.	
Hab 06 Rehabilitation – Shrublands and Heaths Rehabilitation of mixed heath with Banksia sp. with occasional emergent eucalypts on lateritic gravel. Recently burnt.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 07 Kwongan Heathland - uplands Low mixed heath on sandy grey soil. Recently burnt.	
Hab 08 Kwongan Heathland - uplands Mixed heath with Bankisa attenuata and emergent Woody Pear on grey sand. Recently burnt.	
Hab 09 Kwongan Heathland - uplands Low heath. Recently burnt.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 10 Rehabilitation – Shrublands and Heaths Rehabilitation of mixed heath with Banksia spp. with occasional emergent eucalypts on yellow sand.	
Hab 11 Kwongan Heathland - lowlands Mixed shrubland dominated by Allocasuarina and Xanthorrhoea sp. with emergent eucalypts on sandy clays.	
Hab 12 Kwongan Heathland - lowlands Low mixed shrubland with Allocasuarina, some Banksia and emergent eucalypts on sandy clay.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 13 Rehabilitation – Shrublands and Heaths Rehabilitation dominated by myrtaceous shrubs with some Banksia sp. on brown sand.	
Hab 14 Rehabilitation – Shrublands and Heaths Rehabilitation dominated by myrtaceous shrubs with some Banksia sp./Hakea sp. and emergent eucalypts on grey sand.	
Hab 15 Rehabilitation – Shrublands and Heaths Rehabilitation with Acacia and Banksia spp. with emergent eucalypts on gravelly sand.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 16 Rehabilitation – Shrublands and Heaths Rehabilitation with Acacia and Banksia spp. with emergent eucalypts on gravelly sand.	
Hab 17 Rehabilitation – Shrublands and Heaths Rehabilitation with Acacia, Hakea and Banksia spp. with emergent eucalypts on yellow sand.	
Hab 18 Rehabilitation – Shrublands and Heaths Rehabilitation dominated by myrtaceous shrubs with some Banksia sp. in low-lying sandy-clay basin.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 19 Kwongan Heathland - uplands Mixed low heath including Banksia and Hakea spp. with sedeges and emergent Eucalyptus todtiana.	
Hab 20 Kwongan Heathland - uplands Mixed shrubland with sedges and some Banskia spp. With emergent eucalypts on pale sand.	
Hab 21 Kwongan Heathland - uplands Mixed heath including Banksia, Verticordia and Calothamnus sp. with emergent eucalypts on grey sand.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 22 Kwongan Heathland - uplands Mixed heath with sedges, some Banksia spp. and emergent eucalyts on pale sand.	
Hab 23 Kwongan Heathland - uplands Mixed heath including Banksia sp. and sedges of white sand.	
Hab 24 Rehabilitation of mixed heath with Banksia spp. with occasional emergent eucalypts.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 25 Rehabilitation – Shrublands and Heaths Rehabilitation of mixed heath with Lambertia and Banksia spp. with occasional emergent eucalypts on yellow gravelly sand.	
Hab 26 Rehabilitation – Shrublands and Heaths Rehabilitation of mixed heath with Lambertia and Banksia spp. with occasional emergent eucalypts on yellow sandy-clay.	
Hab 27 Rehabilitation – Shrublands and Heaths Rehabilitation dominated by myrtaceous shrubs with some Banksia sp. and emergent Woody Pear on white gravelly sand.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 28 Rehabilitation – Shrublands and Heaths Rehabilitation of mixed heath with Banksia spp. with occasional emergent eucalypts and Woody Pear on brown sand.	
Hab 29 Kwongan Heathland - lowlands Mixed shrubland dominated by Allocasuarina and Xanthorrhoea sp. with emergent eucalypts on sandy clays.	
Hab 30 Kwongan Heathland - uplands Mostly sedges with some low shrubs (including a few banksias) and the occasional Eucalyptus todtiana on pale yellow-cream sands.	

Appendix 5 – Habitat Assessment	
Description	**Photograph**
Hab 31 Minor Creek Melaleuca and Calothamnus shrubs on clay; wetland/dampland area.	
Hab 32 Diverse shrubs and some sedges on pale brown clay/loam (degraded vegetation).	
Hab 33 Kwongan Heathland - uplands Xylomelum angustifolium over mixed shrubs on white sands.	

Appendix 6. EPBC Protected Matters Search Tool results.

Species listed for the area 5km in radius from 29.8878ºS, 115.2954ºE on the EPBC Protected Matters Search Tool.

Species	Status	Type of presence
Curlew Sandpiper *Calidris ferruginea*	Critically Endangered & Migratory	Species or species habitat **MAY OCCUR** within area
Carnaby's Cockatoo *Calyptorhynchus latirostris*	Endangered	**BREEDING LIKELY TO OCCUR** within area
Grey Falcon *Falco hypoleucos*	Vulnerable	Species or species habitat **MAY OCCUR** within area
Malleefowl *Leipoa ocellata*	Vulnerable	Species or species habitat **LIKELY TO OCCUR** within area
Eastern Curlew *Numenius madagascariensis*	Critically Endangered & Migratory	Species or species habitat **MAY OCCUR** within area
Australian Pianted Snipe *Rostratula australis*	Endangered	Species or species habitat **MAY OCCUR** within area
Chuditch *Dasyurus geoffroii*	Vulnerable	Species or species habitat **LIKELY TO OCCUR** within area
Dibbler *Parantechinus apicalis*	Endangered	Species or species habitat **MAY OCCUR** within area
Western Spiny-tailed Skink *Egernia stokesii badia*	Endangered	Species or species habitat **MAY OCCUR** within area
Grey Wagtail *Motacilla cinerea*	Migratory (terrestrial)	Species or species habitat **MAY OCCUR** within area
Common Sandpiper *Actitis hypoleucos*	Migratory (wetland)	Species or species habitat **MAY OCCUR** within area
Sharp-tailed Sandpiper *Calidris acuminata*	Migratory (wetland)	Species or species habitat **MAY OCCUR** within area
Pectoral Sandpiper *Calidris melanotos*	Migratory (wetland)	Species or species habitat **MAY OCCUR** within area
Osprey *Pandion haliaetus*	Migratory (wetland)	Species or species habitat **MAY OCCUR** within area
Fork-tailed Swift *Apus pacificus*	Migratory (marine)	Species or species habitat **LIKELY TO OCCUR** within area