WA Limestone Haddrill Rd Project, Yanchep:

Level 1 Fauna Survey 2014

Bushland on the site

Prepared for: WA Limestone
41 Spearwood Ave
Bibra Lake WA 6163

Prepared by: Western Wildlife
8 Ridgeway Pl
Mahogany Creek WA 6072

10th February 2014

Executive Summary

Introduction

WA Limestone propose to quarry limestone at their Haddrill Rd Project (E70/1437), in Yanchep. WA Limestone commissioned Western Wildlife to undertake a Level 1 fauna survey of the proposed quarry area. The aims of the fauna survey were to identify the fauna habitats present in the study area and the vertebrate fauna that potentially occurring in the study area. Additionally, species of conservation significance, or habitats of particular importance for fauna would be identified and any potential impacts of the proposed quarry would be identified, with recommendations for minimising the potential impacts.

This report details the findings of the fauna survey conducted in December 2013.

Methods

The fauna survey was undertaken in compliance with Environmental Protection Authority (EPA) Position Statement No.3 (EPA 2002) and EPA Guidance Statement 56 (EPA 2004). The fauna survey included a literature review and a field survey. The field survey took place on the morning of the 31st December 2013 and was carried out by two zoologists. The field survey included:

- Identification of fauna habitats.
- Opportunistic records of fauna.
- Identification of areas of habitat trees with a diameter at breast height (DBH) ≥ 50cm.

Species of conservation significance were classified as Conservation Significance 1 if listed under *The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or *The Western Australian Wildlife Conservation Act 1950* (WC Act), Conservation Significance 2 if listed as a Priority species by the Department of Parks and Wildlife (DPAW), or Conservation Significance 3 if a locally significant species.

Results and Discussion

The study area consists of two sites, the northern site (~82ha) and the southern site (~329ha). The study area has five fauna habitats:

- Limestone heath
- Banksia woodland
- Tuarts
- Re-growth shrubland
- Pine plantation

The northern site consists entirely of re-growth shrubland, and the remaining habitats occur on the southern site. There are habitat trees (Tuarts) present in the southern site, some of which have a DBH ≥ 50cm.

Overall, the study area may support up to five species of frog, 47 species of reptile, 94 species of birds and 22 (17 native) species of mammal. There are no frogs of conservation significance likely to occur, but there are nine reptiles, 41 birds, six mammals and one invertebrate of conservation significance that may occur.

The five species of Conservation Significance 1 that may occur are the:

- Carpet Python (*Morelia spilota imbricata*) – WC Act (Schedule 4)
- Peregrine Falcon (*Falco peregrinus*) – WC Act (Schedule 4)
- Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) – EPBC Act (Endangered), WC Act (Schedule 1)
- Fork-tailed Swift (*Apus pacificus*) – EPBC Act (migratory)
- Rainbow Bee-eater (*Merops ornatus*) – EPBC Act (migratory)

Of these Carnaby's Black-Cockatoo is highly likely to occur, foraging in the Banksia woodland and limestone heath, and hollow-bearing Tuarts are potential breeding habitat. The Rainbow Bee-eater is likely to occur, potentially breeding in sandy areas, and Carpet Python is likely to occur, particularly in the limestone heath. The remaining species have a low likelihood of occurring in the study area,

The six species of Conservation Significance 2 that may occur are the:

- Black-striped Snake (*Neelaps calonotos*) – Priority 3
- Masked Owl (*Tyto novaehollandiae*) – Priority 3
- Quenda / Southern Brown Bandicoot (*Isoodon obesulus*) – Priority 5
- Western Brush Wallaby (*Macropus irma*) – Priority 4
- Western False Pipistrelle (*Falsistrellus mackenziei*) – Priority 4
- Graceful Sun-moth (*Synemon gratiosa)* – Priority 4

Of these, all but the Masked Owl potentially occur in the Banksia woodland, and Western False Pipistrelle may roost in hollow Tuarts. The Masked Owl is very rare and only has a low likelihood of occurring.

The 47 species of conservation significance 3 that may be present are mainly locally significant bird species, but also include reptiles and small mammals that are generally scarce on the Swan Coastal Plain, or are at the limit of their distribution in the area.

The development of the limestone quarry will result in the loss of some or all of the site's fauna habitats, depending on the final quarry footprint area. The most significant impacts are likely to be habitat loss and an increase in habitat fragmentation. The following recommendations on minimizing potential impacts are given:

- *Where possible, restrict construction of access roads, firebreaks and fence-lines to existing cleared tracks.*
- *Avoid clearing during late winter and spring in order to minimise the mortality of young birds in nests.*
- *Minimise the quarry footprint so far as practicable, in order to maximise the amount of native vegetation retained.*
- *During clearing or construction, avoid disturbance to adjacent areas of native vegetation that are to be preserved.*
- *Where possible, preserve Tuart trees with a DBH ≥ 50cm, particularly those with existing hollows.*
- *If potential breeding habitat or more than 1ha of foraging habitat (Banksia woodland or limestone heath) for EPBC listed Carnaby's Black-Cockatoo is likely to be cleared, refer the development to DoE for determination whether it constitutes a significant impact under the EPBC Act.*
- *Carry out appropriate revegetation of the site after the completion of quarry activities.*

- *Maintain habitat corridors to allow for east – west movement of fauna.*
- *Avoid the creation of isolated patches of habitat within the quarry development area.*
- *Manage dust emissions from the site to minimise dust penetrating adjacent bushland.*
- *Develop controls to minimise weed invasion into adjacent bushland.*
- *Develop controls to minimise the risk of accidental fires.*
- *Consider temporary fencing along roads during clearing, to prevent fauna exiting the site.*
- *Conduct clearing in a progressive manner, to encourage fauna to move away from roads and towards adjacent remaining bushland.*
- *Where practicable, situate noisy activities away from the larger areas of remaining bushland in order to reduce the amount of disturbance to fauna.*
- *Minimise light spill into adjacent bushland by using the minimum of outdoor lighting.*
- *Ensure that food and other wastes are secure from feral animals.*

Table of Contents

List of Figures

List of Tables

List of Plates

1. Introduction

WA Limestone propose to quarry limestone at their Haddrill Rd Project (E70/1437), in Yanchep. WA Limestone commissioned Western Wildlife to undertake a Level 1 fauna survey of the proposed quarry area. The aims of the fauna survey were to:

- Identify the fauna habitats present in the study area.
- List the vertebrate fauna that were recorded in the study area and/or have the potential to occur in the study area.
- Identify species of conservation significance, or habitats of particular importance for fauna, that may occur in the study area.
- Comment on the potential impacts the proposed development may have on fauna, particularly on fauna of conservation significance.
- Make recommendations on ameliorating the potential impacts.

This report details the findings of the fauna survey conducted in December 2013.

2. The Study Area – Context and Description

The study area (Figure 1) consists of the southern area (~329ha) and the smaller northern area (~82ha). The southern area is almost entirely under native vegetation, and the northern area is re-growth native vegetation after the removal of plantation pines.

The study area is within the Gnangara – Moore River State Forest, a mixture of native vegetation and pine plantations. It is about 1km east of Yanchep National Park and about 8km east of the Yanchep town site.

The southern part of the study area is a small part of Bush Forever Site 381, 'Ridges and adjacent Bushland, Yanchep/Nowergup'. In its entirety, this Bush Forever Site is 3004.9ha and includes Banksia, Tuart and Jarrah woodlands on sandy uplands and heath on Tamala Limestone (Government of Western Australia 2000). Significant populations of Splendid Fairy-wren (*Malurus splendens*), Southern Emu-wren (*Stipiturus malachurus*), Inland Thornbill (*Acanthiza apicalis*), western Thornbill (*Acanthiza inornata*) and Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*) are known to occur, as well as several significant honeyeater species (Government of Western Australia 2000). The Bush Forever Site also has linkages to bushland to the west (Yanchep National Park) and south.

The Bush Forever Site of which the study area is a part has also been identified as park of an ecological linkage in the biodiversity report for the Gnangara Sustainability Strategy (Wilson and Valentine 2009).

The study area is within the Swan Coastal Plain subregion of the Swan Coastal Plain Bioregion according to the Interim Biogeographic Regionalisation for Australia (IBRA) (DEWHA 2004). The Swan Coastal Plain subregion is characterised by a Warm Mediterranean climate, with around 600 to 1000mm of rain annually (Mitchell *et al*. 2002). The primary land-uses are diverse, namely dry-land agriculture, conservation, unallocated Crown land, Crown reserves, urban, rural residential, cultivation (irrigated horticulture, agriculture and plantations), plantation forestry, roads and other infrastructure and grazing on improved pastures (Mitchell *et al*. 2002).

Natural vegetation of the subregion consists generally of heath or Tuart woodland on limestone, Banksia or Jarrah/Banksia woodlands on Quaternary dune systems and Marri on colluvial or alluvial soils. The subregion also includes seasonal wetlands and islands such as Rottnest Island (Mitchell *et al*. 2002).

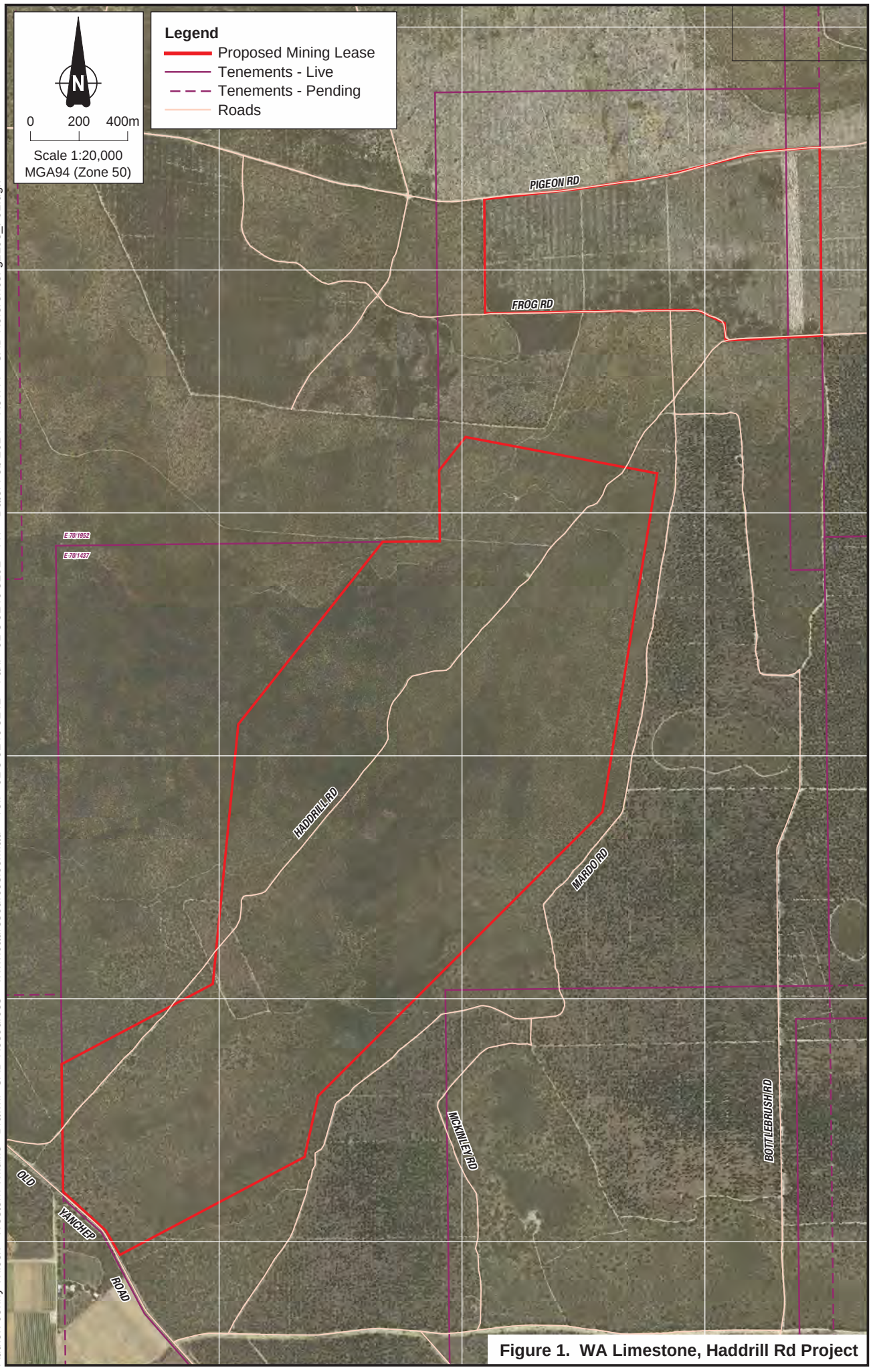


Figure 1. WA Limestone, Haddrill Rd Project

3. Methods

The survey was conducted as a Level 1 fauna survey in accordance with the Environmental Protection Authority (EPA) Position Statement No.3 (EPA, 2002), Guidance Statement 56 (EPA, 2004) and relevant Commonwealth Government guidelines. The Level 1 fauna survey included a search of available literature and databases (a 'desktop' study), and a field survey of the study area for one day on the 31st December 2013. The field survey served to put the desktop study into context, as well as allowing for the identification of fauna habitats and likely fauna assemblages of the study area.

3.1 Personnel

The personnel involved in the fauna survey, their qualifications and company affiliation, were as follows:

- **Supervising Zoologist:**
  - Ms Jenny Wilcox - *BSc.Biol./Env.Sci., Hons.Biol.* - Western Wildlife
- **Field Zoologist:**
  - Mr Richard King - *BSc.Env.Biol.* - Western Wildlife

3.2 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum checklists. These were last updated in June 2013 and are accessed at URL: http://museum.wa.gov.au/research/departments/terrestrial-zoology/checklist-terrestrial-vertebrate-fauna-western-australia. 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.

3.3 Literature Review

Lists of fauna expected to occur in the study area were produced using information from a number of sources. These included publications that provide information on general patterns of distribution of frogs (Tyler and Doughty 2009), reptiles (Storr *et al*. 1983, 1990, 1999 and 2002), birds (Barrett *et al*. 2003; Johnstone and Storr 1998; Johnstone and Storr 2004) and mammals (Churchill 1998, Menkhorst and Knight 2004; 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 as presented in the literature. These species are not included in lists of expected fauna.

These sources of information were used to create lists of species that potentially occur in the study area. As far as possible, expected species are those that are likely to utilise the study area. The lists exclude species that have been recorded in the general region as vagrants, or for which suitable habitat is absent within the study area.

Table 1. Databases used in the preparation of Tables 4 - 7.

Database	Type of records held on database	Area searched
WA Museum Specimen Database (DPAW 2007-)	Records of specimens held in the Western Australian Museum. Includes historical records.	6km radius of 31º 33' 26'' S and 115º 44' 00'' E
Fauna Survey Returns Database (DPAW 2007-)	Records collected from fauna surveys carried out in Western Australia. Includes observational and trapping data.	6km radius of 31º 33' 26'' S and 115º 44' 00'' E
DPAW's Threatened and Priority Fauna Database	Information and records on Threatened and Priority species in Western Australia	7km radius of 380079 E, 6508273 N (Zone 50)
Birds Australia Atlas Database (DPAW 2007-)	Records of bird observations in Australia, 1998-current.	6km radius of 31º 33' 26'' S and 115º 44' 00'' E
EPBC Act Protected Matters Search Tool	Records on matters protected under the EPBC Act, including threatened species and ecological communities, migratory species and marine species.	6km radius of 31º 33' 26'' S and 115º 44' 00'' E

3.4 Field Studies

The field study was carried out by two zoologists on the 31st December 2013. The field study component of a Level 1 fauna survey is primarily to identify the fauna habitats present in the study area. In addition, all fauna encountered during the field survey are recorded. The fauna species recorded are usually conspicuous species such as birds, large mammals and large reptiles. The presence of other species may be inferred from evidence such as tracks, burrows, scats or evidence of foraging.

In the EPBC Act referral guidelines for threatened black cockatoo species, breeding habitat is defined as trees of species known to support breeding within the breeding range of each species, and which either have a nesting hollow or are of a suitable size to develop a nest hollow (DSEWPaC 2012). For Tuart trees a suitable size is a diameter at breast height (DBH) ≥ 50cm. Although not recorded individually, areas of Tuart trees with a DBH ≥ 50cm were noted.

3.5 Survey Limitations

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.

Factors that can affect the outcome of a fauna survey are indicated in Guidance Statement 56 (EPA 2004). These are listed below in Table 2. One of the main limitations for the survey is that as no trapping was undertaken, there are few fauna records for the study area, except for birds. However, this is consistent with all Level 1 fauna surveys, and is ameliorated by the availability of fauna records from surrounding areas of similar habitat.

Table 2. Fauna survey limitations.

Potential Limitation	Extent of limitation for the survey	
Experience of fauna personnel	Not limiting	The supervising zoologist has 13 years experience in fauna consulting. Team member has 7 years experience.
Types of traps or other survey methods used	Not applicable to Level 1 survey	No trapping was undertaken as this was a Level 1 survey. This restricts fauna records to opportunistic observations.
Number of trapping sites	Not applicable to Level 1 survey	As above.
Ability to survey all habitats present	Not limiting	All habitats present were surveyed on foot.
Availability of fauna information for the area in literature and on databases	Not limiting	Moderate amount of fauna information available on databases and in the literature for most taxa.
Effects of weather during the survey	Not limiting	Weather during the field survey was warm and dry. Weather conditions are unlikely to affect the outcomes of a Level 1 fauna survey.
Seasonal effects	Not applicable to Level 1 survey	Seasonal effects are not taken into account with a Level 1 survey, as the primary function is habitat assessment.
Disturbance to site such as recent fires, cattle grazing	Somewhat limiting for northern site	Disturbance across both sites consisted of firebreaks and tracks. The northern site is substantially modified from the original condition, as it is re-growth native vegetation after the removal of plantation pines.
Ease of access to site	Not limiting	Vehicle tracks ran adjacent to each site, and the entire site was accessible on foot.

3.6 Assessment of Conservation Significance

Three levels of conservation significance are used within this report to indicate the level of significance of fauna species. These are described in the following sub-sections.

3.6.1 Conservation Significance 1

Conservation Significance 1 (CS1) is the highest level of conservation significance, describing species that are protected under State or Commonwealth legislation. These species are considered to be of state and/or national conservation significance, and some species (e.g. some migratory species) may be considered of international significance.

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'. These include threatened species, threatened ecological communities and migratory species.

Fauna species are assessed against categories based on International Union for Conservation of Nature (IUCN) criteria, into:

- **Extinct**: Taxa not definitely located in the wild during the past 50 years.
- **Extinct in the wild**: Taxa known to survive only in captivity.
- **Critically Endangered**: Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable**: Taxa facing a very high risk of extinction in the wild in the medium-term future.
- **Conservation Dependent**: Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.

Only fauna classified as 'extinct in the wild' 'critically endangered', 'endangered' or 'vulnerable' are listed as matters of National Environmental Significance.

The migratory species listed under the EPBC Act are those recognised under 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 Bonn Convention for which Australia is a range state. Species listed in JAMBA are also protected under Schedule 3 of the *Western Australian Wildlife Conservation Act 1950*.

Reports on the conservation status of most vertebrate fauna species have been produced by the Commonwealth Department of Environment (DoE) 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 and Crowley 2000 and 2010), monotremes and marsupials (Maxwell *et al*. 1996), rodents (Lee 1995) and bats (Duncan *et al*. 1999). 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 Western Australian Wildlife Conservation Act 1950 (WC Act) is State legislation for fauna protection administered by the Department of Parks and Wildlife (DPAW). The WC Act lists species under a set of Schedules

- **Schedule 1:** Fauna that are rare or likely to become extinct.
- **Schedule 2:** Fauna presumed to be extinct.
- **Schedule 3:** Migratory birds that are listed under JAMBA.
- **Schedule 4:** Other specially protected fauna.

Schedule 1 species are further categorised by DPAW into the categories 'extinct', 'extinct in the wild', 'critically endangered', 'endangered', 'vulnerable' and 'conservation dependent' species.

3.6.2 Conservation Significance 2

Species of Conservation Significance 2 (CS2) are not listed under State or Commonwealth Acts, but are listed as Priority species by DPAW. These species may be considered to be regionally significant.

In Western Australia, DPAW maintains a list of Priority Fauna made up of species that are not considered Threatened under the WA Wildlife Conservation Act, but for which DPAW feels there is cause for concern. There are five levels of Priority as defined by DPAW.

- **Priority 1:** Taxa with few, poorly known populations on threatened lands.
- **Priority 2:** Taxa with few, poorly known populations on conservation lands.
- **Priority 3:** Taxa with several, poorly known populations, some on conservation lands.
- **Priority 4:** Taxa in need of monitoring.
- **Priority 5:** Taxa in need of monitoring (conservation dependent species).

3.6.3 Conservation Significance 3

Conservation Significance 3 (CS3) species are not listed under State or Commonwealth Acts or in publications on threatened fauna or as Priority species by DPAW, but are considered by the author to be of local significance.

These are species considered to be of local significance in the study area 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.

4. Habitats of the Study Area

Five main fauna habitats were identified in the study area. They were identified using a combination of aerial photography, vegetation mapping (Mattiske Consulting 2014) and observations in the field.

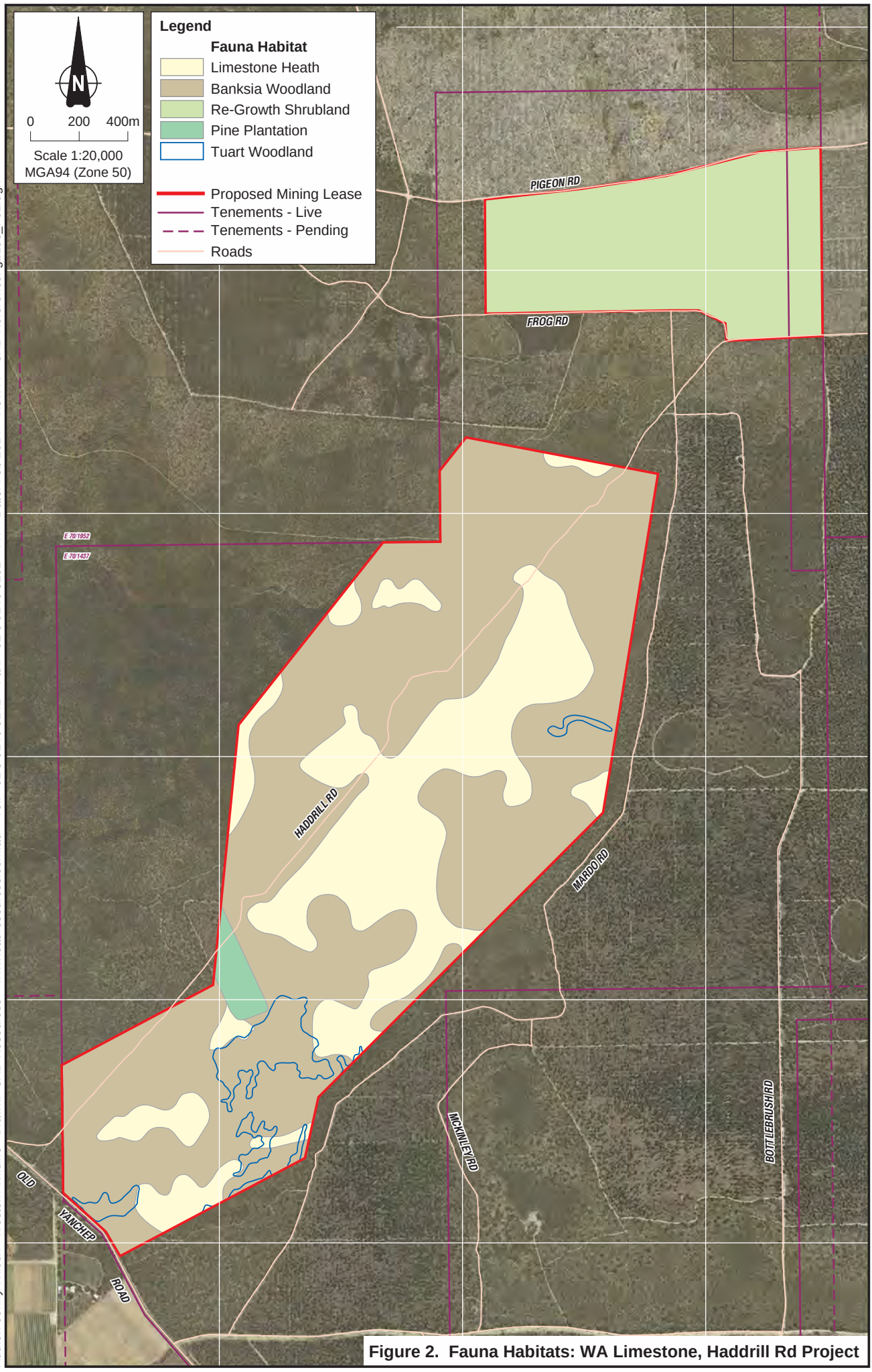
- Limestone heath
- Banksia woodland
- Tuarts
- Re-growth shrubland
- Pine plantation

Each habitat is described in the sections below and illustrated in Figure 2 and Plates 1 - 9. These habitats are common in the surrounding area.

4.1 Limestone Heath

Limestone Heath occurs across the higher parts of the southern site, where shallow sands overlie limestone (Plate 1). It is comprised of Parrotbush (*Banksia sessilis*), *Xanthorrhoea preisii*, *Melaleuca huegelii* and *Calothamnus quadrifidus* over *Hibbertia hypericoides* and *Banksia dallanneyi*. In some areas on the lower slopes, the heath is dominated entirely by thickets of Parrotbush (Plate 2).

As a relatively dense habitat in very good to excellent condition, the Limestone Heath provides shelter and nesting opportunities for birds and ground-dwelling fauna. The flowering shrubs, including species of *Melalueca*, *Calothamnus* and *Banksia*, provide nectar for honeyeaters and other nectarivorous species. The Parrotbush also provides seeds that are a foraging resource for the conservation significant Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*).



Author: Jenny Wilcox - Western Wildlife~ Drawn: CAD Resources ~ www.cadresources.com.au ~ Tel: +61 8 9246 3242 ~ Fax: +61 8 9246 3202 ~ A4 ~ Date: Feb 2014 ~ Rev: A ~ CAD Reference: g2195_F02.dgn

Figure 2. Fauna Habitats: WA Limestone, Haddrill Rd Project

Plate 1. Limestone heath.

Plate 2. Parrotbush (*Banksia sessilis*) thicket.

4.2 Banksia Woodland

The Banksia Woodland occurs on the deeper sands of the lower slopes and flats on the southern site (Plates 3 & 4). The canopy is dominated by *Banksia attenuata* with varying amounts of *Banksia menzeisii*, *Allocasuarina fraseriana*, *Eucalyptus todtiana*, Jarrah (*Eucalyptus marginata*). The understorey is generally of mixed native shrubs, but also included thickets of Parrotbush (*Banksia sessilis*). This habitat is in very good to excellent condition, and is likely to support a relatively intact faunal community. When in flower, the canopy is likely to attract honeyeaters and other nectarivorous species such as the Honey Possum (*Tarsipes rostratus*). The *Banksia* canopy and patches of Parrotbush also provide seeds that are a foraging resource for the conservation significant Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*).

Plate 3. Banksia woodland.

4.3 Tuarts

Scattered about the southern and eastern parts of the southern site, are Tuarts (*Eucalyptus gomphocephala*). The Tuarts overlap with the extent of both the Banksia woodland and the limestone heath (Figure 2). Some of the trees, particularly those on the eastern edges of the site, are quite small, while others are larger and appear to bear hollows (Plates 5 and 6). As some of the taller trees in the local landscape, they are likely to be favoured for perching and nesting by some birds, particularly birds of prey. Tuarts with hollows may be used by hollow-nesting species of birds, bats and other mammals, as well as by arboreal reptiles that shelter in hollows and crevices. Tuarts in nearby Yanchep National Park are known to support breeding by the conservation significant Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*), and some of the trees in the central and southern parts of the site are large enough to be potential breeding habitat. Unfortunately Feral Bees (*Apis mellifera*) were noted in some hollows, and this renders them unsuitable for native fauna.

Plate 4. Banksia woodland.

Plate 5. Tuart tree.

Plate 6. Tuart tree.

4.4 Re-growth Shrubland

After the removal of pines, the vegetation in the northern area has regenerated somewhat, with a mixture of native shrubs including *Acacia pulchella*, *Xanthorrhoea preissii*, *Gastrolobium linearifolium* and *Stirlingia latifolia*, *Hibbertia hypericoides*, *Gompholobium tomentosum* and *Scaevola repens* (Plate 7). There are also scattered Christmas Trees (*Nuytsia floribunda*), and around the edge of the area pine logs are stacked into piles (Plate 8). Although this habitat is considerably degraded compared to its likely original condition of Banksia Woodland, it is still likely to support a range of vertebrate species, particularly birds. Birds, including honeyeaters and small insectivores, are likely to forage and nest in the re-growth shrubland. As reptiles are generally poor colonizers, the reptile community is likely to be diminished from the original state, however the stacked pine logs provide reptile habitat. If left to regenerate, the faunal community in this habitat is likely to change over time, as the vegetation structure changes.

4.5 Pine Plantation

Pine Plantation makes up a small part of the southern site (Plate 9). Dominated by exotic pines, this habitat is likely to support few native fauna species. However, the seeds of the pine trees are likely to provide a foraging resource for the conservation significant Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*). The small area of plantation pine in the study area appeared unhealthy, and therefore may not be a good seed resource.

Plate 7. Re-growth shrubland.

Plate 8. Re-growth shrubland with pine logs.

Plate 9. Pine plantation.

5. Vertebrate Fauna of the Study Area

The numbers of vertebrate species potentially occurring in the study area are summarised below in Table 3. The amphibians, reptiles, birds and mammals that have the potential to occur in the study area are listed in Tables 4 - 7. Indicated in each table are the species recorded:

- In each study area by Western Wildlife during the 2013 site visit.
- In the wider area on the WA Museum Specimen Database (see Table 1).
- In the wider area on the Birds Australia Atlas Database (see Table 1).
- In the wider area on DPAW's Threatened and Priority Fauna Database (see Table 1).
- In the wider area on the EPBC Protected mattered Search Tool (see Table 1).

Table 3. Summary of vertebrate fauna potentially occurring in the study area.

Taxon	Total species	Introduced species	Conservation significant species		
			CS1	CS2	CS3
Amphibians	5	-	-	-	-
Reptiles	47	-	1	1	7
Birds	94	5	4	1	36
Mammals	22	5	3	3	4
Totals:	**168**	**10**	**8**	**5**	**47**

Fauna of conservation significance are discussed in the sections below and are summarised in Table 8. The results of the EPBC Act Protected Matters search and the DPAW Threatened and Priority Fauna Database search are given in Appendices 1 and 2.

5.1 Amphibians

There are five species of frog that have the potential to occur on the site (Table 4). No frogs were recorded during the site visit and there are no wetlands on the site. However, there are wetlands within 4km, including Loch McNess in Yanchep National Park. The frog species listed in Table 4 are those that use terrestrial habitats in addition to wetland habitats.

The Turtle Frog (*Myobatrachus gouldii*) inhabits sandy soil, potentially occurring in Banksia woodland on the site. This species is entirely terrestrial and does not require open water for breeding. Other species of frog, such as the Moaning Frog (*Heleioporus eyrei*) and Pobblebonk Frog (*Limnodynastes dorsalis*), may be found considerable distances from wetlands. These species may breed in wetlands nearby and move into the site during the non-breeding season.

5.1.1 Amphibians of Conservation Significance

There are no frogs of conservation significance expected to occur on the site, and no wetland habitats are likely to be directly impacted by the quarry development.

5.2 Reptiles

There are 47 species of reptile that have the potential to occur in the study area, of which two were recorded opportunistically during the site visit (Table 5). The majority of reptile species in the study area are likely to occupy native bushland, and the Banksia woodland and limestone heath are likely to support a relatively intact reptile community. The re-growth shrubland is likely to support a less diverse community, due to past disturbance, and the pine plantation is likely to support only a few species.

Many small reptile species shelter and forage under leaf litter and fallen timber. Other species, particularly geckoes, are likely to shelter under bark or in rock crevices. Some species also use artificial shelter such as old tin, sheds or rubbish. Semi-arboreal species, such as the Carpet Python (*Morelia spilota imbricata*) or Black-tailed Tree Goanna (*Varanus tristis*), may shelter in trees or in roof spaces. Generalist species, such as the Dwarf Skink (*Menetia greyii*) and Fence Skink (*Cryptoblepharus buchananii*) may live in more degraded areas, as well as in other habitats.

5.2.1 Reptiles of Conservation Significance

There are nine reptiles of conservation significance that may occur in the study area. Each species is listed and discussed below.

Conservation Significance 1

Carpet Python (southwest pop[n]) *Morelia spilota imbricata*
This species is listed under Schedule 4 (specially protected fauna) of the WC Act, and is Priority 4 according to DPAW.

The **Carpet Python** occurs in a range of habitats, and is known to occur in Neerabup National Park and Yanchep National Park (Government of Western Australia 2000, Bush *et al*. 2010). This species appears to require large tracts of bushland in order to persist and is mainly nocturnal, sheltering during the day in a range of places, such as tree hollows, rock crevices and in the burrows of other animals (Bush *et al*. 2010). On the Swan Coastal Plain, the Carpet Python favours areas of heath over limestone (Bush *et al*. 1995), so this species may be present on the site, in particular in the Limestone heath. It may also utilise hollows in Tuart trees. There are records of the Carpet Python in the Yanchep area on DPAW's Threatened and Priority Fauna Database, two of which are historical, but one is from 2001 (Appendix 2). The quarry development is likely to result in some loss of habitat for this species.

Conservation Significance 2

Black-striped Snake *Neelaps calonotos*
This species is listed as Priority 3 by DPAW.

The **Black-striped Snake** is generally restricted to the coastal plain between Mandurah and Lancelin, and as such is vulnerable to habitat loss due to urban developments (Bush *et al*. 1995). The Black-striped Snake occurs in Banksia woodlands and coastal dunes (Bush *et al*. 2010). This species was recorded in Yanchep in 1963 on DPAW's Threatened and Priority Fauna Database (Appendix 2). This species is likely to occur in the Banksia woodland on the site, but is unlikely to occur in the Limestone heath.

Conservation Significance 3

Speckled Stone Gecko	*Diplodactylus polyophthalmus*
White-spotted Ground Gecko	*Lucasium alboguttatum*
Javelin Legless Lizard	*Delma concinna*
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolatus*
Yellow-faced Whipsnake	*Demansia psammophis*
Bardick	*Echiopsis curta*
Crowned Snake	*Elapognathus coronatus*

There are seven reptiles of conservation significance 3 listed above. These are species that are scarce on the northern Swan Coastal Plain, some of them reaching the edges of their distribution in the vicinity of the study area (Bush *et al*. 2010), so may be of local significance. Some of these species are common in other parts of their range, including on the Darling Scarp. Most of these species inhabit Banksia woodlands (Bush *et al*. 2010), and may use this habitat in the study area.

5.3 Birds

There are 94 species of bird that have the potential to occur on the site, of which 23 were observed during site visit (Table 6). Most birds in the study area are likely to rely on bushland for all or most of their needs, but many species will also use re-growth shrubland, particularly species that usually inhabit dense understorey, or birds that forage on the open ground between patches.

The list in Table 6 is extensive, however not all species are likely to occur on the site, as the site is relatively small. It is difficult to say with certainty which species will and will not occur on the site as they all occur in the general area. Waterbirds have been excluded from the list as the site does not contain waterbird habitat, nor is it adjacent to waterbird habitat.

Hollows in Tuart trees in the southern site (Figure 2) are likely to be used for nesting by a range of species, potentially including the Southern Boobook, cockatoos, parrots, pardalotes and the Tree Martin. Birds of prey may also favour the Tuart trees for nesting, and small passerines are likely to favour dense vegetation, such as the Limestone Heath and parts of the re-growth area, for nest-building. When in flower, the thickets of Parrotbush (*Banksia sessilis*) and (*Calothamnus quadrifidus*) are likely to attract a range of honeyeaters, as is the canopy of the *Banksia* woodland. When the Parrotbush, *Banksia* spp. *Eucalyptus* spp. and *Hakea trifurcata* produce seed, they are likely to attract foraging parrots and cockatoos.

5.3.1 Birds of Conservation Significance

There are 41 birds of conservation significance that have the potential to occur on the sites. Each species is listed and discussed below. There are several waterbirds and seabirds of conservation significance listed in database search results (Appendices 1 & 2), but these have been omitted from the section below as the site lacks suitable habitat for these species.

Conservation Significance 1

Peregrine Falcon *Falco peregrinus*
This falcon is listed under Schedule 4 (other specially protected fauna) of the WC Act.

Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*
This cockatoo is listed under Schedule 1 (Endangered) of the WC Act and as Endangered under the EPBC Act.

Fork-tailed Swift *Apus pacificus*
This species is listed as migratory under the EPBC Act and is listed under Schedule 3 of the WC Act.

Rainbow Bee-eater *Merops ornatus*
This species is listed as migratory under the EPBC Act.

Carnaby's Black-Cockatoo is endemic to the southwest of Western Australia, and has declined due to loss of breeding habitat in the wheatbelt and foraging habitat along the west coast (Johnstone and Storr 1998). It forages on the seeds of a range of plant species, but are particularly attracted to proteaceous heaths, *Banksia* and *Eucalyptus* woodlands and pine plantations (Johnstone and Storr 1998). On the Swan Coastal Plain, important food plants include various Banksia species, Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) (Shah 2006). Between February and September, large flocks of birds aggregate in feeding flocks on the northern Swan Coastal Plain (Johnstone *et al*. 2011). These birds are foraging mainly in heaths, *Banksia* woodlands and pine plantations, and can be in large numbers of up to 7,000 birds (Johnstone e*t al*. 2011). Typically, Carnaby's Black-Cockatoo breeds in the wheatbelt region of Western Australia, nesting in large hollows in smooth-barked eucalypts such as the Salmon Gum (*Eucalyptus salmonophloia)* and Wandoo (*Eucalyptus wandoo*). However, it has also started breeding in areas further west and south than its traditional breeding range, including areas in the Darling Range and on the Swan Coastal Plain (Johnstone *et. al*. 2005, Johnstone *et al*. 2011). Breeding has been recorded from areas such as Baldivis, Lake Clifton, Yanchep and near Bunbury, with these nests always in Tuart (*Eucalyptus gomphocephala*) (Johnstone *et al*. 2011). Carnaby's Black-Cockatoo is highly likely to forage in Banksia woodland and the limestone heath in the study area, particularly on *Banksia attenuata*, *Banksia menzeisii*, *Banksia sessilis* and *Hakea trifurcata*. Carnaby's Black-Cockatoo has been recorded breeding nearby at Yanchep National Park (Johnstone *et al*. 2005), so there is potential that this species may breed in large Tuarts in the southern site.

The **Peregrine Falcon** is a wide-ranging bird of prey that may be a visitor to the site, or may use the site as part of a larger territory. However, there are no records of this species nearby on DPAW's Threatened and Priority Fauna Database (Appendix 2). This species is widespread throughout Australia, occurring mainly in ranges and on cliffs along rivers and coasts (Johnstone and Storr 1998). The Peregrine Falcon nests mainly on ledges on cliffs, rock outcrops and quarries, but may also nest in hollow trees in wetlands or on old nests of other bird species (Johnstone and Storr 1998). The site would only be highly significant for this falcon if they were breeding on the site.

The **Fork-tailed Swift** is a non-breeding visitor to Australia between September and April (Boehm 1962). While it can be common further north, in southwest Australia this species is generally scarce (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, a large population that appears to be stable (Birdlife International 2014). The Fork-tailed Swift is a largely an aerial species and is unlikely to be affected by changes to the study area.

The **Rainbow Bee-eater** is a common species that migrates southwards in summer to breed. Although not recorded in the study area during the site visit, it has been recorded from the general area on databases (Table 6, Appendix 2). The Rainbow Bee-eater may forage anywhere over the study area. For breeding, this species requires sandy soils in which to burrow, so breeding habitat potentially includes the open parts of the northern site and the sandy soils of the Banksia woodland in the southern site, particularly alongside sandy tracks. As the Rainbow Bee-eater is a relatively common species, development of the study area is unlikely to affect the conservation status of this species in the region, particularly if breeding habitat is avoided. If development is to occur in sandy areas, it should be timed to avoid disturbance to eggs and chicks in burrows during the summer breeding period.

Conservation Significance 2

Masked Owl *Tyto novaehollandiae*
This species is listed as Priority 3 by DPAW.

The southwest subspecies of the **Masked Owl** occurs in forests, and breeds in large hollows in eucalypts. This species may move north and northeast in autumn and winter (Johnstone and Storr 1998) and so may be more common in the area in those seasons. The Masked Owl has declined due to habitat loss (Garnett and Crowley 2000). This species may potentially occur in the study area, as there is one record of the species from Yanchep in 1973 on DPAW's Threatened and Priority Fauna Database (Appendix 2). This owl has a home range of about 5 – 10 km^2 (Garnett and Crowley 2000), so the study area would represent part of the habitat for one bird.

Conservation Significance 3

Emu	*Dromaius novaehollandiae*
Square-tailed Kite	*Hamirostra isura*
Whistling Kite	*Haliastur sphenurus*
Brown Goshawk	*Accipiter fasciatus*
Collared Sparrowhawk	*Accipiter cirrocephalus*
Little Eagle	*Aquila morphnoides*
Wedge-tailed Eagle	*Aquila audax*
Brown Falcon	*Falco berigora*
Painted Button-Quail	*Turnix varia*
Common Bronzewing	*Phaps chalcoptera*
Brush Bronzewing	*Phaps elegans*
Variegated Fairy-wren	*Malurus lamberti*
White-winged Fairy-wren	*Malurus leucopterus*
Splendid Fairy-wren	*Malurus splendens*
Southern Emu-wren	*Stipiturus malachurus*
White-browed Scrubwren	*Sericornis frontalis*
Weebill	*Smicrornis brevirostris*
Inland Thornbill	*Acanthiza apicalis*
Western Thornbill	*Acanthiza inornata*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
White-naped Honeyeater	*Melithreptus chloropsis*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
White-cheeked Honeyeater	*Phylidonyris nigra*
Tawny-crowned Honeyeater	*Phylidonyris melanops*
Yellow-throated Miner	*Manorina flavigula*
Western Wattlebird	*Anthochaera lunulata*
Scarlet Robin	*Petroica multicolor*
Hooded Robin	*Petroica cucullata*
White-breasted Robin	*Eopsaltria georgiana*
Western Yellow Robin	*Eopsaltria australis*
Varied Sittella	*Daphoenositta chrysoptera*
Golden Whistler	*Pachycephala pectoralis*
Grey Shrike-Thrush	*Colluricincla harmonica*
Black-faced Woodswallow	*Artamus cinereus*
Dusky Woodswallow	*Artamus cyanopterus*
Grey Currawong	*Strepera versicolor*

There are 36 bird species of conservation significance 3 that potentially occur in the study area, as listed above and indicated in Table 6. These birds are considered to be of significance on the Swan Coastal Plain (Government of Western Australia 2000). The species may be either wide-ranging species with a reduced population on the Swan Coastal Plain, or habitat specialists with a reduced distribution on the Swan Coastal Plain (Government of Western Australia 2000). Of these locally significant species, 12 were recorded during the site visit (Table 6). Of particular interest was the Southern Emu-wren (*Stipiturus malachurus*) as this species was sighted in the northern site, but is generally considered to have declined or become locally extinct on the northern Swan Coastal Plain (Wilson and Valentine 2009). Many of these locally significant species are common in other parts of their distribution, but populations may be vulnerable to increasing development or urbanisation.

5.4 Mammals

There are 22 species of mammal that potentially occur in the study area, of which 17 are native and five introduced (Table 7). One native mammal was recorded opportunistically during the site visit, the Western Grey Kangaroo (*Macropus fuliginosus*). Two introduced species, the Fox (*Vulpes vulpes*) and Rabbit (*Oryctolagus cuniculus*), were also recorded. As the site is continuous with surrounding native vegetation, most native mammals still extant on the Swan Coastal Plain are likely to be present.

The Common Brush-tail Possum (*Trichosurus vulpecula*) may occur in the area, nesting in large hollows in Tuarts in the southern site. Other mammals that use tree hollows are bats, and many of the bats listed in Table 7 roost in tree hollows or hollow tree trunks. Roosts of some species can be quite large (e.g. Southern Forest Bat roosts may have up to 100 individuals) while male bats may roost alone (e.g. Gould's Wattled Bat) (Van Dyck and Strahan 2008).

5.4.1 Mammals of Conservation Significance

There are six mammals of conservation significance that may occur in the study area. Each species is listed and discussed below. Three other mammals are listed on DPAW's Threatened and Priority Fauna Database for the area, the Black-flanked Rock-wallaby (*Petrogale lateralis*), Woylie (*Bettongia penicillata*) and Chuditch (*Dasyurus geoffroii*) (Appendix 2). These species are locally extinct, so have not been discussed in this section.

Conservation Significance 2

Quenda (Southern Brown Bandicoot) *Isoodon obesulus*
This species is listed as Priority 5 by DPAW.

Western Brush Wallaby *Macropus irma*
This wallaby is listed as Priority 4 by DPAW.

Western False Pipistrelle *Falsistrellus mackenziei*
This bat is listed as Priority 4 by DPAW.

The **Quenda** favours areas with dense understorey, and is often particularly common in dense wetland vegetation. The Quenda has been recorded from Carabooda in 2003 on DPAW's Threatened and Priority Fauna Database (Appendix 2). It has also been recorded in Bush Forever Site 381, of which the study area is a part, and in nearby Yanchep National Park (Government of Western Australia 2000). The Quenda may be present in wherever there is dense vegetation at ground level, but favouring the lower lying areas of *Banksia* woodland. However, fauna surveys for the Gnangara Sustainability Strategy found that Quenda were uncommon in the region, recorded at very few sites in the area (Wilson and Valentine 2009), and may be restricted to dense vegetation around damplands (Reaveley 2009). The quarry development may result in some loss of habitat for this species, but is not likely to result in isolation of Quenda populations.

The **Western Brush Wallaby** is endemic to the southwest of Western Australia and occurs in open forests or woodlands (Van Dyck and Strahan 2008). On the northern Swan Coastal Plain, this species favours Banksia/Eucalypt woodland with a dense understorey and long-unburnt vegetation for shelter (Reaveley 2009). The home-range size of this species has been estimated at about 9.9ha for males and 5.3ha for females (Bamford and Bamford 1999), so if present, the study area could support several individuals. This species has been recorded in Bush Forever Site 381, of which the study area is a part, and in nearby Yanchep National Park (Government of Western Australia 2000). It is thought to be less common on the northern Swan Coastal Plain compared with other parts of its range, and is vulnerable to fox predation, changed fire regimes and habitat loss (Reaveley 2009). Although not observed during the site visit, the Western Brush Wallaby may occur in Banksia woodland and re-growth shrubland habitats in the study area, at least on occasion.

The **Western False Pipistrelle** inhabits high rainfall forests including Karri forests, the wetter parts of the Jarrah forest and Tuart woodlands on the Swan Coastal Plain (Van Dyck and Strahan 2008, McKenzie and Readon 2008). This species roosts in colonies in tree hollows or hollow logs, and have been found in groups of 5 to 30 bats (Churchill 1998, Van Dyck and Strahan 2008). This bat may potentially forage and roost in Tuart tress in the southern site, but the northern site lacks roosting sites. The quarry development may result in some loss of foraging habitat for this species, and may possibly result in the loss of a roost site.

Conservation Significance 3

Honey Possum	*Tarsipes rostratus*
Western Pygmy Possum	*Certcartetus concinnus*
Bush Rat	*Rattus fuscipes*

Three small mammal species have been listed as conservation significance 3. While these species are relatively common and widespread in the southwest of Western Australia, in the Perth metropolitan area they are extremely uncommon and likely to be locally extinct in many areas. On the outskirts of Perth, and in larger patches of native vegetation, some of these species persist.

The **Honey Possum** is a small marsupial that feeds on nectar and pollen, and occurs in areas that provide sufficient flowers all year round including floristically diverse heath and Banksia woodland. The Honey Possum has been recorded nearby from Neerabup National Park (Government of Western Australia 2000), and this species is likely to be present in both Banksia woodland and limestone heath. The Honey Possum moves in order to take advantage of seasonal availability of flowering plants, so is vulnerable to the effects of habitat fragmentation.

The **Western Pygmy Possum** feeds on nectar, pollen and insects, and are very mobile, moving between areas of plants in flower (Van Dyck and Strahan 2008). During the day this species nests in a tree hollow, in grasstrees or other sheltered sites. Like the Honey Possum, the Western Pygmy Possum may occur in woodland and heath parts of the study area, where there are flowering plants, and as they need to move to find flowering plants, this species also requires large tracts of native vegetation for survival.

The **Bush Rat** is rarely recorded in the northern Swan Coastal Plain (Reaveley 2009), though it is known from Yanchep National Park. It may be that it prefers near-coastal habitats with a dense understorey (Reavley 2009), so may not occur as far inland as the study area. If present, it is likely to favour areas with dense understory.

6. Invertebrates

In general, invertebrate fauna is far less well known than the vertebrate fauna, while being far more numerous. Although this report is primarily concerned with vertebrate species, two invertebrates of conservation significance were listed on DPAW's Threatened and Priority Fauna Database for the area (Appendix 2). The Freshwater Mussel (*Westralunio carteri*) is not likely to occur due to lack of suitable habitat, but the remaining species is listed and discussed below.

Conservation Significance 2

Graceful Sun-moth *Synemon gratiosa*
This species is listed as Priority 4 by DPAW.

Until recently, the **Graceful Sun-moth** was listed under Schedule 1 of the WC Act, but it was downgraded to a Priority 4 in November 2012. In January 2013, this species was removed from its listing as Threatened (Endangered) under the EPBC Act. The Graceful Sun-moth is known to inhabit coastal dunes and *Banksia* woodlands (DEC 2011). Populations in coastal dunes are usually more numerous and dense than those in *Banksia* woodlands (DEC 2011). The larvae of the Graceful Sun-moth feed on *Lomandra maritima* in coastal dunes, or *Lomandra hermaphrodita* in Banksia woodland, and adult moths are usually found in close proximity to breeding areas (Bishop *et al*. 2010, DEC 2011). The adult moths fly between late February and early April, with the male moths establishing territories in open areas, including along tracks and firebreaks. Female moths are harder to observe and after mating tend to be found near the patches of *Lomandra* that are breeding areas (Bishop *et al*. 2010). There are records of the Graceful Sun-moth from Yanchep National Park and Eglinton on DPAW's Threatened and Priority Fauna Database (Appendix 2). The Graceful Sun-moth may occur in Banksia woodland at the site, but is unlikely to occur in any of the other habitats.

7. Summary and Conclusions

7.1 Summary of Fauna Habitats and Conservation Significant Fauna

The study area consists of two sites, the northern site (~82ha) and the southern site (~329ha). The study area has five fauna habitats:

- Limestone heath
- Banksia woodland
- Tuarts
- Re-growth shrubland
- Pine plantation

The northern site consists entirely of re-growth shrubland, and the remaining habitats occur on the southern site. These habitats are well represented in the surrounding area, though to the east the vegetation becomes dominated by pine plantation. There are habitat trees (Tuarts) present in the southern site, some of which have a DBH ≥ 50cm.

The southern site is likely to support a relatively intact assemblage of native fauna in the Banksia woodland, limestone heath and Tuart habitats, but the faunal diversity and species richness in the northern site is likely to be reduced due to past disturbance. Overall, the study area may support up to five species of frog, 47 species of reptile, 94 species of birds and 22 (17 native) species of mammal. Twenty-three species of bird, two reptiles and one native mammal were recorded during the December 2013 site visit.

There are no frogs of conservation significance likely to occur, but there are nine reptiles, 41 birds, six mammals and one invertebrate of conservation significance that may occur. Fauna of CS1 and CS2 are summarised in Table 8.

The study area has the potential to support five species of Conservation Significance 1; the Carpet Python, Carnaby's Black-Cockatoo, Peregrine Falcon, Rainbow Bee-eater and Fork-tailed Swift. Of these, Carnaby's Black-Cockatoo is highly likely to forage on the southern site, and may potentially breed in large Tuart hollows. The Carpet Python is likely to be present, particularly in the limestone heath, and the Rainbow Bee-eater is likely to forage in the area and may breed in the re-growth shrubland or Banksia woodland. The sites are only likely to be significant for the Peregrine Falcon if this species was found to be nesting.

The study area has the potential to support five species of Conservation Significance 2; the Black-striped Snake, Masked Owl, Quenda (Southern Brown Bandicoot), Western Brush Wallaby and Western False Pipistrelle. The Black-striped Snake, Quenda, Western Brush Wallaby, Western False Pipistrelle and Graceful Sun-moth may occur in the Banksia woodland, and are unlikely to inhabit the limestone heath. The Western False Pipistrelle may also roost in Tuart hollows and forage over other habitat types. The Masked Owl may potentially occur, but is very rare on the Swan Coastal Plain so the likelihood is low.

The 47 species of conservation significance 3 that may be present are mainly locally significant bird species, but also include reptiles and small mammals that are generally scarce on the Swan Coastal Plain, or are at the limit of their distribution in the area. Twelve of the CS3 birds were recorded during the site visit.

7.2 Potential Impacts

The development of the limestone quarry will result in the loss of some or all of the site's fauna habitats, depending on the final quarry footprint area. The most likely potential impacts of the proposed limestone quarry are:

- Direct mortality of fauna
- Habitat loss
- Habitat fragmentation
- Habitat degradation
- Road mortalities
- Increased disturbance to fauna
- Increase in feral predators

The most significant impacts are likely to be habitat loss and an increase in habitat fragmentation.

7.2.1 Direct mortality of fauna

Direct mortality of fauna may occur when clearing or construction activities are carried out. For example, small terrestrial fauna species, young birds in nests and fauna roosting in hollows are usually unable to move out of the way of large machinery. Some direct mortality of fauna is usually unavoidable, and although it is unlikely to affect the conservation status of any species in this case, it is desirable to minimise it where possible.

Recommendation 1: Where possible, restrict construction of access roads, firebreaks and fence-lines to existing cleared tracks.

Recommendation 2: Avoid clearing during late winter and spring in order to minimise the mortality of young birds in nests.

7.2.2 Habitat loss

Almost all native fauna rely on native vegetation for foraging, shelter and nest sites. Any clearing in the study area is likely to result in some habitat loss for native fauna. Clearing the southern site may result in the loss of over 10% of Bush Forever Site 281. Most of the native vegetation present is Banksia woodland and limestone heath, and therefore foraging habitat for conservation significant species such as the CS1 Carnaby's Black-Cockatoo. Tuart trees with a DBH ≥ 50cm represent potential current or future breeding habitat for Carnaby's Black-Cockatoo. If potential nesting trees or more than 1ha of foraging habitat are to be disturbed, it is appropriate to refer the proposal to the Commonwealth DoE for the determination of any significant impacts under the EPBC Act.

Recommendation 3: Minimise the quarry footprint so far as practicable, in order to maximise the amount of native vegetation retained.

Recommendation 4: During clearing or construction, avoid disturbance to adjacent areas of native vegetation that are to be preserved.

Recommendation 5: Where possible, preserve Tuart trees with a DBH ≥ 50cm, particularly those with existing hollows.

Recommendation 6: If potential breeding habitat or more than 1ha of foraging habitat (Banksia woodland or limestone heath) for EPBC listed Carnaby's Black-Cockatoo is likely to be cleared, refer the development to DoE for determination whether it constitutes a significant impact under the EPBC Act.

Recommendation 7: Carry out appropriate revegetation of the site after the completion of quarry activities.

7.2.3 Habitat fragmentation

In an un-fragmented landscape fauna are free to move, allowing gene-flow between populations and the capacity to move to take advantage of dispersed or temporary resources such as food or nesting sites. Clearing native vegetation can result in the increased isolation of the remaining native vegetation in the area. Natural animal movements can be disrupted, and if a complete barrier is formed between populations, genetic isolation results (Bennet 1991). It can be difficult for fauna to move through a landscape that includes areas of cleared land, and this difficultly will be greater for some species than others. Highly mobile species (such as some birds) may be able to negotiate cleared areas to travel between isolated patches of native vegetation. Small ground-dwelling species (such as many reptiles) may not be able to traverse cleared land, impacting on their ability to maintain gene-flow between populations.

The study area is set within a partly fragmented landscape, where native vegetation is interspersed with pine plantation (particularly to the east and north) and rural land uses (to the south). If the entire study area were to be cleared, it would increase the isolation of bushland in the surrounding area by increasing the distances that fauna must travel between remaining native vegetation. In particular, the movement of fauna between the north and west (including Yanchep National Park) and the south and east (patches of bushland within pine plantation) is likely to be impeded.

Recommendation 8: Maintain habitat corridors to allow for east – west movement of fauna.

Recommendation 9: Avoid the creation of isolated patches of habitat within the quarry development area.

7.2.4 Habitat degradation

Dust, weeds and altered fire regimes can affect habitats adjacent to a development, causing habitat degradation. This may occur on remaining bushland within a development area, or in adjacent bushland areas. Dust may be generated from the quarrying process and from the action of vehicles on roads of crushed limestone. Dust can penetrate into adjacent bushland areas, covering vegetation and changing soil surface conditions.

Weeds may be brought in to a site on vehicles, and/or spread into adjacent bushland along the increased 'edge' created by clearing. Increased fires can also exacerbate the spread of weeds (Wilson and Valentine 2009). The response of fauna to fire is complex. Many native mammal species on the northern Swan Coastal Plain are at risk from too frequent or too large fires (Reaveley 2009) and overall reptile abundance is higher is long-unburnt areas (Wilson and Valentine 2009). Overall, maintenance of a diverse range of post-fire aged habitat, including long-unburnt habitat, is thought to best provide for the diversity of fauna in the region (Wilson and Valentine 2009). In any development there is a risk that more fires may occur accidentally and burn out large areas of habitat.

Recommendation 10: Manage dust emissions from the site to minimise dust penetrating adjacent bushland.

Recommendation 11: Develop controls to minimise weed invasion into adjacent bushland.

Recommendation 12: Develop controls to minimise the risk of accidental fires.

7.2.5 Road mortalities

Road mortalities are undesirable as they may have impacts on local wildlife populations, may have ethical issues (e.g. injured or orphaned wildlife) and can affect human safety on the road (Magnus 2006). Rowden *et al*. (2008) report that between 2001 and 2005, seven fatal crashes and 101 crashes requiring hospitalisation in Western Australia were due to animals hit on the roads. However, except for threatened species, road mortality has not been found to significantly impact bird population sizes at a national level, at least in England (Forman and Alexander 1998).

Fauna at risk of road mortalities include reptiles that may bask on warm bitumen roads, such as the conservation significant Carpet Python. Road mortalities also affect ground fauna that cross roads on foot, including the conservation significant Quenda as well as reptiles and frogs. Larger mammals such as Western Grey Kangaroos and Western Brush Wallaby are also at risk.

There is a temporary risk of mortalities when clearing at the site is undertaken, as some fauna may be disturbed from the site onto roads. In addition, fauna that enter the site from adjacent bushland may be at risk from light vehicle and truck traffic within the site.

Recommendation 13: Consider temporary fencing along roads during clearing, to prevent fauna exiting the site.

Recommendation 14: Conduct clearing in a progressive manner, to encourage fauna to move away from roads and towards adjacent remaining bushland.

7.2.6 Increased human disturbance to fauna

Disturbance to fauna can be due to noise, vibration, movement or light, and includes examples such as the use of vehicles, earthmoving equipment, drilling, blasting, workshop noises, office or driveway lighting, or the presence of people. Disturbance to fauna may result in fauna avoiding an area, e.g. due to excessive noise, and therefore being unable to utilise an area of available habitat. Fauna may also experience increased stress and/or expend extra energy in avoidance behaviours.

Recommendation 15: Where practicable, situate noisy activities away from the larger areas of remaining bushland in order to reduce the amount of disturbance to fauna.

Recommendation 16: Minimise light spill into adjacent bushland by using the minimum of outdoor lighting.

7.2.7 Increased feral predators

Feral predators in the study area are represented by the fox and cat. Feral predators may compete with native predators, and also prey on a range of native fauna including frogs, reptiles, birds and small mammals. Mammals and birds of about 200g or under are most at risk from cat predation, as are ground foraging or ground nesting birds (Dickman 1996). Increased habitat fragmentation of native vegetation may make native fauna more vulnerable to predators where they have to negotiate cleared areas, and the presence of waste (e.g. skips and bins) can attract feral predators to a site.

Recommendation 17: Ensure that food and other wastes are secure from feral animals.

7.3 Conclusions

The southern site is likely to support a relatively intact faunal community, including some species of conservation significance. The northern site is likely to support less species, due to past disturbance, though some conservation significant species may also occur.

The development of a quarry at the site is likely to result in the loss of some native vegetation (and therefore fauna habitats) from the study area. Although the extent of the clearing is likely to be small on a regional scale, on a local scale the most significant potential impacts include habitat loss, including habitat loss for conservation significant species such as Carnaby's Black-Cockatoo, and increased habitat fragmentation. Other potential impacts include some direct mortality of fauna when clearing, road mortalities, increased human disturbance to fauna, habitat degradation and an increase in feral predators. Recommendations have been given above, with the aim of minimising or ameliorating impacts where possible.

Table 4. Amphibians that potentially occur in the study area.

+ = species recorded in the study area during the 2013 level 1 fauna survey.
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 DPAW 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).

Species		Status	Records				
			Study Area	WAM	FSDB	TF	EPBC
Limnodynastidae (ground frogs)							
Moaning Frog	*Heleioporus eyrei*			+			
Sand Frog	*Heleioporus psammophilus*						
Pobblebonk	*Limnodynastes dorsalis*						
Myobatrachidae (ground frogs)							
Turtle Frog	*Myobatrachus gouldii*				+		
Guenther's Toadlet	*Pseudophryne guentheri*						
# frog species expected in the study area:		**5**					
# frog species recorded in the study area 2013:		**2**					

Table 5. Reptiles that potentially occur in the study area.

+ = species recorded in the study area during the 2012 level 1 fauna survey.
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 DPAW 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).

Species		Status	Records				
			Study Area	WAM	FSDB	TF	EPBC
Agamidae (dragon lizards)							
Western Bearded Dragon	*Pogona minor*				+		
Western Heath Dragon	*Ctenophorus adelaidensis*						
Diplodactylidae (geckoes)							
Clawless Gecko	*Crenadactylus ocellatus*						
White-spotted Ground Gecko	*Lucasuim alboguttatum*	CS3					
Speckled Stone Gecko	*Diplodactylus polyophthalmus*	CS3					
Southern Spiny-tailed Gecko	*Strophurus spinigerus*						
Carphodactylidae (Knob-tailed geckoes)							
Barking Gecko	*Underwoodisaurus milii*						
Gekkonidae (geckoes)							
Marbled Gecko	*Christinus marmoratus*			+			
Pygopodidae (legless lizards)							
Sandplain Worm Lizard	*Aprasia repens*						
Javelin Legless Lizard	*Delma concinna*	CS3					
Fraser's Legless Lizard	*Delma fraseri*						
Gray's Legless Lizard	*Delma grayii*			+			
Burton's Legless Lizaard	*Lialis burtonis*			+			
Keeled Legless Lizard	*Pletholax gracilis*						
Common Scalyfoot	*Pygopus lepidopodus*						
Scincidae (skink lizards)							
Cool Skink	*Acritoscincus trilineatus*						
Fence Skink	*Cryptoblepharus buchananii*		+		+		
Limestone Ctenotus	*Ctenotus australis*						
West Coast Ctenotus	*Ctenotus fallens*						
Odd-striped Ctenotus	*Ctenotus impar*						
Western Slender Bluetongue	*Cyclodomorphus melanops*						
King's Skink	*Egernia kingii*						
Salmon-bellied Skink	*Egernia napoleonis*						
	Hemiergis quadrilineata				+		
	Lerista elegans				+		
	Lerista lineopunctulata						
	Lerista praepedita						
Dwarf Skink	*Menetia greyii*						
	Morethia lineoocellata			+			

Table 5. (cont.)

Species		Status	Records				
			Study Area	WAM	FSDB	TF	EPBC
Scincidae continued…							
Dusky Morethia	*Morethia obscura*				+		
Western Bluetongue	*Tiliqua occipitalis*			+			
Bobtail	*Tiliqua rugosa*		+	+	+		
Varanidae (goanna or monitor lizards)							
Gould's Goanna	*Varanus gouldii*						
Black-tailed Tree Goanna	*Varanus tristis*						
Typhlopidae (blind snakes)							
Southern Blind Snake	*Ramphotyphlops australis*						
Boidae (pythons)							
Carpet Python	*Morelia spilota imbricata*	CS1		+		+	
Elapidae (front-fanged snakes)							
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolatus*	CS3					
Southern Shovel-nosed Snake	*Brachyurophis semifasciatus*						
Yellow-faced Whip-Snake	*Demansia psammophis*	CS3		+			
Bardick	*Echiopsis curta*	CS3					
Crowned Snake	*Elapognathus coronatus*	CS3					
Black-naped Snake	*Neelaps bimaculatus*						
Black-striped Snake	*Neelaps calonotos*	CS2		+		+	
Gould's Hooded Snake	*Parasuta gouldii*			+			
Black-backed Snake	*Parasuta nigriceps*						
Dugite	*Pseudonaja affinis*			+			
Jan's Banded Snake	*Simoselaps bertholdi*			+			
# reptile species expected in the study area:			**47**				
# reptile species recorded in the study area in 2013:			**2**				

Table 6. Birds that potentially occur in the study area.

+ = species recorded in the study area during the 2013 level 1 fauna survey.
BA = species recorded in the area on the Birds Australia Atlas 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 DPAW 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).
Int = introduced species.

Species		Status	Records					
			Study Area	BA	WAM	FSDB	TF	EPBC
Casuriidae (cassowaries and emus)								
Emu	*Dromaius novaehollandiae*	CS3		+				
Phasianidae (pheasants and quails)								
Stubble Quail	*Coturnix pectoralis*							
Accipitridae (kites, hawks and eagles)								
Black-shouldered Kite	*Elanus caeruleus*				+			
Square-tailed Kite	*Hamirostra isura*	CS3						
Whistling Kite	*Haliastur sphenurus*	CS3		+	+			
Brown Goshawk	*Accipiter fasciatus*	CS3		+				
Collared Sparrowhawk	*Accipiter cirrocephalus*	CS3		+				
Wedge-tailed Eagle	*Aquila audax*	CS3		+				
Little Eagle	*Aquila morphnoides*	CS3						
Spotted Harrier	*Circus assimilis*		+	+				
Falconidae (falcons)								
Australian Kestrel	*Falco cenchroides*			+				
Brown Falcon	*Falco berigora*	CS3		+	+			
Australian Hobby	*Falco longipennis*			+				
Peregrine Falcon	*Falco peregrinus*	CS1					+	
Turnicidae (buttton-quails)								
Painted Button-quail	*Turnix varia*	CS3						
Columbidae (pigeons & doves)								
Rock Dove	*Columba livia*	Int.		+				
Spotted Dove	*Streptopelia chinensis*	Int.		+				
Laughing Dove	*Streptopelia senegalensis*	Int.		+				
Common Bronzewing	*Phaps chalcoptera*	CS3	+	+				
Brush Bronzewing	*Phaps elegans*	CS3						
Crested Pigeon	*Ocyphaps lophotes*			+				
Psittacidae (parrots & cockatoos)								
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	CS1		+	+	+		
Galah	*Cacatua roseicapillus*							
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*							
Australian Ringneck	*Platycercus zonarius*							
Red-capped Parrot	*Platycercus spurius*		+					
Elegant Parrot	*Neophema elegans*			+				
Rainbow Lorikeet	*Trichoglossus haematodus*	Int.		+				

Table 6. (cont.)

Species		Status	Records					
			Study Area	BA	WAM	FSDB	TF	EPBC
Cuculidae (cuckoos)								
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*							
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*							
Pallid Cuckoo	*Cacomantis pallidus*							
Fan-tailed Cuckoo	*Cacomantis flabelliformis*							
Strigidae (hawk owls)								
Southern Boobook	*Ninox novaeseelandiae*			+				
Tytonidae (barn owls)								
Barn Owl	*Tyto alba*							
Masked Owl	*Tyto novaehollandiae*	CS2			+		+	
Podargidae (frogmouths)								
Tawny Frogmouth	*Podargus strigoides*			+	+			
Caprimulgiidae (nightjars)								
Spotted Nightjar	*Eurostopodus argus*							
Aegothelidae (owlet-nightjars)								
Australian Owlet-nightjar	*Aegotheles cristatus*							
Apodidae (swifts)								
Fork-tailed Swift	*Apus pacificus*	CS1		+			+	+
Halcyonidae (tree kingfishers)								
Laughing Kookaburra	*Dacelo novaeguineae*	Int.		+				
Sacred Kingfisher	*Todiramphus sanctus*			+				
Meropidae (bee-eaters)								
Rainbow Bee-eater	*Merops ornatus*	CS1		+	+		+	+
Maluridae (fairy-wrens)								
Variegated Fairy-wren	*Malurus lamberti*	CS3	+					
White-winged Fairy-wren	*Malurus leucopterus*	CS3		+	+			
Splendid Fairy-wren	*Malurus splendens*	CS3	+	+				
Southern Emu-wren	*Stipiturus malachurus*	CS3	+					
Pardalotidae (pardalotes)								
Spotted Pardalote	*Pardalotus punctatus*			+				
Striated Pardalote	*Pardalotus striatus*		+	+	+			
Acanthizidae (scrubwrens and allies)								
White-browed Scrubwren	*Sericornis frontalis*	CS3	+	+				
Weebill	*Smicrornis brevirostris*	CS3	+	+				
Western Gerygone	*Gerygone fusca*		+	+	+			
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	CS3	+	+				
Inland Thornbill	*Acanthiza apicalis*	CS3	+	+				
Western Thornbill	*Acanthiza inornata*	CS3	+	+	+			

Table 6. (cont.)

Species		Status	Records					
			Study Area	BA	WAM	FSDB	TF	EPBC
Meliphagidae (honeyeaters and chats)								
Western Spinebill	*Acanthorhynchus superciliosus*			+				
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*							
Singing Honeyeater	*Gavicalis virescens*							
Yellow-throated Miner	*Manorina flavigula*	CS3			+			
Western Wattlebird	*Anthochaera lunulata*	CS3		+	+			
Red Wattlebird	*Anthochaera carunculata*			+	+			
Tawny-crowned Honeyeater	*Phylidonyris melanops*	CS3	+					
Brown Honeyeater	*Lichmera indistincta*			+	+			
New Holland Honeyeater	*Phylidonyris novaehollandiae*	CS3		+	+			
White-cheeked Honeyeater	*Phylidonyris nigra*	CS3	+		+			
White-naped Honeyeater	*Melithreptus chloropsis*	CS3						
White-fronted Chat	*Epthianura albifrons*			+				
Petroicidae (robins)								
Jacky Winter	*Microeca fascinans*							
Hooded Robin	*Petroica cucullata*	CS3			+			
Scarlet Robin	*Petroica multicolor*	CS3						
Red-capped Robin	*Petroica goodenovii*							
White-breasted Robin	*Eopsaltria georgiana*	CS3		+				
Western Yellow Robin	*Eopsaltria australis*	CS3						
Neosittidae (sittellas)								
Varied Sittella	*Daphoenositta chrysoptera*	CS3		+				
Pachycephalidae (whistlers)								
Golden Whistler	*Pachycephala pectoralis*	CS3						
Rufous Whistler	*Pachycephala rufiventris*		+	+				
Grey Shrike-thrush	*Colluricincla harmonica*	CS3		+				
Dicruridae (fantails & magpie-lark)								
Grey Fantail	*Rhipidura fuliginosa*		+					
Willie Wagtail	*Rhipidura leucophrys*			+	+			
Magpie-lark	*Grallina cyanoleuca*			+				
Campephagidae (cuckoo-shrikes)								
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			+	+			
White-winged Triller	*Lalage tricolor*				+			
Artamidae (woodswallows)								
Black-faced Woodswallow	*Artamus cinereus*	CS3		+	+			
Dusky Woodswallow	*Artamus cyanopterus*	CS3	+					

Table 6. (cont.)

Species		Status	Records					
			Study Area	BA	WAM	FSDB	TF	EPBC
Cracticidae (magpie & butcherbirds)								
Grey Butcherbird	*Cracticus torquatus*		+	+	+			
Australian Magpie	*Cracticus tibicen*			+				
Grey Currawong	*Strepera versicolor*	CS3						
Corvidae (ravens and crows)								
Australian Raven	*Corvus coronoides*			+				
Hirundinidae (swallows and martins)								
White-backed Swallow	*Cheramoeca leucosterna*		+		+			
Welcome Swallow	*Hirundo neoxena*							
Tree Martin	*Hirundo nigricans*		+					
Zosteropidae (white-eyes)								
Silvereye	*Zosterops lateralis*		+	+	+			
Sylviidae (songlarks and grassbirds)								
Rufous Songlark	*Cincloramphus mathewsi*							
Dicaeidae (mistletoebird)								
Mistletoebird	*Dicaeum hirundinaceum*			+				
Motacillidae (pipits and wagtails)								
Australian Pipit	*Anthus australis*		+		+			
# bird species expected in the study area:		**94**						
# bird species recorded in the study area in 2013:		**23**						

Table 7. Mammals that potentially occur in the study area.

+ = species recorded in the study area during the 2013 level 1 fauna survey.
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 DPAW 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).
Int = introduced species.

Species		Status	Records				
			Study Area	WAM	FSDB	TF	EPBC
Tachyglossidae (echidnas)							
Echidna	*Tachyglossus aculeatus*			+			
Peramelidae (bandicoots and bilbies)							
Quenda or Brown Bandicoot	*Isoodon obesulus*	CS2		+		+	
Burramyidae (pygmy possum)							
Western Pygmy-possum	*Cercartetus concinnus*	CS3		+			
Tarsipedidae (honey possum)							
Honey Possum	*Tarsipes rostratus*	CS3		+			
Macropodidae (kangaroos and wallabies)							
Western Grey Kangaroo	*Macropus fuliginosus*		+	+			
Western Brush Wallaby	*Macropus irma*	CS2					
Phalangeridae (brushtail possums)							
Common Brushtail Possum	*Trichosurus vulpecula*						
Molossidae (freetail bats)							
White-striped Bat	*Tadarida australis*						
Western Freetail Bat	*Mormopterus planiceps*						
Vespertilionidae (ordinary bats)							
Southern Forest Bat	*Vespadelus regulus*						
Gould's Wattled Bat	*Chalinolobus gouldii*			+			
Chocolate Wattled Bat	*Chalinolobus morio*			+			
Western False Pipistrelle	*Falsistrellus mackenziei*	CS2					
Lesser Long-eared Bat	*Nyctophilus geoffroyi*						
Gould's Long-eared Bat	*Nyctophilus gouldi*						
Greater Long-eared Bat	*Nyctophilus timoriensis*						
Muridae (rats and mice)							
House Mouse	*Mus musculus*	Int.		+	+		
Bush Rat	*Rattus fuscipes*	CS3		+			
Black Rat	*Rattus rattus*	Int.		+			
Leporidae (rabbit)							
Rabbit	*Oryctolagus cuniculus*	Int.	+				
Canidae (foxes and dogs)							
Fox	*Vulpes vulpes*	Int.	+	+			

Table 7. (cont.)

Species	Status	Records				
		Study Area	WAM	FSDB	TF	EPBC
Felidae (cats)						
Feral Cat *Felis catus*	Int.					
# mammal species expected in the study area:	**22 (17 native)**					
# mammal species recorded in the study area in 2013:	**3 (1 native)**					

Table 8. Summary of conservation significance 1 (CS1) and CS2 fauna in the study area.

Species	Status	Nearby records on DPAW database	Potential habitat use in study area					Likelihood of occurrence in the study area
			Limestone heath	Banksia woodland	Tuarts	Re-growth Shrubland	Pine Plantation	
REPTILES								
Morelia spilota imbricata **Carpet Python**	CS1	Yes (but old record)	✓	✓	✓			High
Neelaps calonotos **Black-striped Snake**	CS2	Yes (but old record)		✓				Moderate
BIRDS								
Falco peregrinus **Peregrine Falcon**	CS1	-		✓	✓	✓	✓	Low
Calyptorhynchus latirostris **Carnaby's Black-Cockatoo**	CS1	Yes	✓	✓	✓		✓	High
Apus pacificus **Fork-tailed Swift**	CS1	-	*may overfly any habitat*					Low
Merops ornatus **Rainbow Bee-eater**	CS1	Yes	✓	✓	✓	✓		High
Tyto novaenollandiae **Masked Owl**	CS2	Yes (but old record)		✓	✓			Low
MAMMALS								
Isoodon obesulus **Quenda / Southern Brown Bandicoot**	CS2	Yes		✓		✓		Moderate
Macropus irma **Western Brush Wallaby**	CS2	-		✓		✓		High
Falsistrellus mackenziei **Western False Pipistrelle**	CS2	-		✓	✓			Moderate
INVERTEBRATES								
Synemon gratiosa **Graceful Sun-moth**	CS2	Yes		✓				Moderate

* see Table 1 and Appendix 2.

8. References

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). *The New Atlas of Australian Birds*. Royal Australasian Ornithologists Union, Victoria.

Bennett, A.F. (1991). Roads, roadsides and wildlife conservation: a review. In: Nature Conservation 2: the role of corridors. Ed by D.A. Saunders and R.J. Hobbs, Surrey Beaty, Chipping Norton, Australia: pp 99-118.

BirdLife International (2014). IUCN Red List for birds. URL: http://www.birdlife.org

Bishop, C., Williams, M., Mitchell, D. and Gamblin, T. (2010). *Survey Guidelines for the Graceful Sun-moth & site habitat assessments Version 1.2*. Department of Environment and Conservation, Kensington, Western Australia.

Bush, B., Maryan, B., Brown-Cooper, R. and Robinson, D. (1995). *A Guide to the Reptiles and Frogs of the Perth Region.* University of Western Australia Press, Perth.

Christidis, L. and Boles, W.E. (1994). *The Taxonomy and Species of Birds of Australia and its Territories*. Royal Australasian Ornithologists Union, Monograph 2.

Churchill, S. (1998). *Australian Bats*. Reed New Holland, Sydney.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. and Eggler, P. (1993). *The Action Plan for Australian Reptiles*. Endangered Species Programme Project Number 124, Australian Nature Conservation Agency, Canberra.

DEC (2011). Conservation Advice for *Synemon gratiosa* (graceful sun-moth) – January 2011.

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2004). Interim Biogeographic Regionalisation for Australia (IBRA), Version 6.1.

Dickman, C. (1996). *Overview of the Impacts of Feral Cats on Australian Native Fauna*. Prepared for the Auustralian Nature Conservation Agency, Canberra, ACT.

DPAW (2007-). *Naturemap: Mapping Western Australia's Biodiversity*. Department of Environment and Conservation. URL: http://naturemap.dec.wa.gov.au/

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2012). *EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo, Baudin's Cockatoo & Forest red-tailed black cockatoo*. Commonwealth of Australia, 2012.

Duncan, A., Baker, G.B. and Montgomery, N. (1999). *The Action Plan for Australian Bats*. Environment Australia, Canberra.

Environmental Protection Authority (2002). *Terrestrial Biological Surveys as an Element of Biodiversity Protection*. Position Statement No. 3. March 2002, Perth Western Australia.

Forman, R.T.T. and Alexander, L.E. (1998). Roads and their major ecological effects. *Annual Review of Ecology and Systematics* 29: 207-231.

Garnett, S. and Crowley, G. (2000). *The Action Plan for Australian Birds*. Environment Australia and the Royal Australasian Ornithologists Union.

Government of Western Australia (2000). *Bush Forever Volume 2*. Department of Environmental Protection, Perth.

Johnstone, R.E., Johnstone, C.E. and Kirkby, T. (2011). *Black Cockatoos on the Swan Coastal Plain*. Report to the Department of Planning, Western Australia.

Johnstone, R., Kirkby, T., Stone, P. and Minton, C. (2005) *White-tailed Black-Cockatoos: Identification challenges and changes in distribution and status, and links with a community program – Cockatoo Care.* In: Conserving Carnaby's Black-Cockatoo: Future Directions, Proceedings from a conservation symposium, Edited by C. Gole, Perth, Western Australia.

Johnstone, R.E. & Storr, G.M. (1998). *Handbook of Western Australian Birds. Volume 1: Non-passerines (Emu to Dollarbird)*. Western Australian Museum, Perth.

Lee, A.K. (1995). *The Action Plan for Australian Rodents*. Environment Australia, Canberra.

Magnus, Z. (2006) Wildlife Roadkill Mitigation Information Kit, *A Guide for Local Government and Land Managers*. Report prepared for Sustainable Living Tasmania, Hobart, Tasmania.

Mattiske Consulting (2014). Vegetation of the Yanchep Ridges. Unpublished Report to WA Limestone.

Maxwell, S., Burbidge, A.A. and Morris, K. (1996). *Action Plan for Australian Marsupials and Monotremes*. Environment Australia, Canberra.

McKenzie, N. and Reardon, T. (2008). *Falsistrellus mackenziei*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. URL: www.iucnredlist.org.

Menkhorst, P. and Knight, F. (2004). *A field guide to the mammals of Australia*. 2nd Edition. Oxford University Press, South Melbourne.

Mitchell, D., Williams, K. and Desmond, A. (2002). Swan Coastal Plain 2 *(SWA2 – Swan Coastal Plain subregion).* In: *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002.* Ed by J.E. May and N.L. McKenzie. Dept. of Conservation and Land Management, Western Australia.

Reaveley, A. (2009). Mammal Fauna of the Gnangara Sustainability Strategy Study Area. Report for the Gnangara Sustainability Strategy and the Department of Environment and Conservation.

Shah, B. (2006). *Conservation of Carnaby's Black-Cockatoo on the Swan Coastal Plain, Western Australia* Project Report, Birds Australia Western Australia, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1983). *Lizards of Western Australia. II. Dragons and Monitors*. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (2002). *Snakes of Western Australia*. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1990). *Lizards of Western Australia. III. Geckoes and Pygopods*. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1999). *Lizards of Western Australia. I. Skinks*. 2nd edition. W.A. Museum, Perth.

Tyler, MJ. (1997). *The Action Plan for Australian Frogs*. Wildlife Australia, Endangered Species Program. Canberra.

Tyler, M.J., Smith, L.A. and Johnstone, R.E. (2000). *Frogs of Western Australia*. W.A. Museum, Perth.

Van Dyck and Strahan, R. (Ed.) (2008). *The Mammals of Australia*. 3rd Edition. Australian Museum/Reed Books, Sydney.

WA Museum. (2001). Checklists of the Vertebrates of Western Australia. *Records of the WA Museum* Supplement No. 63.

Wilson, B.A. and Valentine, L.E (2009). *Biodiversity Values and Threatening Processes of the Gnangara Groundwater System*. Report for the Gnangara Sustainability Strategy and the Department of Environment and Conservation.

Appendix 1. EPBC Protected Matters Search Tool results.

Species listed for the area within 6km of 31º 33' 26'' S and 115º 44' 00'' E on the EPBC Protected Matters Search Tool.

Species	Status	Author's Comment
Botaurus poiciloptilus Australasian Bittern	Endangered	Unlikely to occur in study area – no suitable habitat.
Calyptorhynchus latirostris Carnaby's Black-Cockatoo	Endangered	Likely to occur in the study area.
Leipoa ocellata Malleefowl	Vulnerable & Migratory	Locally extinct in the vicinity of the study area.
Rostratula australis Australian Painted Snipe	Vulnerable & Migratory	Unlikely to occur in study area – no suitable habitat.
Dasyurus geoffroii Chuditch	Vulnerable	Locally extinct in the vicinity of the study area.
Fork-tailed Swift *Apus pacificus*	Migratory (marine)	May possibly occur in the study area.
Great Egret *Ardea alba*	Migratory (wetland & marine)	Unlikely to occur in study area – no suitable habitat.
Cattle Egret *Ardea ibis*	Migratory (wetland & marine)	Unlikely to occur in study area – no suitable habitat.
White-bellied Sea-Eagle *Haliaeetus leucogaster*	Migratory (terrestrial)	Unlikely to occur in study area – no suitable habitat.
Rainbow Bee-eater *Merops ornatus*	Migratory (terrestrial)	Likely to occur in the study area.

Appendix 2. DPAW Threatened and Priority Fauna Database results.

Species listed for the area within 7km of 380079 E, 6508273 N (Zone 50) on the DPAW Threatened and Priority Fauna Database.

Species	Status	DPAW records	Author's Comments
Calyptorhynchus latirostris Carnaby's Black-Cockatoo	Schedule 1	Records from Yanchep National Park (2000 – 2002, 2005, 2010 & 2012), Delich Rd, Carabooda (2001, 2002, 2004, 2007 & 2008), Carabooda Quarry (2003), Pigeon Rd, Yanchep (2006), possible roost at Carabooda Rd, Carabooda (2010).	Likely to occur on the site.
Calyptorhynchus baudinii Baudin's Black-Cockatoo	Schedule 1	Records from Yanchep (1977 - 1981).	Unlikely to occur on the site – records likely to be of Carnaby's Black-Cockatoo before it was recognised as a separate species.
Dasyurus geoffroii Chuditch	Schedule 1	Undated record from Nowergup and Yanchep and a record from Wanneroo Rd, Yanchep (1972).	Not likely to occur on site – locally extinct.
Bettongia penicillata Woylie	Schedule 1	Undated records from Nowergup and Yanchep.	Not likely to occur on site – locally extinct.
Botaurus poicilopterus Australian Bittern	Schedule 1	Record from Yanchep (1977).	Not likely to occur on site – lack of suitable habitat.
Calidris ferruginea Curlew Sandpiper	Schedule 1	Record from Yanchep (1980).	Not likely to occur on site – lack of suitable habitat.
Anous tenuostris Australian Lesser Noddy	Schedule 1	Record from Yanchep (1946).	Not likely to occur on site – lack of suitable habitat.
Diomedea melanophris Black-browed Albatross	Schedule 1	Record from Yanchep National Park (1974).	Not likely to occur on site – lack of suitable habitat.
Petrogale latirostris Black-flanked Rock Wallaby	Schedule 1	Undated record from Nowergup.	Not likely to occur on site – locally extinct.
Falco peregrinus Peregrine Falcon	Schedule 4	Records from Yanchep (1977, 1978 & 1980)	May possibly occur.
Morelia spilota imbricata Carpet Python (southern pop[n])	Schedule 4	Records from Yanchep (1957 & 1963) and Old Yanchep Rd, Carabooda (2001)	May possibly occur.
Merops ornatus Rainbow Bee-eater	Schedule 3	Records from Yanchep (1977 – 1980 & 2000), Lake Coogee, Carabooda (2008 & 2009) and Delich Rd, Carabooda (2000 & 2005).	Likely to occur on the site.
Tringa nebularia Common Greenshank	Schedule 3	A record from Yanchep (1978).	Not likely to occur on site – lack of suitable habitat.
Plegadis falcinellus Glossy Ibis	Schedule 3	Records from Yanchep (1979 & 1980).	Not likely to occur on site – lack of suitable habitat.

Appendix 2. (cont.).

Species	Status	DPAW records	Author's Comments
Limosa lapponica Bar-tailed Godwit	Schedule 3	A record from Yanchep (1980).	Not likely to occur on site – lack of suitable habitat.
Egretta sacra Eastern Reef Egret	Schedule 3	A record from Lake Coogee, Carabooda (2008).	Not likely to occur on site – lack of suitable habitat.
Calidris ruficollis Red-necked Stint	Schedule 3	Records from Yanchep (1980) and Yanchep Lake (1924).	Not likely to occur on site – lack of suitable habitat.
Ardea modesta Eastern Great Egret	Schedule 3	Records from Yanchep (1978 - 1981), Lake Coogee, Carabooda (2008 & 2009) and Delich Rd, Carabooda (2002).	Not likely to occur on site – lack of suitable habitat.
Apus pacificus Fork-tailed Swift	Schedule 3	Records from Yanchep (1978) and Yanchep National Park (2000).	May possibly occur.
Isoodon obesulus Quenda / Southern Brown Bandicoot	Priority 5	Records from Carabooda Quarry (2003) Bernard Park, Carabooda (2003) and undated records from Yanchep and Nowergup.	May possibly occur.
Synemon gratiosa Graceful Sun-moth	Priority 4	Multiple records from Yanchep National Park (2010 & 2011) and Eglington (2010 & 2011).	May possibly occur.
Westralunio carteri Carter's Freshwater Mussel	Priority 4	Undated record from Nowergup.	Not likely to occur on site – lack of suitable habitat.
Macronectes giganteus Southern Giant Petrel	Priority 4	A record from Yanchep Lagoon (1984).	Not likely to occur on site – lack of suitable habitat.
Ixobrychus minutus Australian Little Bittern	Priority 4	Undated record from Lake Yanchep.	Not likely to occur on site – lack of suitable habitat.
Tyto navaehollandiae Masked Owl	Priority 3	A record from Yanchep (1973).	May possibly occur.
Neelaps calonotos Black-striped Snake	Priority 3	A record from Yanchep (1963).	May possibly occur.

ATTACHMENT 4

CARNABY'S COCKATOO BREEDING AND ROOSTING HABITAT SURVEY, PROPOSED PROSPECTING LEASE, RIDGES AREA, YANCHEP.

Carnaby's Cockatoo *Calyptorhynchus latirostris* is known to use the general Yanchep area for feeding, breeding and roosting. The aim of the survey was to identify potential breeding hollows, breeding habitat and roost trees.
Tree species at the site which are suitable to provide a Carnaby's Cockatoo breeding hollow are Jarrah *Eucalyptus marginata* and Tuart *E. gomphocephala*. Both species need to have reached 500mm diameter at breast height (DBH) in order to be large enough to have possibly formed a hollow.
Both Jarrah and Tuart are suitable for use as Carnaby's Cockatoo roost trees. Debris in the form of clipped branches, moulted feathers and droppings will be evident under trees used for roosting.

Methods

Trees on site over 500mm DBH were measured and their locations taken using a Garmin handheld GPS, WGS84. UTM. Zone 50.The exception to this was line of Jarrah trees midway along the eastern border which although reaching the 500mm DBH were too small and stunted to provide a suitable breeding hollow.
Hollows were inspected from ground level using binoculars for any signs of chewing and wear which is present at the entrance to a Carnaby's Cockatoo hollow. Any tree with a suitable hollow was raked with a pole to flush an incubating female. This was unlikely given the time of year as most breeding is completed by early March.
Searches for evidence of roosting sites were made beneath suitable trees.

Timing and results

The survey was conducted on the 25th February and 3rd March 2014 and the following observations were made.
A total of 44 Jarrah and 89 Tuart were recorded over 500mm DBH (see spreadsheet for details). The majority of these were recorded from the south of the survey area.

Trees of note were.
379241E - 6506860N. Tuart with worn side entry hollow suitable for Carnaby's Cockatoo.
379357E - 6506839N. Tuart with two suitable hollows. None show signs of use.
379149E - 6506681N. Tuart with large side entry hollow suitable for Carnaby's Cockatoo. Shows no signs of use.
379354E - 6506596N. Tuart with large side entry hollow suitable for cockatoo. Shows no signs of use.
379036E - 6506658N. Tuart with branch hollow. Shows no signs of use.
378532E - 6506195N. Tuart with hollow showing old chewing and wear at entrance. Possibly a Carnaby's Cockatoo hollow.
378662E - 6506163N. Tuart with side entry hollow showing heavy recent chewing. Probably a Carnaby's Cockatoo hollow.
Of the above hollows two show definite signs of use and one appears to have been used in the past breeding season.

Roosting

No evidence of roosting at the survey area was located.
Just after dawn on the morning of 3rd March a large (>100) group of Carnaby's Cockatoos came to the survey area from the east, indicating a roost out in that direction.

Tony Kirkby

Of the above hollows two show definite signs of use and one appears to have been used in the past breeding season.

Roosting

No evidence of roosting at the survey area was located.
Just after dawn on the morning of 3rd March a large (>100) group of Carnaby's Cockatoos came to the survey area from the east, indicating a roost out in that direction.

Tony Kirkby
9th March 2014

0419927384

Record number	Eastings Zone 50 GDA 94	Northings	Tree species	Approximate diameter mm.	Remarks
48	379288	6506477	Tuart (dead)	500	
11	378513	6506140	Tuart (dead)	900	Has feral bees
123	380540	6508005	Tuart		Two trunks. Both 500mm DBH
122	380527	6507998	Tuart		Two trunks. Both 500mm DBH
121	380549	6507996	Tuart	600	
120	379048	6507541	Tuart		Two trunks. 600 and 500mm DBH
119	379036	6507609	Tuart	700	
118	379065	6507606	Tuart	1000	
117	379084	6507599	Tuart	800	Trunk forks early into small trunks too small to form a hollow
116	379106	6507554	Tuart	800	
115	379116	6507440	Tuart	500	
114	379119	6507436	Tuart		Two trunks. 600 and 500mm
113	379186	6507437	Tuart		Two trunks. 600 and 500mm
112	379206	6507419	Tuart	600	
111	379169	6507405	Tuart	600	Trunk forks early into small trunks too small to form a hollow
96	379358	6507000	Tuart		Trunk forks early into small trunks too small to form a hollow
95	379339	6506990	Tuart	600	
94	379340	6506972	Tuart	600	
93	379346	6506962	Tuart	600	
92	379328	6506934	Tuart	600	
90	379237	6507015	Tuart	700	
89	379258	6506990	Tuart	700	
88	379245	6506976	Tuart		Multi trunked. 800, 700 and 500mm DBH. Also has feral bees
86	379220	6506951	Tuart	1000	
85	379225	6506874	Tuart	700	
84	379241	6506860	Tuart	800	Worn side entry hollow suitable for Carnaby's Cockatoo. Fallen Wedge-tailed Eagle nest
83	379266	6506857	Tuart	600	
82	379269	6506892	Tuart		Trunk forks early into small trunks too small to form a hollow
81	379282	6506889	Tuart		Multi trunked. 1000, 600 and 500mm DBH. Also has feral bees
80	379297	6506918	Tuart	600	
79	379328	6506901	Tuart	900	
78	379330	6506904	Tuart	1000	
77	379340	6506893	Tuart	500	
76	379376	6506843	Tuart	600	
75	379372	6506838	Tuart		Two trunks. 500 and 500mm DBH
74	379357	6506839	Tuart	1400	Two hollows. Side and top entry. Both look suitable as Carnaby's Cockatoo hollow but show no signs of use
73	379343	6506822	Tuart	1300	Trunk forks early into small trunks too small to form a hollow
72	379327	6506810	Tuart	600	
71	379330	6506776	Tuart	800	
70	379318	6506790	Tuart		Trunk forks early into small trunks too small to form a hollow
68	379394	6506688	Tuart	700	
67	379380	6506680	Tuart	700	
62	379271	6506744	Tuart	500	
61	379260	6506747	Tuart	500	
60	379224	6506751	Tuart	700	
59	379220	6506720	Tuart	600	
58	379203	6506787	Tuart	800	
57	379209	6506817	Tuart	1000	Two trunks. Both 800mm DBH
56	379177	6506842	Tuart	800	
55	379149	6506886	Tuart		Side entry hollow suitable for Carnaby's Cockatoo. Shows no signs of use.
54	379357	6506699	Tuart	1100	Has feral bees
53	379356	6506681	Tuart	1000	Large side entry hollow suitable for Carnaby's Cockatoo. Shows no signs of use.
51	379354	6506596	Tuart	1000	Large side entry hollow suitable for Carnaby's Cockatoo. Shows no signs of use.
42	379152	6506695	Tuart		Two trunks. 800 and 700mm DBH. Also feral bees
41	379141	6506647	Tuart	800	
40	379036	6506658	Tuart	800	Has branch hollow of suitable size for Carnaby's Cockatoo. Shows no signs of use
39	379076	6506666	Tuart	700	
38	379070	6506745	Tuart	600	
37	379094	6506788	Tuart	600	
36	379089	6506817	Tuart	800	
35	379066	6506820	Tuart	1000	Trunk forks early into small trunks too small to form a hollow
34	379042	6506784	Tuart	800	
33	379029	6506793	Tuart		Trunk forks early into small trunks too small to form a hollow
32	379008	6506793	Tuart	600	
31	378989	6506786	Tuart	600	
30	378985	6506767	Tuart		Two trunks 800 and 600 DBH. Has small Galah scarred hollow
29	378997	6506671	Tuart	1000	
28	379040	6506628	Tuart	1000	

27	379120	6506601	Tuart	1200	
26	379097	6506498	Tuart	1000	
25	379098	6506476	Tuart	900	
24	379072	6506442	Tuart		Multi trunked. 600,600 and 500 DBH
23	379098	6506361	Tuart	900	
22	379154	6506383	Tuart	600	
21	379143	6506361	Tuart	600	
20	379149	6506339	Tuart	900	
19	379343	6506452	Tuart	1200	
18	378706	6506275	Tuart	1000	
17	378532	6506195	Tuart	1000	Possible Carnaby's Cockatoo hollow. Old chewing and wear at hollow entrance. Side entry
12	378453	6506135	Tuart	700	Trunk forks early into small trunks too small to form a hollow
10	378548	6506145	Tuart	600	Trunk forks early into small trunks too small to form a hollow
9	378537	6506158	Tuart	600	Trunk forks early into small trunks too small to form a hollow
8	378640	6506207	Tuart	600	Trunk forks early into small trunks too small to form a hollow
7	378662	6506163	Tuart	1200	Well chewed side entry hollow. Probably Carnaby's Cockatoo breeding hollow.
6	378641	6506080	Tuart	1300	Two good hollows but being used by Galah's
5	378617	6506128	Tuart	1000	Trunk forks early into small trunks too small to form a hollow
4	378569	6506129	Tuart	1000	
3	378583	6506088	Tuart	1300	
1	378632	6505989	Tuart	1000	
97	379188	6507088	Jarrah (dead)	1000	
91	379206	6507028	Jarrah (dead)	1100	
66	379319	6506677	Jarrah (dead)		
50	379388	6506552	Jarrah (dead)		Two trunks. Both 500mm DBH
49	379392	6506531	Jarrah (dead)	1000	
47	379275	6506513	Jarrah (dead)	800	
44	379208	6506614	Jarrah (dead)	800	
43	379199	6506619	Jarrah (dead)	600	
133	378598	6506682	Jarrah	900	
132	378616	6506694	Jarrah	800	Trunk forks early into small trunks too small to form a hollow
131	378649	6506683	Jarrah	600	
130	378651	6506686	Jarrah	600	
129	378636	6506749	Jarrah	600	
128	378636	6506751	Jarrah	900	
127	378747	6506903	Jarrah	700	Trunk forks early into small trunks too small to form a hollow
126	378720	6506900	Jarrah	1000	Trunk forks early into small trunks too small to form a hollow
125	378733	6506914	Jarrah	1000	Trunk forks early into small trunks too small to form a hollow
124	380201	6507436	Jarrah	1200	
110	379125	6507357	Jarrah	800	
109	379075	6507289	Jarrah	600	
108	379066	6507302	Jarrah	1000	Trunk forks early into small trunks too small to form a hollow
107	379036	6507331	Jarrah	500	
106	379097	6507228	Jarrah	600	
105	379083	6507240	Jarrah	800	
104	379073	6507269	Jarrah	900	
103	379107	6507257	Jarrah		Trunk forks early into small trunks too small to form a hollow
102	379231	6507212	Jarrah	900	
101	379258	6507177	Jarrah	600	
100	379233	6507176	Jarrah	900	
99	379173	6507127	Jarrah	600	
98	379149	6507111	Jarrah	800	
87	379241	6506973	Jarrah	500	
69	379407	6506687	Jarrah	600	
65	379298	6506676	Jarrah	900	Trunk forks early into small trunks too small to form a hollow
64	379255	6506648	Jarrah	900	
63	379265	6506707	Jarrah	600	
52	379354	6506641	Jarrah	600	
46	379268	6506573	Jarrah	700	
45	379245	6506610	Jarrah	800	
16	378496	6506197	Jarrah	600	
15	378366	6506248	Jarrah	900	
14	378399	6506249	Jarrah	700	
13	378447	6506208	Jarrah	600	
2	378599	6505979	Jarrah	800	