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Yanchep Rail Extension Part 2 Fauna Desktop Study

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1 Introduction

The Public Transport Authority (PTA) has proposed an extension of the Joondalup Rail Line between its current terminus at Butler to Yanchep, termed the Yanchep Rail Extension (YRE; the Project). This project is divided into Part 1 (YRE1), consisting of the extension from Butler to Eglinton, including two new stations, and Part 2 (YRE2) which is the extension from Eglinton to Yanchep, with a new station at Yanchep. The YRE2 is being prepared for scrutiny by the state's Environmental Protection Authority (EPA). In support of the approval process for YRE2, Bamford Consulting Ecologists (BCE) has been commissioned to undertake a fauna desktop study for the YRE2 railway line as an update to previous similar studies such as GHD (2018).

Butler Station lies approximately 38 km from Perth CBD and the proposed Yanchep Station lies approximately 52 km from the CBD. The area lies on the Northern Swan Coastal Plain and spans approximately 13.5 km of urban, peri-urban and bushland landscapes, including through approximately 2.5 km of the Ningana Bush Forever Site No. 289.

This report details the desktop methodology undertaken and provides a revised list of vertebrate fauna that can be expected along the Development Envelope. The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the YRE2 project area based on unpublished and published data using a precautionary approach and local knowledge. Data are not available to provide a complete list of invertebrate fauna, but invertebrates of conservation significance are considered.

The primary reason for producing this revised species list is in order to assess the likely value of wildlife underpasses currently being considered as part of YRE2 where it passes through Ningana Bushland (see Figure 1). Underpasses are being considered at this location because Ningana Bushland is part of an east-west corridor of bushland that lies between coastal reserves and Yanchep National Park. Maintaining habitat connectivity through this region may be important for fauna as the loss of connectivity can lead to local declines and extinction in some species. YRE2 where it passes through Ningana Bushland is seen as a possible threat to this connectivity, and underpasses as a possible means to ameliorate this threat. This report therefore concludes with a discussion on the species most likely

to benefit from underpasses. A broader review of underpasses and their value in minimising fauna impacts of the YRE2 project is provided by Shepherd and Bamford (2018).

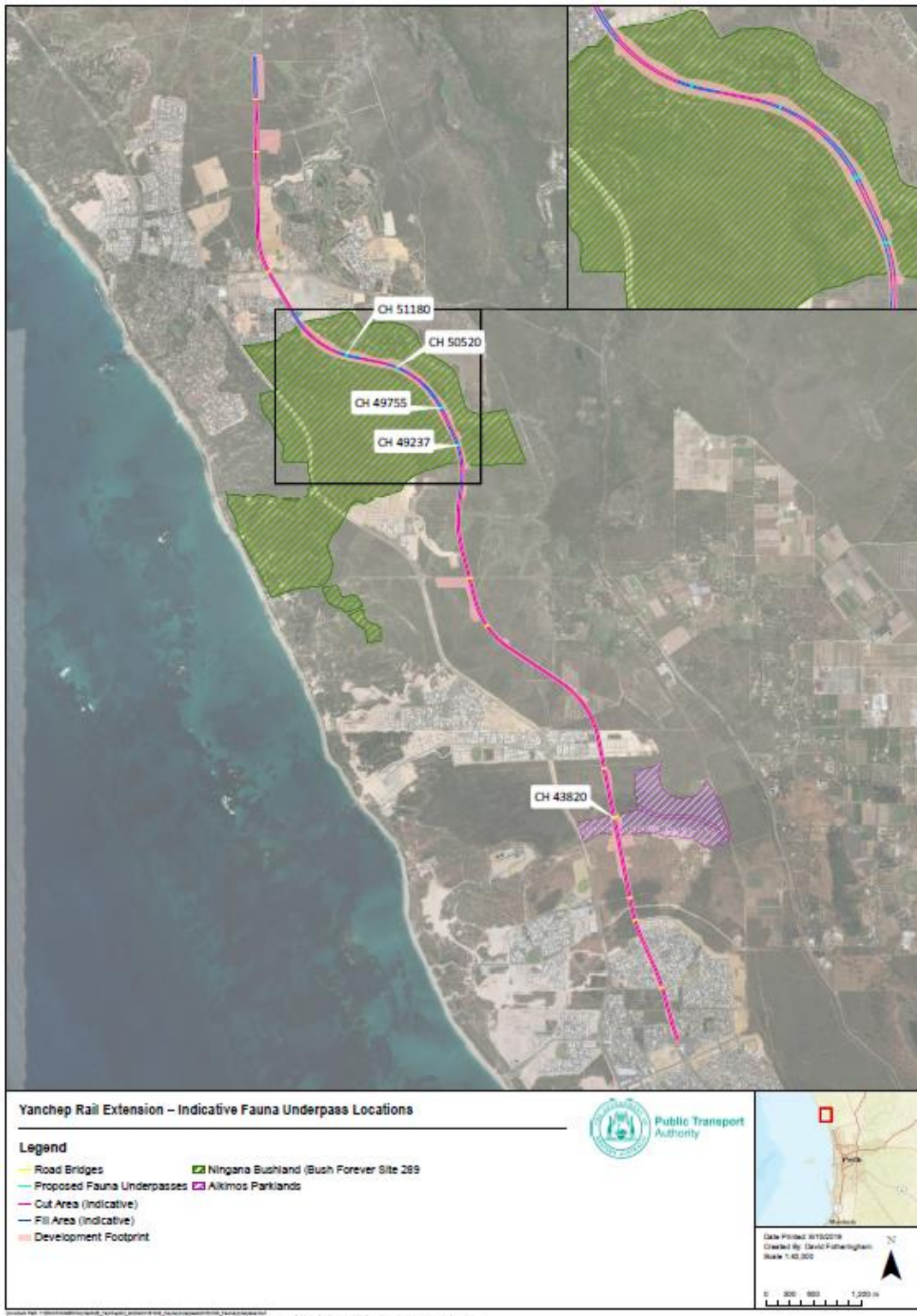


Figure 1. Location of the Yanchep Rail Extension showing indicative locations of the underpasses (from GHD (2018)). The desktop study relates to the entire length of the YRE2 but the current field survey was confined solely to the railway route located within the black box insert.

2 Method

2.1 Sources of information

Information on the fauna assemblage of the YRE2 project area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Atlas of Living Australia (ALA), Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap (incorporating the Western Australian Museum's FaunaBase and the DBCA Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA) and the EPBC Protected Matters Search Tool of the Department of Energy and the Environment (DEE) (Table 1). Databases were searched for a greater area than the YRE2 project area as it is the nature of databases that they do not necessarily contain information from very small sites. The databases searches were limited to regions with similar environments to the YRE2 project area. Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Frogs: Tyler and Doughty (2009) and Anstis (2013)
- Reptiles: Storr *et al.* (1983, 1990, 1999 and 2002) and Wilson and Swan (2017)
- Birds: Johnstone and Storr (1998, 2005) and Barrett *et al.* (2003)
- Mammals: Menkhorst & Knight (2004); Churchill (2008); Armstrong (2011); and Van Dyck and Strahan (2008).

Table 1. Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched
Atlas of Living Australia.	Records of biodiversity data from multiple sources across Australia.	Point search: 31° 29' 55"S, 115° 53' 15"E plus 20 km buffer. Searched: May 2018.
NatureMap (DBCA)	Records in the WAM and DBCA databases. Includes historical data and records on Threatened and Priority species in WA.	Line search from: Butler Station at 31° 31' 22"S, 115° 38' 41"E to 31° 38' 05" S, 115° 41' 58" E plus 2 km buffer. Searched: December 2018
BirdLife Australia Atlas Database (Birdlife Australia)	Records of bird observations in Australia, 1998-2019.	Area within approximately 2 km of the YRE2 footprint searched using Birdata Browse Data.
EPBC Protected Matters (DEE)	Records on matters of national environmental significance protected under the EPBC Act.	Line search from: Butler Station at 31° 31' 22"S, 115° 38' 41"E to 31° 38' 05" S, 115° 41' 58" E plus 2 km buffer. Searched: December 2018

2.1.1 Previous fauna surveys and studies

The Northern Swan Coastal Plain is known for its high biodiversity, and a number of studies has been carried out to better understand the regional and biodiversity values, especially terrestrial fauna at landscape scale, such as Valentine *et al.* (2009), and Reaveley & Bettink (2009). Several previous fauna surveys have been conducted in the northern Swan Coastal Plain and general area, by BCE and other organisations. References include: Bancroft *et al.* (2018); Bamford *et al.* (2015) and Turpin and Bamford (2010). BCE has also undertaken several level 2 (site inspection and field sampling) surveys in the general region including Burns Beach (Bamford 1998) and Jindalee (2010). In support of the early development impact assessment, GHD (2018) undertook a preliminary desktop study and survey which was also referred to for this desktop study. Glauert (1948) provides a list of mammal species now extinct in the general area.

2.1.2 Nomenclature and taxonomy

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

2.1.3 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey area, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the project area is of no importance. Similarly, waterbirds were generally excluded even though they could over-fly the site, since the site provides little habitat for them. The only exceptions were species that might nest on the site, such as some duck species that nest in tree hollows, and species that might use seasonally inundated paddocks. Locally extinct species are also included in Appendix 3.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the survey area at least occasionally, whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the survey area.

The status categories used are:

Resident: species with a population permanently present in the survey area

Migrant or regular visitor: species that occur within the project area regularly in at least moderate numbers, such as part of annual cycle

Irregular Visitor: species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the project area in at least moderate numbers and for some time

Vagrant: species that occur within the project area unpredictably, in small numbers and/or for very brief periods. Therefore, the project area is unlikely to be of importance for the species

Locally extinct: species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the project area.

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

2.1.4 *Categories of conservation significance*

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (BC Act). In addition, the Western Australian DBCA recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in Appendix 1.

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

Species listed under the EPBC Act are generally assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention).

Species that are threatened (and generally follows the IUCN and EPBC Act listings) are also listed under Part 2, Division 1, Subdivision 2 of the *Biodiversity Conservation Act 2016* (BC Act)(formerly the *Wildlife Conservation Act 1950*). Extinct species are recognised and listed under Part 2, Division 1, Subdivision 3 of the BC Act.

Native species that are not extinct or threatened but are considered specially protected, are listed under Part 2, Division 1, Subdivision 1 of the BC Act. These include migratory fauna, cetaceans, species of special conservation interest, are subject to international agreement or, are in need of special protection.

Threatened and extinct species are identified and reported through Ministerial Guidelines No. 2 and specially protected species are identified and reported through Ministerial Guidelines No 3 as prescribed under section 260(1) of the BC Act.

The DBCA lists threatened, extinct and specially protected species in a series of seven schedules listed in the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and published through the Government Gazette. The first fauna notice under the BC Act is yet to be published.

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

In Western Australia, the DBCA has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the BC Act but for which the DBCA feels there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

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

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Populations on the edge of a species' range are often less abundant and more vulnerable to local extinction than populations at the centre of the range (Curnutt *et al.* 1996), and thus such populations can be considered significant. In addition, species that are sensitive to impacts such as habitat fragmentation may be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DBCA, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

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

crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

2.2 Field investigation

The project area was visited on 28th November 2018 by Dr Mike Bamford (B.Sc. Hons. Ph.D. Biol.) and Dr Barry Shepherd (B.Sc. Ph.D.). The site visit involved walking the rail alignment of the YRE2 project area where it passes through Ningana Bushland to familiarise the consultants with the environment (landform and vegetation), the proposed locations for wildlife underpasses and to make some opportunistic observations on wildlife. Familiarity with the environment is essential for the interpretation of species lists generated from databases. Targeted searching was undertaken for several significant species known from the general area; in particular foraging evidence of Quenda and evidence of foraging by black-cockatoos.

3 Site Description

The environmental characteristics of the YRE2 project area, including Ningana Bushland, are described in detail by GHD (2018) but can be summarised as follows. Within the Ningana Bushland section of YRE2, the landform is of the Quindalup dune system, which are young but stabilised sand-dunes with sharp relief. The surface soils are quartz sand and calcareous material, with underlying calcareous marls and limestone. The natural vegetation consists of coastal heaths high in the landscape on the steepest slopes, shrublands and thickets in dune swales, and banksia woodland in areas of low relief sheltered by the dunes. This vegetation along the proposed railway line within Ningana Bushland is intact in the north of the alignment, but in the centre and south there are plantations of eucalypts (Tuart *Eucalyptus gomphocephala* and a mallee), and what appear to be degraded areas of Coojong (*Acacia saligna*) and Balga (*Xanthorrhoea* sp.). Vegetation mapping produced by GHD (2018) is provided in Appendix 1. Examples of the vegetation are illustrated in Figures 2 to 5.



Figure 2. Coastal heath on stabilised dunes with thickets in valley and a Tuart plantation in the background; in the north of Ningana Bushland. The cleared track indicates the approximate location of the rail alignment.



Figure 3. Partly degraded shrubland.



Figure 4. Tuart plantation on right with an understorey of local shrubs.



Figure 5. Plantation of Mallee eucalypts with an understorey of grassy weeds.

4 Results

4.1 Overview of fauna assemblage

The desktop study identified 185 vertebrate fauna species as potentially occurring in the YRE2 project area as summarised in Table 2 and included in Appendix 2. This assemblage includes seven frogs, 47 reptiles, 107 birds, 19 native mammals (but these include five species that may be locally extinct) and five introduced mammals. The assemblage includes species of conservation significance (Appendix 3) that are further discussed below (section 4.2).

The databases also returned a suite of species that would not be expected, probably because of errors in the records or taxonomic change (Appendix 4), and waterbirds that might overfly the site but would not utilise the area (Appendix 4). Regionally extinct species are not included in this assemblage, but are also listed in Appendix 4.

Potential residents or regular visitors of the Development Envelope include one frog, 44 reptiles, 38 birds and 15 mammals (10 native). The remainder are considered visitors to some degree.

Table 2. Composition of vertebrate fauna assemblage of the project area.

Taxon	Number of species	Number of species in each status category				
		Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Frogs	7	1	3	3	-	-
Reptiles	47	44	-	1	1	1
Birds	107 (8 introduced)	38	32	27	10	?
Native Mammals	19 (including locally extinct)	10	2	1	1	5
Introduced Mammals	5	5	-	-	-	-
Total	185	98	37	32	12	6

The seven frog species include one resident, the Turtle Frog, which is able to breed within woodland areas in the absence of surface water. Other species are terrestrial as adults but breed in seasonal wetlands nearby, including the lakes in Yanchep National Park. Species such as the Moaning Frog and Pobblebonk or Banjo Frog have been known to occur in the terrestrial environment up to 3-4 km from water bodies (M. Bamford pers. observation) and are thus considered to be regular visitors. The remaining species would occur irregularly. All the frog species are at least moderately widespread in the South-West.

The 47 reptile species are mostly considered resident, but two may occur as irregular visitors or vagrants from nearby wetlands, while one, the Carpet Python, may be locally extinct. Comprehensive sampling would be required to determine which species are actually present. The reptile assemblage is rich in fossorial and burrowing species. Most of the species are widespread, but several species have a restricted distribution and/or are listed as priority as Priority fauna (thus

of conservation significance). Much of the reptile assemblage has disappeared due to development in surrounding areas.

The bird assemblage of 107 species includes 38 classed as residents and 32 classed as regular visitors. Over half (20; 53%) of resident species were recorded in the half day site inspection. The bird assemblage includes a suite of significant species discussed in Section 3.2; this includes many species of local significance due to their decline in the urban area. No locally extinct bird species are documented but this is probably due to poor historic records.

The mammal assemblage is depauperate with at least five regionally extinct species (Appendix 4) and a further five species considered to be locally extinct. The locally extinct species have largely disappeared even from extensive and intact reserves north of Perth, such as Yanchep National Park, Melaleuca Park and Yeal Nature Reserve. The most recent records of the Noodji and Coastal Little Dunnart close to Perth are from between Muchea and Gingin (BCE; November 2018). In contrast, the Honey Possum is still present within 5km of the Wanneroo city centre (BCE; October 2018), and is therefore considered likely to persist in the project area. A high proportion (about 36 percent) of the resident mammals presented in Table 2 and Appendix 2 are introduced species; this is typical proportion for the bioregion.

The key features of the fauna assemblage expected in the YRE2 project area are:

- **Uniqueness:** The assemblage is likely to be typical of Banksia woodlands and coastal heaths of the Perth Swan Coastal Plain and can be expected to vary across the site with differences in landform and in vegetation type and condition. The fauna assemblage may be the closest more or less intact such assemblage with respect to Perth because of the size and condition of the Ningana Bush forever site, and because this site is part of more extensive bushland to the east. A distinctive feature of the assemblage in the context of Perth is the presence of a few coastal heath species that do not occur further south on the coastal plain, such as the White-breasted Robin and Moodit (Bush-Rat).
- **Completeness:** The assemblage is likely to be intact in terms of frogs, reptiles and possibly birds due to the extent and quality of some areas of the environment, and to the area being part of a larger areas of bushland that lies to the east (Yanchep and Neerabup National Parks). However, the assemblage has lost some mammal species. This is likely to be due to a range of factors including predation by feral species (discussed further in Section 3.2).
- **Richness:** The assemblage is moderately rich in the local context, due to the large extent and high quality of environments. The vegetation and soils are also moderately uniform so species richness that can result from having a range of terrestrial ecosystems is absent.

4.2 Conservation significant fauna

The vertebrate assemblage includes 75 species of conservation significance; summarised in Table 3 and listed in Appendix 4. A further two invertebrates of conservation concern may also be present. Species or groups of species are discussed below.

Table 3. Composition of extant conservation significant fauna of the YRE2 project area.

Taxon	Conservation Significant fauna		
	CS1	CS2	CS3
Frogs	-	-	3
Reptiles	-	3	21
Birds	5	1	33
Native Mammals	1	2	6
Invertebrates	-	1	1
	6	7	64

(CS – Conservation Significant: CS1 = listed under WA State and/or Commonwealth legislation; CS2 = listed as Priority by DBCA; CS3 = considered locally significant (including species listed by DEP 2000).

Conservation Significance Level 1

Five bird and one mammal species listed under legislation may occur in the YRE2 project area (Table 3). Of the birds, most are expected to be irregular visitors only. For example, the Fork-tailed Swift is a non-breeding migrant from Asia that is largely aerial and of unpredictable occurrence in southern Western Australia. It does not rely closely on small areas of native vegetation. The Eastern Osprey is a marine raptor that may occasionally overfly the site. The Peregrine Falcon may be a more regular visitor and the site may lie within the foraging range of a pair, but does not provide nesting habitat (large trees or cliff faces). Both the Forest Red-tailed and Carnaby's Black-Cockatoos may occur on the site, but the former only as an irregular visitor as there is little foraging habitat present. In contrast, there is suitable foraging habitat (mainly *Banksia attenuata*) for Carnaby's Black-Cockatoo and this species is expected to be a regular visitor, most likely in the autumn when large flocks roost in the Gnarangara pine plantation and disperse over the coastal plain woodlands and shrublands to feed each day. The project area does not provide nesting habitat for either species of black-cockatoo.

The one mammal species is the Chuditch and it is expected only as a vagrant. The species is very rarely recorded on the coastal plain; the nearest recent record might be from BCE at Ellenbrook in 2004. As the Chuditch is expected only as a vagrant and the project area does not provide any ecological function, such as facilitating dispersal between populations, the project area cannot be considered significant for the species. The regionally extinct mammal species (Appendix 4) are mostly of high (CS1) conservation significance and have declined for a variety of reasons, particularly the impact of feral predators (Burbidge and McKenzie 1989), and these impacts pre-date urbanisation in the area.

Conservation Significance Level 2

Species listed as priority by the DBCA include three reptiles, one bird, two mammals and a moth. The three reptiles, the Jewelled Ctenotus, the Black-naped Snake and the Black-striped Snake, are all predicted to be residents. The ecology and habitat preferences of the ctenotus are not well-known, so the species may not be present, but both the Black-naped and Black-striped Snakes are considered very likely to be present as it has been found regularly in the general region (B. Maryan pers. comm.). How and Shine (1999) concluded that these and other fossorial 'sand-swimming' snakes did not persist in small remnants of native vegetation, but loss of surrounding habitat has been only recent.

The one CS2 bird, the Masked Owl, is expected only as an irregular visitor, perhaps as occasional foraging or dispersing birds. The site has no trees large enough to provide nesting hollows. The two mammals are the Quenda and Brush Wallaby, the latter was recorded by GHD (2018) but the former has not been found either by GHD or during the recent site visit, despite generally being easy to detect from its distinctive foraging holes. Furthermore, it has been recorded regularly nearby (Burns Beach and Yanchep; BCE records). It is thus considered to be locally extinct but may have the potential to recolonise the site, or the site could be used as a release site for relocated animals.

GHD had previously recorded one possible CS2 (P1) invertebrate: *Pachysaga strobila* (a cricket). GHD acknowledged that it was not fully keyed out and instead may have been another species of *Pachysaga*, some of which can be common in the Coastal Plain. This species may or may not still be present. There is the possibility of other significant invertebrates being present, as invertebrates in general are poorly-documented.

Conservation Significance Level 3

The 64 CS3 species included three frogs all of which are known to decline in close proximity to urbanisation but only the Turtle Frog is considered resident. 21 species of reptile are listed as CS3 species which includes the Carpet Python, which occurs in the general area but may be locally extinct in YRE2 project area. The remaining CS3 reptiles have a varied response to urbanisation with the Heath Monitor for example declining even in large reserves, whereas others, such as the Bobtail which was recorded during the BCE site visit, can persist even in small reserves due to their longevity, but are vulnerable to injury through urban hazards such as roadkill and cats.

There are 33 birds of conservation significance listed for the YRE2 project area and these are mostly species listed as declining in the Perth urban area by DEP (2000). They have declined due to their reliance on native vegetation and sensitivity to fragmentation, being unable to persist in any but the largest of bushland remnants (Davis *et al.* 2013). Significantly, a number of these species were recorded during the BCE site inspection: Common Bronzewing, Splendid Fairy-wren, White-browed Scrubwren, Inland Thornbill, White-breasted Robin and Grey Shrike-thrush. These are all likely to be residents and may represent the closest resident populations of species such as the White-breasted Robin and Grey Shrike-thrush to urban areas. There was also evidence (recent droppings) of the Emu, but this was probably a single dispersing bird and the species is considered unlikely to be resident.

Similarly, for the five CS3 mammals, three are considered to be locally extinct. The remaining CS3 mammals are one bat and the Moodit or Bush-Rat, which persists in coastal shrublands at least as far south as Quinns Rock (BCE records).

NatureMap returned one CS3 invertebrate, the Graceful Sun-Moth, and this is considered very likely to be present as the heathland on high dunes in the north in particular were suitable habitat, with high densities of the tussock grass *Lomandra maritima*, a key food plant for the moth's larvae. There is the possibility of other significant invertebrates being present, as invertebrates in general are poorly-documented.

5 Discussion; the fauna assemblage and usage of underpasses

The fauna assemblage of the project area is already modified due to habitat loss and modification, with substantial species loss and further species loss likely due to the juxtaposition of urban areas with associated feral species, disturbance and decline in vegetation condition. The YRE2 project passes through the Ningana Bush forever site and a potential impact is the fragmentation of populations that could further contribute to local declines and extinctions. This is discussed by Shepherd and Bamford (2018) who conclude that management of the bush forever site may be more critical to biodiversity conservation than the presence/absence of wildlife underpasses as proposed. The majority of the fauna is expected to persist in viable populations without underpasses; but assuming effective management of the bushland. Issues noted include the length and width of proposed underpasses, which will limit their usage by many species, the potential for such underpasses to encourage feral predators, and the need to manage numbers of Western Grey Kangaroos which will use (at least occasionally) even very narrow underpasses. Shepherd and Bamford (2018) concluded that an open bridge structure might provide a better conservation outcome than a series of box culvert underpasses. They did suggest, however, that installation of underpasses would mean they were available as an option, and could be closed if they resulted in adverse impacts.

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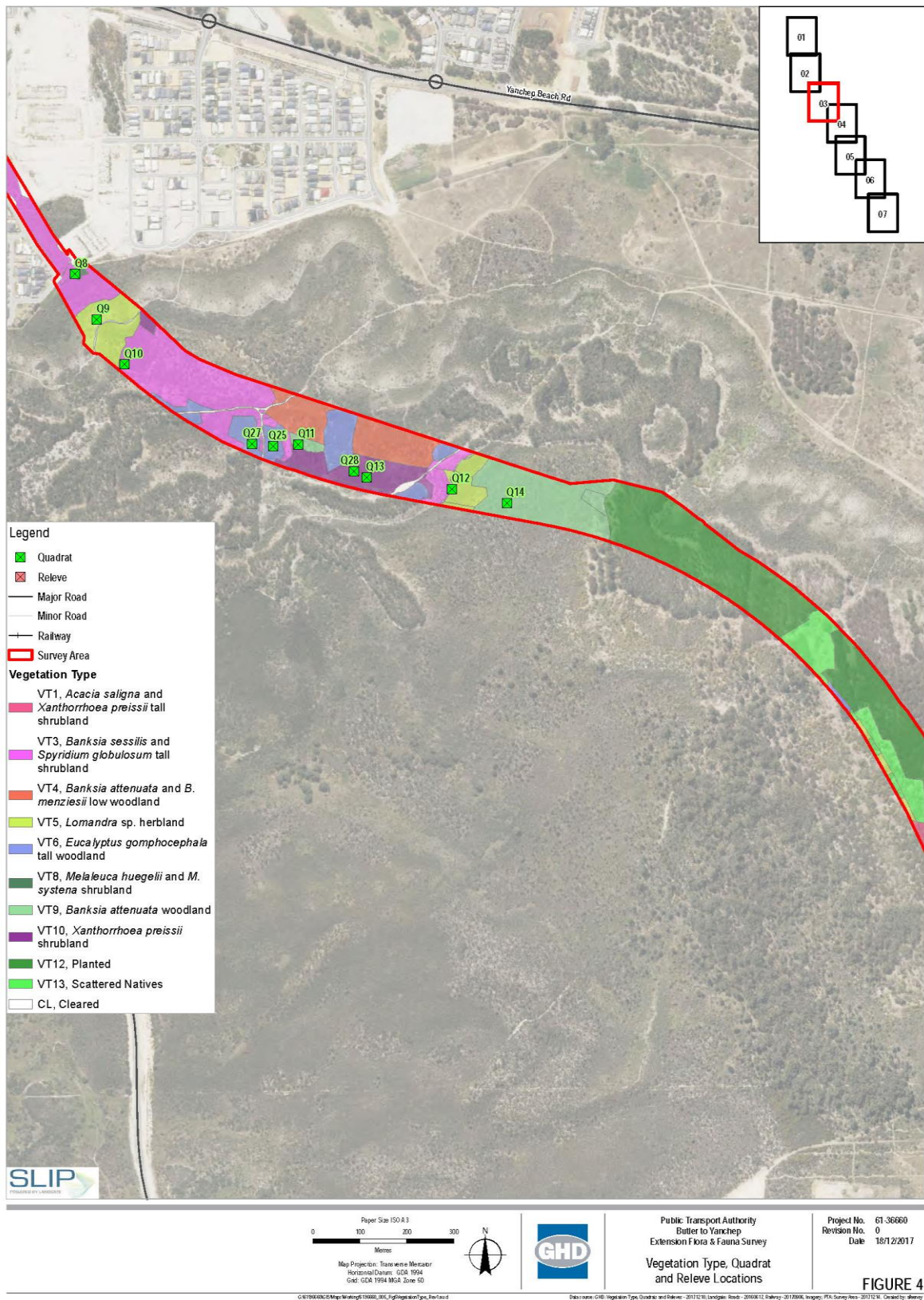
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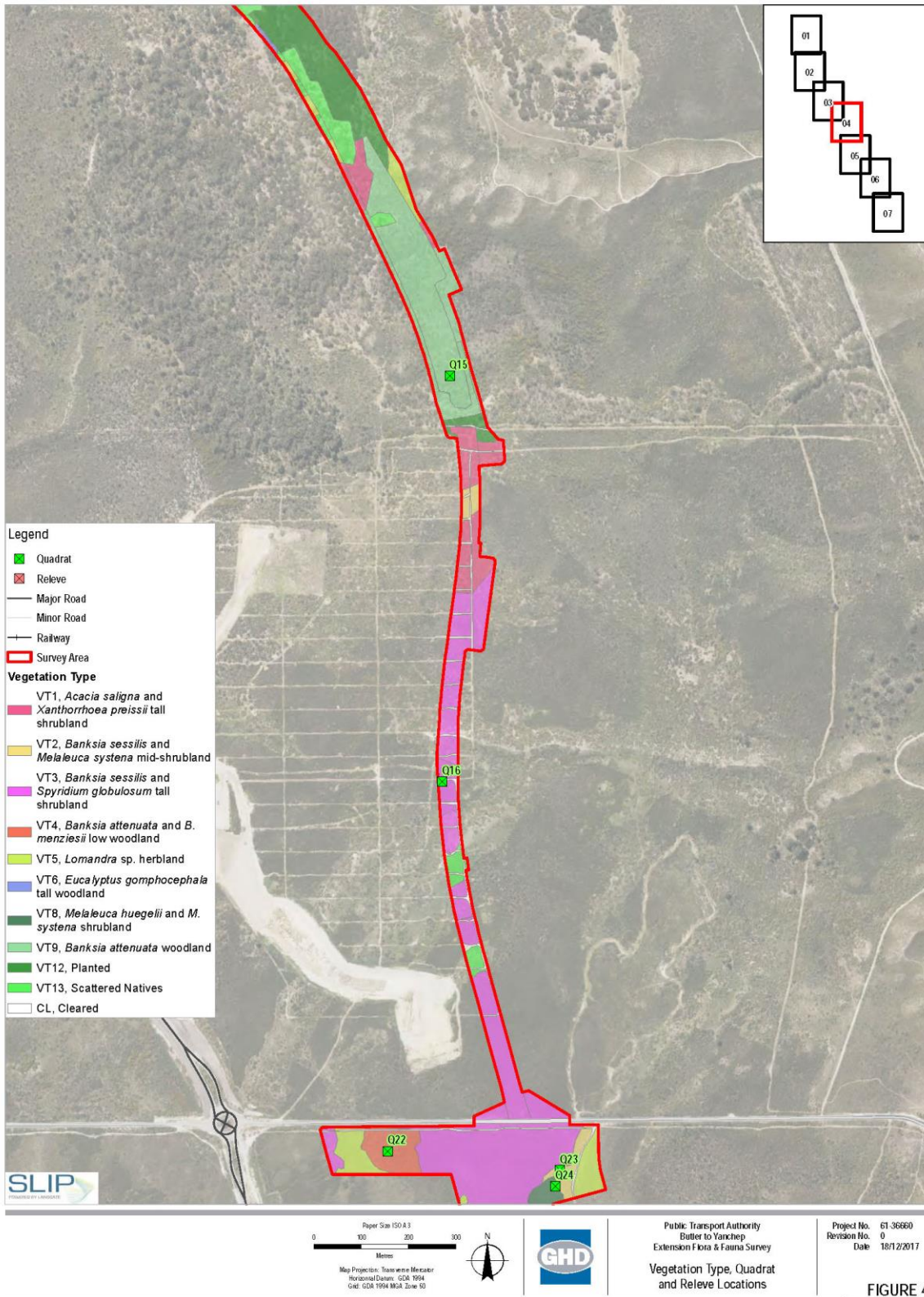
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Appendix 1. Vegetation mapping of the railway line route through the Ningana Bush Forever Site (reproduced from GHD (2018)).





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

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the *Western Australian Biodiversity Conservation Act 2016* (formerly the *Wildlife Conservation Act 1950*). Conservation status is assigned as follows:

- Species listed as threatened, extinct, migratory or specially protected in state and commonwealth legislation can be grouped as Conservation Significance level 1 **(CS1)**
- Those listed a Priority as Conservation Significance 2 **(CS2)**
- Species listed by Dell and Banyard (2000) or assessed by BCE as locally significant can be classed as Conservation Significance 3 **(CS3)**
- Least Concern are those species that are not considered rare or threatened by IUCN.

Category definitions are provided below and are taken from the Conservation Codes of the DBCA. Letter codes applied to each are used as abbreviations in Appendices 3, 4, 5 and 6.

Extinct	Taxa listed as extinct or extinct in the wild
• Extinct	Taxa not definitely located in the wild during the past 50 years.
• Extinct in the Wild (Ex)	Taxa known to survive only in captivity.
Threatened (CS1)	Taxa that are listed as critically endangered, endangered or vulnerable as defined below:
• Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
• Endangered (E)	Taxa facing a very high risk of extinction in the wild in the near future.
• Vulnerable (V)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Specially Protected Species (CS1)	Taxa that are listed as one or more of the following:
• Migratory (M):	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth.
• Species of special conservation interest:	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
• Other specially protected species:	Fauna otherwise in need of special protection to ensure their conservation
Priority Species (CS2)	Possibly threatened species that are considered poorly known (data deficient), rare, near threatened, or in need of monitoring as defined below:
• Rare	Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change
• Near Threatened	Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.
• Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

Schedules used in the WA *Wildlife Conservation Act 1950* (replaced in January 2019 by the *Biodiversity Conservation Act 2016* but for which a Fauna Notice has not yet been issued).

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

WA Department of Environment and Conservation Priority species (species not listed under the Biodiversity Conservation Act 2018, but for which there is some concern).

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

Appendix 3. Vertebrate fauna expected to occur in the survey area.

Status in project area is based on the categories described in Section 2.1.3. R = Resident; M = Migrant; RV = Regular Visitor; IV = Irregular Visitor; Va = Vagrant. Wholly marine species have been excluded.

Conservation significance codes used in the tables (as defined in Appendix 2):

- CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 2 for full explanation.
- EPBC Act listings: Ex = Presumed Extinct, C = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory.
- Wildlife Conservation Act (replaced by the BC Act) listings in Schedules 1 to 7 shown in brackets as:
S1(c) = Schedule 1: Critically Endangered
S2(e) = Schedule 2: Endangered
S3(v) = Schedule 3: Vulnerable
S4(x) = Schedule 4: Extinct
S5(m) = Schedule 5: Migratory
S6 = Schedule 6: Fauna that is conservation dependent
S7 = Schedule 7: Other specially protected fauna
- DBCA Priority species: P1 to P4 = Priority 1 to 4.
- Bush Forever (DEP 2000) status: HS = habitat specialists with a reduced distribution on the Swan Coastal Plain, LE = locally extinct, WR = wide ranging species with reduced populations on the Swan Coastal Plain.
- LS = considered to be of local significance by Bamford Consulting Ecologists.
- Int = introduced species.
- X = recorded during the field investigation.

Sources of information (see Section 2.1 for more details):

- 1 = Atlas of Living Australia database search.
- 2 = NatureMap database search.
- 3 = BirdLife Australia Atlas II database search.
- 4 = EPBC Protected Matters Search Tool
- 5 = Recorded by GHD (2018)
- 6 = Glauert 1948.
- BCE = added by BCE through prior knowledge of the area.

Species		Conservation significance	Status in project area	Source	Recorded by BCE
Hylidae (Tree frogs)					
<i>Litoria adelaidensis</i>	Slender Tree Frog		IV	1	
<i>Litoria moorei</i>	Motorbike Frog		RV	1,2	
Limnodynastidae (Burrowing frogs)					
<i>Heleioporus eyrei</i>	Moaning Frog	CS3	RV	1,2	
<i>Limnodynastes dorsalis</i>	Pobblebonk		RV	1,2	
Myobatrachidae (Australian frogs)					
<i>Crinia insignifera</i>	Squelching Froglet		IV	BCE	
<i>Myobatrachus gouldii</i>	Turtle Frog	CS3	R	1	
<i>Pseudophryne guentheri</i>	Crawling Toadlet	CS3	IV	1	
Chelidae (Freshwater Tortoises)					
<i>Chelodina collei</i>	Oblong Tortoise ^w	CS3	Va	1	

Species		Conservation significance	Status in project area	Source	Recorded by BCE
Agamidae (Dragons)					
<i>Ctenophorus adelaidensis</i>	Western Heath Dragon	CS3	R	1	
<i>Pogona minor</i>	Dwarf Bearded Dragon	CS3	R	1,2,5	
Carphodactylidae (Knob-tailed Geckoes)					
<i>Underwoodisaurus milii</i>	Barking Gecko		R	1	
Diplodactylidae (Ground geckoes)					
<i>Crenadactylus ocellatus</i>	Clawless Gecko		R	1	
<i>Diplodactylus polyophthalmus</i>	Spotted Sandplain Gecko		R	1	
<i>Strophurus spinigerus</i>	Soft Spiny-tailed Gecko		R	1,2,5	
<i>Lucasium alboguttatum</i>	White Spotted Gecko		R	BCE	
Gekkonidae (Gekkonids)					
<i>Christinus marmoratus</i>	Marbled Gecko		R	1,2	
Pygopodidae (Legless lizards)					
<i>Aprasia repens</i>	Sand-plain Worm-lizard		R	1,2	
<i>Delma concinna</i>	Javelin Legless Lizard		R	1,2	
<i>Delma fraseri</i>	Fraser's Legless Lizard	CS3	R	2	
<i>Delma grayii</i>	Gray's Legless Lizard	CS3	R	1,2	
<i>Lialis burtonis</i>	Burton's Legless Lizard	CS3	R	1,2,5	X
<i>Pletholax gracilis</i>	Keeled Legless Lizard	CS3	R		
<i>Pygopus lepidopodus</i>	Common Scaly-foot	CS3	R	2	
Scincidae (Skinks)					
<i>Acritoscincus trilineatus</i>	Cool Skink		IV	1	
<i>Cryptoblepharus buchananii</i>	Buchanan's Snake-eyed Skink		R	1,2,5	
<i>Ctenotus australis</i>	Western Limestone Ctenotus	CS3	R	1,2	
<i>Ctenotus fallens</i>	West Coast Ctenotus	CS3	R	2,5	
<i>Ctenotus gemmula</i>	Jewelled Sand-plain Skink	CS2 (P3)	R	5	
<i>Cyclodomorphus celatus</i>	Western Slender Blue-tongue		R	2,5	
<i>Egernia kingii</i>	King's Skink	CS3	R	1	
<i>Egernia napoleonis</i>	Salmon-bellied Skink		R	1,2	
<i>Hemiergis quadrilineata</i>	Two-toed Earless Skink		R	1,2,5	
<i>Lerista elegans</i>	West Coast Four-toed Slider		R	1,2	
<i>Lerista lineopunctulata</i>	West Coast Line-spotted Slider		R	1,2	
<i>Lerista praepedita</i>	West Coast Worm-slider		R	1,2	X
<i>Menetia greyii</i>	Common Dwarf Skink		R	1,2,5	
<i>Morethia lineocellata</i>	Western Pale-flecked Morethia		R	1	
<i>Morethia obscura</i>	Dusky Morethia		R	1,2,5	
<i>Tiliqua occipitalis</i>	Western Blue-tongue	CS3	R	1,2,5	
<i>Tiliqua rugosa</i>	Bobtail	CS3	R	1,2,5	X
Varanidae (Monitor lizards)					
<i>Varanus gouldii</i>	Gould's Monitor	CS3	R	2,5	

Species		Conservation significance	Status in project area	Source	Recorded by BCE
<i>Varanus tristis</i>	Black-headed Monitor	CS3	R	1	
Typhlopidae (Blind snakes)					
<i>Anilius australis</i>	Southern Blind Snake		R	1	
Boidae (Pythons)					
<i>Morelia spilota imbricata</i>	Carpet Python (south-west pop'n)	CS3	possibly locally extinct	1,2	
Elapidae (Venomous land snakes)					
<i>Brachyurophis fasciolatus</i>	Narrow-banded Burrowing Snake		R	1	
<i>Brachyurophis semifasciatus</i>	Southern Shovel-Nosed Snake	CS3	R	1	
<i>Demansia reticulata</i>	Yellow-faced Whip Snake	CS3	R	1,2	
<i>Echiopsis curta</i>	Bardick	CS3	R	1,2	
<i>Neelaps bimaculatus</i>	Black-naped Snake	CS2 (P4)	R	1	
<i>Neelaps calonotos</i>	Black-striped Snake	CS2 (P3)	R	1	
<i>Parasuta gouldii</i>	Gould's Snake	CS3	R	1,2	
<i>Pseudechis australis</i>	Mulga Snake		R	BCE	
<i>Pseudonaja affinis</i>	Dugite		R	1,2,5	
<i>Simoselaps bertholdi</i>	Jan's Banded Snake	CS3	R	1,2	
Casuariidae (Cassowaries, emu)					
<i>Dromaius novaehollandiae</i>	Emu		IV	1,2,3,5	X
Phasianidae (Pheasants and allies)					
<i>Coturnix pectoralis</i>	Stubble Quail		IV	1	
<i>Coturnix ypsilophora</i>	Brown Quail		IV	1,2,3	
Columbidae (Pigeons and doves)					
<i>Columba livia</i>	Rock Dove/Feral Pigeon	Int	Va	1,2,3,5	
<i>Streptopelia chinesensis</i>	Spotted Dove	Int	R	1,2,3	
<i>Streptopelia senegalensis</i>	Laughing Dove	Int	R	1,2,3,5	
<i>Phaps chalcoptera</i>	Common Bronzewing	CS3 (HS)	R	1,2,3,5	X
<i>Phaps elegans</i>	Brush Bronzewing	CS3 (HS)	RV	2,3	
<i>Ocyphaps lophotes</i>	Crested Pigeon		R	1,2,3,5	X
Podargidae (Australian frogmouth)					
<i>Podargus strigoides</i>	Tawny Frogmouth		R	1,3	
Caprimulgidae (Nightjars)					
<i>Eurostopodus argus</i>	Spotted Nightjar		IV	1	
Aegothelidae (Owlet-nightjars)					
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar		R?	1	
Apodidae (Typical swifts)					
<i>Apus pacificus</i>	Fork-tailed Swift	CS1 (M, S5)	IV	4	
Accipitridae (Osprey, hawk, eagle)					
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk	CS3 (WR)	R	1,3	
<i>Accipiter fasciatus</i>	Brown Goshawk	CS3 (WR)	RV	1,3,5	
<i>Aquila audax</i>	Wedge-tailed Eagle	CS3 (WR)	RV	1,3,5	

Species		Conservation significance	Status in project area	Source	Recorded by BCE
<i>Circus approximans</i>	Swamp Harrier		IV	1,2,3	
<i>Circus assimilis</i>	Spotted Harrier		IV	1	
<i>Elanus caeruleus (axillaris)</i>	Black-shouldered Kite		RV	1,3,5	
<i>Haliastur sphenurus</i>	Whistling Kite	CS3 (WR)	RV	1,3,5	
<i>Hieraetus morphnoides</i>	Little Eagle	CS3 (WR)	RV	1,2,3	
<i>Lophoictinia isura</i>	Square-tailed Kite	CS3 (WR)	RV	1,5	X
<i>Pandion cristatus</i>	Eastern Osprey ^o	CS1 (IA)	IV	2,3,4	
Falconidae (Falcons)					
<i>Falco berigora</i>	Brown Falcon	CS3 (WR)	RV	1,2,3,5	
<i>Falco cenchroides</i>	Nankeen Kestrel		RV	1,2,3,5	
<i>Falco longipennis</i>	Australian Hobby		RV	1,2,3,5	
<i>Falco peregrinus</i>	Peregrine Falcon	CS1 (S7)	RV	3	
Turnicidae (Button-quails)					
<i>Turnix varius</i>	Painted Button-quail	CS3 (WR)	R	1	
<i>Turnix velox</i>	Little Button-quail		IV	1	
Cacatuidae (Cockatoos)					
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black-Cockatoo	CS1 (V, S3[v])	IV	1,4	
<i>Calyptorhynchus latirostris</i>	Carnaby's Black-Cockatoo	CS1 (E, S2[e])	RV	2,3,4,5	
<i>Eolophus roseicapilla</i>	Galah		R	1,2,3,5	
<i>Cacatua galerita</i>	Sulphur-crested Corella	Int	Va	1	
<i>Cacatua pastinator</i>	Western Long-billed Corella		RV	2,3	
<i>Cacatua sanguinea</i>	Little Corella	Int	IV	1,2,3,5	
<i>Cacatua tenuirostris</i>	Eastern Long-billed Corella	Int	IV	1	
Psittacidae (Parrots)					
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	Int	IV	1,2,3	
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet		IV	1,3	
<i>Platycercus icterotis</i>	Western Rosella	CS3 (WR)	Va	1	
<i>Platycercus zonarius</i>	Australian Ringneck		R	1,2,3,5	X
<i>Purpureicephalus spurius</i>	Red-capped Parrot		RV	1,3	X
<i>Neophema elegans</i>	Elegant Parrot		RV	1,2,3	
Cuculidae (Old world cuckoos)					
<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo		RV	1,3	
<i>Chalcites lucidus</i>	Shining Bronze-Cuckoo		RV	1,3,5	X
<i>Chalcites osculans</i>	Black-eared Cuckoo		Va	1	
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo		RV	1,2,3,5	
<i>Cacomantis pallidus</i>	Pallid Cuckoo		RV	1,2,3	
Strigidae (Hawk owls)					
<i>Ninox boobook</i>	Southern Boobook		RV	1	
Tytonidae (Barn owls)					
<i>Tyto javanica</i>	Eastern Barn Owl		RV	1	
<i>Tyto novaehollandiae</i>	Masked Owl	CS2 (P3)	IV	BCE	

Species		Conservation significance	Status in project area	Source	Recorded by BCE
Halcyonidae (Tree kingfishers)					
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	Int	R	1,2,3,5	X
<i>Todiramphus sanctus</i>	Sacred Kingfisher		RV	1,2,3	
Meropidae (Bee-eaters)					
<i>Merops ornatus</i>	Rainbow Bee-eater		RV	2,3,4,5	X
Maluridae (Fairy-wrens and allies)					
<i>Malurus splendens</i>	Splendid Fairy-wren	CS3 (HS)	R	1,2,3,5	X
<i>Malurus leucopterus</i>	White-winged Fairy-wren	CS3 (HS)	RV	2,3,5	
<i>Malurus lamberti</i>	Variiegated Fairy-wren	CS3 (HS)	R	1,2,3,5	
Acanthizidae (thornbills and allies)					
<i>Sericornis frontalis</i>	White-browed Scrubwren	CS3 (HS)	R	1,2,3	X
<i>Smicronis brevirostris</i>	Weebill	CS3 (HS)	R	1,2,3,5	X
<i>Gerygone fusca</i>	Western Gerygone		R	1,2,3,5	X
<i>Acanthiza apicalis</i>	Inland Thornbill	CS3 (HS)	R	1,2,3,5	X
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	CS3 (HS)	R	1,2,3,5	X
<i>Acanthiza inornata</i>	Western Thornbill	CS3 (HS)	R	1,2,3	X
Pardalotidae (Pardalotes)					
<i>Pardalotus punctatus</i>	Spotted Pardalote		IV	1,3	
<i>Pardalotus striatus</i>	Striated Pardalote		R	1,2,3,5	
Meliphagidae (Honeyeaters)					
<i>Acanthorhynchus superciliosus</i>	Western Spinebill		R	1,2,3	
<i>Anthochaera carunculata</i>	Red Wattlebird		R	1,2,3,5	X
<i>Anthochaera lunulata</i>	Western Wattlebird	CS3 (WR)	R	1,2,3,5	
<i>Manorina flavigula</i>	Yellow-throated Miner		IV	1,2,3	
<i>Epthianura albifrons</i>	White-fronted Chat		IV	1,2,3	
<i>Gavicalis virescens</i>	Singing Honeyeater		R	1,3	
<i>Glyciphila melanops</i>	Tawny-crowned Honeyeater	CS3 (WR)	RV	1,2,3	
<i>Lichmera indistincta</i>	Brown Honeyeater		R	1,2,3	X
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater		IV	BCE	
<i>Melithreptus lunatus</i>	White-naped Honeyeater		Va	1	
<i>Phylidonyris niger</i>	White-cheeked Honeyeater	CS3 (WR)	R	1,2,3	
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	CS3 (WR)	R	1,2,3	X
<i>Ptilotula ornata</i>	Yellow-plumed Honeyeater		Va	5	
<i>Sugomel nigrum</i>	Black Honeyeater		Va	1	
Neosittidae (Sittellas)					
<i>Daphoenositta chrysoptera</i>	Varied Sittella	CS3 (HS)	RV	1,2,3	
Campephagidae (Cuckoo-shrikes and trillers)					
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		RV	1,2,3,5	
<i>Lalage sueurii</i>	White-winged Triller		RV	1,3,5	
Pachycephalidae (Whistlers, shrike-thrushes)					
<i>Pachycephala rufiventris</i>	Rufous Whistler		R	1,2,3,5	X

Species		Conservation significance	Status in project area	Source	Recorded by BCE
<i>Pachycephala occidentalis</i>	Golden Whistler	CS3 (HS)	IV	5	
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	CS3 (HS)	R	1,2,3,5	X
Artamidae (Woodswallows, butcherbirds, currawong)					
<i>Artamus cinereus</i>	Black-faced Woodswallow	CS3 (WR)	RV	1,3	
<i>Artamus cyanopterus</i>	Dusky Woodswallow	CS3 (WR)	Va	1,2,3,5	
<i>Cracticus tibicen</i>	Australian Magpie		R	1,2,3,5	X
<i>Cracticus torquatus</i>	Grey Butcherbird		R	1,2,3,5	X
Corvidae (Crows and Ravens)					
<i>Corvus bennitti</i>	Little Crow		Va	1	
<i>Corvus coronoides</i>	Australian Raven		R	1,2,3,5	
Rhipiduridae (Fantails)					
<i>Rhipidura albiscapa</i>	Grey Fantail		R	1,2,3,5	X
<i>Rhipidura leucophrys</i>	Willie Wagtail		R	1,2,3,5	
Monarchidae (Flycatchers and magpie-lark)					
<i>Myiagra inquieta</i>	Restless Flycatcher	CS3 (HS)	Va	1	
<i>Grallina cyanoleuca</i>	Magpie-lark		R	1,2,3,5	X
Petroicidae (Robins)					
<i>Petroica boodang</i>	Scarlet Robin	CS3 (HS)	IV	1,2,3	
<i>Petroica goodenovii</i>	Red-capped Robin	CS3 (HS)	IV	5	
<i>Eopsaltria georgiana</i>	White-breasted Robin	CS3 (HS)	R	1,3	X
<i>Melanodryas cucullata</i>	Hooded Robin	CS3 (HS)	IV	1,3	
Megaluridae (Grassbirds)					
<i>Cincloramphus cruralis</i>	Brown Songlark		IV	1	
<i>Cincloramphus mathewsi</i>	Rufous Songlark		IV	1,3,5	
Timaliidae (White-eyes)					
<i>Zosterops lateralis</i>	Silvereeye		R	1,2,3,5	X
Hirundinidae (Swallows and martins)					
<i>Cheramoeca leucosterna</i>	White-backed Swallow		IV	1,3,5	
<i>Hirundo neoxena</i>	Welcome Swallow		R	1,2,3,5	
<i>Petrochelidon ariel</i>	Fairy Martin		IV	1,5	
<i>Petrochelidon nigricans</i>	Tree Martin		RV	1,2,3	
Nectariniidae (Sunbirds and allies)					
<i>Dicaeum hirundinaceum</i>	Mistletoebird		RV	1,2,3	
Motacillidae (Old world wagtail, pipit)					
<i>Anthus novaeseelandiae</i>	Australasian Pipit		RV	1,2,3,5	
Tachyglossidae (Echidnas)					
<i>Tachyglossus aculeatus</i>	Echidna		R	1,5	X
Dasyuridae (Dasyurids)					
<i>Dasyurus geoffroi</i>	Chuditch	CS1 (V, S3[v])	Va	1,2,4	
<i>Sminthopsis aff dolichura</i>	Coastal Little Dunnart	CS3	locally extinct	BCE	
<i>Sminthopsis fuliginosus</i>	Grey-bellied Dunnart	CS3 (LS)	locally extinct	BCE	

Species		Conservation significance	Status in project area	Source	Recorded by BCE
Peremelidae (Bandicoots)					
<i>Isodon fusciventer</i>	Quenda	CS2 (P4)	locally extinct	2	
Macropodidae (Kangaroos, wallabies)					
<i>Macropus fuliginosus</i>	Western Grey Kangaroo		R	1,2,5	X
<i>Notamacropus irma</i>	Brush Wallaby	CS2 (P4)	R	5	
Phalangeridae (Brushtail possums)					
<i>Trichosurus vulpecula</i>	Brush-tailed Possum		IV	BCE	
Burramyidae (Pygmy possums)					
<i>Cercartetus concinnus</i>	Western Pygmy-possum	CS3 (LS)	locally extinct	1	
Tarsipedidae (Honey Possum)					
<i>Tarsipes rostratus</i>	Honey Possum		R	1,2	
Vespertilionidae (Vespertilionid bats)					
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		R	1,2	
<i>Chalinolobus morio</i>	Chocolate Wattled Bat		RV	1	
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat		R	BCE	
<i>Nyctophilus major</i>	Western long-eared Bat		R	BCE	
<i>Vespadelus regulus</i>	Southern Forest Bat		R	1,2	
Molossidae (Freetail bats)					
<i>Austronomus australis</i>	White-striped Freetail-Bat		RV	BCE	
<i>Ozimops kitcheneri</i>	Western Freetail-Bat	CS3 (LS)	R	BCE	
Muridae (Rats and mice)					
<i>Mus musculus</i>	House Mouse	Int	R	1,2,5	
<i>Pseudomys albocinereus</i>	Noodji, Ash-grey Mouse	CS3 (LS)	locally extinct	BCE	
<i>Rattus fuscipes</i>	Bush Rat	CS3 (P4)	R	1,2	
<i>Rattus rattus</i>	Black Rat	Int	R	1,2	
Leporidae (Rabbits and hares)					
<i>Oryctolagus cuniculus</i>	Rabbit	Int	R	2,5	X
Canidae (Dogs and foxes)					
<i>Vulpes vulpes</i>	Red Fox	Int	R	1,2,5	X
Felidae (Cats)					
<i>Felis catus</i>	Cat	Int	R	2,5	X
Significant invertebrates					
<i>Pachysaga munggai/strobila</i>	Pachysaga	CS2 (P3/P1)	R	5	
<i>Synemon gratiosa</i>	Graceful Sun-moth	CS3 (P4)	R	1	

Appendix 4. Significant vertebrate species expected to occur in the survey area.

For codes used in table see Appendix 3.

Species		Conservation significance	Status in project area	Recorded by BCE
<i>Heleioporus eyrei</i>	Moaning Frog	CS3	RV	
<i>Myobatrachus gouldii</i>	Turtle Frog	CS3	R	
<i>Pseudophryne guentheri</i>	Crawling Toadlet	CS3	IV	
<i>Chelodina collei</i>	Oblong Tortoise ^w	CS3	Va	
<i>Ctenophorus adelaidensis</i>	Western Heath Dragon	CS3	R	
<i>Pogona minor</i>	Dwarf Bearded Dragon	CS3	R	
<i>Delma fraseri</i>	Fraser's Legless Lizard	CS3	R	
<i>Delma grayii</i>	Gray's Legless Lizard	CS3	R	
<i>Lialis burtonis</i>	Burton's Legless Lizard	CS3	R	X
<i>Pletholax gracilis</i>	Keeled Legless Lizard	CS3	R	
<i>Pygopus lepidopodus</i>	Common Scaly-foot	CS3	R	
<i>Ctenotus australis</i>	Western Limestone Ctenotus	CS3	R	
<i>Ctenotus fallens</i>	West Coast Ctenotus	CS3	R	
<i>Ctenotus gemmula</i>	Jewelled Sand-plain Skink	CS2 (P3)	R	
<i>Egernia kingii</i>	King's Skink	CS3	R	
<i>Tiliqua occipitalis</i>	Western Blue-tongue	CS3	R	
<i>Tiliqua rugosa</i>	Bobtail	CS3	R	X
<i>Varanus gouldii</i>	Gould's Monitor	CS3	R	
<i>Varanus tristis</i>	Black-headed Monitor	CS3	R	
<i>Morelia spilota imbricata</i>	Carpet Python (south-west pop'n)	CS3	possibly locally extinct	
<i>Brachyurophis semifasciatus</i>	Southern Shovel-Nosed Snake	CS3	R	
<i>Demansia reticulata</i>	Yellow-faced Whip Snake	CS3	R	
<i>Echiopsis curta</i>	Bardick	CS3	R	
<i>Neelaps bimaculatus</i>	Black-naped Snake	CS2 (P4)	R	
<i>Neelaps calonotos</i>	Black-striped Snake	CS2 (P3)	R	
<i>Parasuta gouldii</i>	Gould's Snake	CS3	R	
<i>Simoselaps bertholdi</i>	Jan's Banded Snake	CS3	R	
<i>Phaps chalcoptera</i>	Common Bronzewing	CS3 (HS)	R	X
<i>Phaps elegans</i>	Brush Bronzewing	CS3 (HS)	RV	
<i>Apus pacificus</i>	Fork-tailed Swift ^a	CS1 (M, S5)	IV	
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk	CS3 (WR)	R	
<i>Accipiter fasciatus</i>	Brown Goshawk	CS3 (WR)	RV	
<i>Aquila audax</i>	Wedge-tailed Eagle	CS3 (WR)	RV	
<i>Haliaastur sphenurus</i>	Whistling Kite	CS3 (WR)	RV	
<i>Hieraetus morphnoides</i>	Little Eagle	CS3 (WR)	RV	
<i>Lophoictinia isura</i>	Square-tailed Kite	CS3 (WR)	RV	X
<i>Pandion cristatus</i>	Eastern Osprey ^o	CS1 (IA)	IV	

Species		Conservation significance	Status in project area	Recorded by BCE
<i>Falco berigora</i>	Brown Falcon	CS3 (WR)	RV	
<i>Falco peregrinus</i>	Peregrine Falcon	CS1 (S7)	RV	
<i>Turnix varius</i>	Painted Button-quail	CS3 (WR)	R	
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black-Cockatoo	CS1 (V, S3[v])	IV	
<i>Calyptorhynchus latirostris</i>	Carnaby's Black-Cockatoo	CS1 (E, S2[e])	RV	
<i>Platycercus icterotis</i>	Western Rosella	CS3 (WR)	Va	
<i>Tyto novaehollandiae</i>	Masked Owl	CS2 (P3)	IV	
<i>Malurus splendens</i>	Splendid Fairy-wren	CS3 (HS)	R	X
<i>Malurus leucopterus</i>	White-winged Fairy-wren	CS3 (HS)	RV	
<i>Malurus lamberti</i>	Variegated Fairy-wren	CS3 (HS)	R	
<i>Sericornis frontalis</i>	White-browed Scrubwren	CS3 (HS)	R	X
<i>Smicronis brevirostris</i>	Weebill	CS3 (HS)	R	X
<i>Acanthiza apicalis</i>	Inland Thornbill	CS3 (HS)	R	X
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	CS3 (HS)	R	X
<i>Acanthiza inornata</i>	Western Thornbill	CS3 (HS)	R	X
<i>Anthochaera lunulata</i>	Western Wattlebird	CS3 (WR)	R	
<i>Glyciphila melanops</i>	Tawny-crowned Honeyeater	CS3 (WR)	RV	
<i>Phylidonyris niger</i>	White-cheeked Honeyeater	CS3 (WR)	R	
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	CS3 (WR)	R	X
<i>Daphoenositta chrysoptera</i>	Varied Sittella	CS3 (HS)	RV	
<i>Pachycephala occidentalis</i>	Golden Whistler	CS3 (HS)	IV	
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	CS3 (HS)	R	X
<i>Artamus cinereus</i>	Black-faced Woodswallow	CS3 (WR)	RV	
<i>Artamus cyanopterus</i>	Dusky Woodswallow	CS3 (WR)	Va	
<i>Myiagra inquieta</i>	Restless Flycatcher	CS3 (HS)	Va	
<i>Petroica boodang</i>	Scarlet Robin	CS3 (HS)	IV	
<i>Petroica goodenovii</i>	Red-capped Robin	CS3 (HS)	IV	
<i>Eopsaltria georgiana</i>	White-breasted Robin	CS3 (HS)	R	X
<i>Melanodryas cucullata</i>	Hooded Robin	CS3 (HS)	IV	
<i>Dasyurus geoffroi</i>	Chuditch	CS1 (V, S3[v])	Va	
<i>Sminthopsis aff dolichura</i>	Coastal Little Dunnart	CS3	locally extinct	
<i>Sminthopsis fuliginosus</i>	Grey-bellied Dunnart	CS3 (LS)	locally extinct	
<i>Isodon fusciventer</i>	Quenda	CS2 (P4)	locally extinct	
<i>Notamacropus irma</i>	Brush Wallaby	CS2 (P4)	R	
<i>Cercartetus concinnus</i>	Western Pygmy-possum	CS3 (LS)	locally extinct	
<i>Ozimops kitcheneri</i>	Western Freetail-Bat	CS3 (LS)	R	
<i>Pseudomys albocinereus</i>	Noodji, Ash-grey Mouse	CS3 (LS)	locally extinct	
<i>Rattus fuscipes</i>	Bush Rat	CS3 (P4)	R	
<i>Pachysaga munggai/strobila</i>	Pachysaga	CS2 (P3/P1)	R	
<i>Synemon gratiosa</i>	Graceful Sun-Moth	CS3 (P4)	R	

Appendix 5. Species listed in databases or previously listed as recorded but unlikely to occur in the area.

For codes used in tables see Appendix 3.

5a Species returned from databases and reports but not expected to occur in the project area due to lack of suitable habitat and or project area is outside recognised range of the species.

Binomial Name	Common Name	Conservation significance	Source
<i>Bostokia porosa</i>	Nightfish		1
<i>Heleioporus psammophilus</i>	Sand Frog	CS3	2
<i>Crinia georgiana</i>	Quacking Frog	CS3	1
<i>Cryptoblepharus plagiocephalus</i>	Peron's Snake-eyed Skink		2
<i>Anilius pinguis</i>	Stout Blind Snake		1
<i>Ctenotus inornatus</i>	Bar-shouldered Ctenotus		1
<i>Lerista christinae</i>	Bold-striped Slider	CS3	
<i>Acanthiza iredalei</i>	Slender-billed Thornbill		1
<i>Lichenostomus leucotis</i>	White-eared Honeyeater		5
<i>Ptilotula ornata</i>	Yellow-plumed Honeyeater	CS3 (WR)	1
<i>Oreoica gutturalis</i>	Crested Bellbird		1
<i>Cracticus nigrogularis</i>	Pied Butcherbird		5
<i>Eopsaltria griseogularis</i>	Western Yellow Robin		1
<i>Microeca fascinans</i>	Jacky Winter		5
<i>Megalurus gramineus</i>	Little Grassbird		1,2,3
<i>Acrocephalus australis</i>	Australian Reed Warbler		1,2,3
<i>Mustela putorius</i>	European Polecat, Ferret	Int	2
<i>Sus scrofa</i>	Pig	Int	5
<i>Hydromys chrysogaster</i>	Rakali (water-rat)	CS2 (P4)	2
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart		1

5b. Waterbird species returned from databases. Not expected to occur in the project area but could overfly the site.

Binomial Name	Common Name	Conservation significance	Source
<i>Cygnus atratus</i>	Black Swan ^w		1,2,3
<i>Biziura lobata</i>	Musk Duck ^w		1,2,3
<i>Tadorna tadornoides</i>	Australian Shelduck ^w		1,2,3
<i>Chenonetta jubata</i>	Australian Wood Duck ^w		1,2,3
<i>Anas castanea</i>	Chestnut Teal ^w		1,2
<i>Anas gracilis</i>	Grey Teal ^w		1,2,3
<i>Anas platyrhynchos</i>	Mallard Duck ^w		1,2
<i>Anas rhynchos</i>	Australasian Shoveler ^w		1,2,3
<i>Anas superciliosa</i>	Pacific Black Duck ^w		1,2,3
<i>Aythya australis</i>	Hardhead ^w		1,2,3
<i>Oxyura australis</i>	Blue-billed Duck ^w		1,2,3

<i>Egretta garzetta</i>	Little Egret ^w		1
<i>Egretta novaehollandiae</i>	White-faced Heron ^w		1,2,3
<i>Ardea alba</i>	Great Egret ^w		3,4
<i>Ardea ibis</i>	Cattle Egret ^w	M	4
<i>Ardea pacifica</i>	White-necked Heron ^w		1,2,3
<i>Threskiornis molucca</i>	Australian White Ibis		1,3
<i>Threskiornis spinicollis</i>	Straw-necked Ibis		1,2,3
<i>Tribonyx ventralis</i>	Black-tailed Native-hen ^w		1,3

Appendix 6. Species returned from database and literature searches but that are locally extinct

For codes used in table see Appendix 3.

Species	Conservation significance	Source
<i>Austroconops mcmillani</i>	McMillan's Biting Midge	CS2 (P4)
<i>Lerista distinguenda</i>	South-west Four-toed Slider	
<i>Ardeotis australis</i>	Australian Bustard	CS3 (WR) 1
<i>Malurus pulcherrimus</i>	Blue-Breasted Fairy-wren	CS3 (HS)
<i>Malurus elegans</i>	Red-winged Fairy wren	CS3 (HS)
<i>Rostratula australis</i>	Australian Painted-snipe	CS1 (E, S2[e])
<i>Megalurus gramineus</i>	Little Grassbird	1,2
<i>Macrotis lagotis</i>	Bilby, Dalgyte	CS1 (V, S3[v]) 6
<i>Potorous gilbertii</i>	Gilbert's Potoroo	CS1 (CR, S1[c]) 6
<i>Bettongia lesueur graii</i>	Boodie (inland), Burrowing Bettong	CS1 (Ex, S4[e]) 6
<i>Bettongia penicillata ogilbyi</i>	Woylie, Brush-tailed Bettong	CS1 (E, S1[c]) 6
<i>Petrogale lateralis lateralis</i>	Black-footed Rock-Wallaby	CS1 (E, S2[e]) 6
<i>Notamacropus eugenii</i>	Tammar Wallaby	CS3 (P5) 6
<i>Onychogalea lunata</i>	Tjawalpa, Crescent Nail-tail Wallaby	CS1 (Ex, S4[e]) 6
<i>Setonix brachyurus</i>	Quokka	CS1 (V, S3[v]) 6