Terrestrial Fauna Surveys





Level 1 Vertebrate Fauna Assessment for the Sandy Ridge Project



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Front Cover: Tawny Frogmouth - Podargus strigoides (one was flushed from a tree during the field assessment)

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EXECUTIVE SUMMARY

Tellus Holdings Limited (Tellus) has undertaken a preliminary drilling program to assess the mineralisation on part of its tenement (E16/440) in the Shire of Yilgarn. Tellus proposes to develop a kaolin mine with complimentary storage and waste isolation facilities at its Sandy Ridge Project. The Sandy Ridge Project is approximately 140km north-west of Kalgoorlie and 75km north-east of Koolyanobbing, WA.

A Level 1 fauna assessment was undertaken to provide an indication of the vertebrate fauna assemblage (reptiles, amphibians, small mammals and birds) on and in the vicinity of the project area so that potential impacts on the fauna might be adequately assessed, to assess whether the proposed impact area supports active Malleefowl mounds and to assess the impact and environmental risks associated with the proposed development on the fauna assemblage.

There were two broad fauna habitats present in the project area; an open eucalypt woodland with an open understorey of shrubs over ephemeral grasses or scattered spinifex on red sandy clay soils, and a moderately dense to dense sand plain shrubland varying in height from 0.5-1.8m on yellow sandy soils. The project area contains a few vehicle tracks and there has been some exploration drilling and associated access tracks in the proposed mine pit and infrastructure development areas. Other than this disturbance, the habitat is in very good to excellent condition.

Because of the two broad fauna habitat types and the limited disturbance to the area, the fauna assemblages are likely to be intact and diverse, except for the impact of feral predators. There is a low possibility that Major Mitchell's Cockatoo, Western Rosella and Woma are potentially in the project area. However, the proposed impact area is small (~52ha), so the probability of significantly impacting on any of these species is very low. The project area was searched for Malleefowl tracks and mounds and none were found. Therefore there is a very low probability of impact on this species.

Other conservation significant species that are potentially in the project area include the Rainbow Bee-eater, Fork-tailed Swift, Peregrine Falcon, Crested Bellbird, Bush Stone-curlew, Australian Bustard and the Central Long-eared Bat. These aerial species will readily move into adjacent areas when vegetation clearing commences and the mine becomes operational, so any impacts on these species when considered in a bioregional context will be very low. Vegetation clearing will result in the loss of numerous small vertebrates in the project area and indirect impacts such as a reduction or loss of activity areas and closure of burrows, habitat fragmentation, increased presence of feral predators, road deaths and unnatural noises, vibrations, artificial light sources and vehicle and human movement in an area may force animals into adjacent areas.

To mitigate and minimise impacts on vertebrate fauna it is recommended that:

- information on protecting fauna and reporting deaths and sightings of Malleefowl and other conservation significant species should be incorporated into the project induction program;
- all areas disturbed during exploration are rehabilitated as soon as practical after they are no longer required;
- where possible, access routes are aligned to existing roads, tracks and other barriers or follow the boundaries of broad-scale vegetation associations in the area;
- pets are not permitted on the project;
- all waste and rubbish be contained in bins and regularly removed from the project or placed in landfill;
- feeding of native fauna is prohibited;
- a log of all on-site drill holes is maintained detailing when they were capped, how and by whom; and
- a fauna management plan is prepared and implemented for the life of the project.



1 INTRODUCTION

1.1 Background

Tellus Holdings Limited (Tellus) has undertaken a preliminary drilling program to assess the mineralisation on part of its tenement (E16/440) in the Shire of Yilgarn. Tellus proposes to develop a kaolin mine with complimentary storage and waste isolation facilities at its Sandy Ridge Project.

The Sandy Ridge Project is located approximately 140km north-west of Kalgoorlie and 75km north-east of Koolyanobbing, WA (Figure 1). The assessed project area included all the area with purple and blue boundaries in inset A, within the blue boundary in inset B and within the green boundary in inset C in Figure 2 ('project area').

1.2 **Project objectives and scope of works**

Terrestrial Ecosystems was commissioned by Tellus to undertake a Level 1 fauna assessment which will be included with environmental approval documentation when seeking to develop the project as a kaolin mine. The purpose of this fauna assessment was to provide information to enable an assessment of potential impacts from the proposed development activity on the vertebrate fauna assemblage that could be present in the project area. The methodology broadly follows that described in the Environmental Protection Authority (EPA) Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002), Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004) and the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA / DEC 2010).

The objectives of this fauna assessment were to:

- provide an indication of the vertebrate fauna assemblage (reptiles, amphibians, small mammals and birds) on and in the vicinity of the project area so that potential impacts on the fauna might be adequately assessed;
- assess whether the proposed impact area supports active Malleefowl mounds; and
- assess the impact and environmental risks associated with the proposed development on the fauna assemblage.

To achieve these objectives, Terrestrial Ecosystems has:

- reviewed Terrestrial Ecosystems fauna survey database [includes WA Museum and Department of Parks and Wildlife (DPaW) records] to identify potential vertebrate fauna within the project area and surrounds;
- reviewed DPaW listed Threatened and Priority species as recorded in NatureMap that are likely to occur in the project area and surrounds;
- searched the Commonwealth government's on-line database to identify fauna species of national environmental significance that are protected under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999)* potentially occurring in the project area and surrounds;
- reviewed previous fauna surveys conducted in the region;
- undertaken a one day reconnaissance survey of the project area, which included a search for Malleefowl tracks and mounds; and
- provided a discussion of the likelihood of *EPBC Act 1999* and *Wildlife Conservation Act (1950)* listed species being present in the project area.



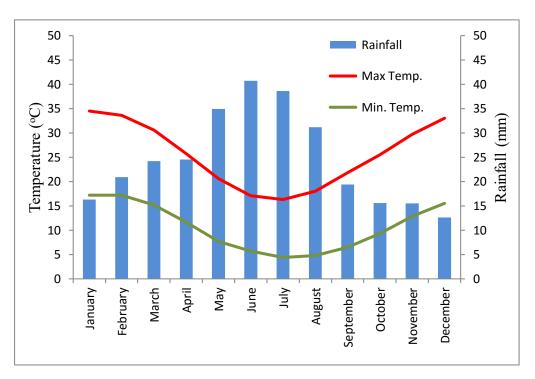
2 EXISTING ENVIRONMENT

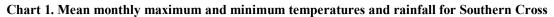
2.1 Southern Cross IBRA subregion

The project area is located in the Coolgardie (COO2 – Southern Cross) Interim Biogeographic Regionalisation for Australia (IBRA) sub-region. The Southern Cross subregion is characterised as a weathered plain comprising gently undulating uplands dissected by broad valleys with bands of low greenstone hills. The subregion contains a diverse eucalypt woodland (*Eucalyptus salmonophloia, E. salubris, E. transcontinentalis, E. longicornis, E. leptopoda, E. platycorys, E. scyphocalyx*) and low heaths (*Allocasuarina corniculata, Callitris preissii, Melaleuca uncinata, Acacia beauverdiana*; Cowan et al. 2002).

2.2 Climate

Chart 1 shows the average mean monthly maximum and minimum temperatures and rainfall for Southern Cross, the closest weather station. Temperatures are highest in December – February. Most rain comes in mid winter. Winter rain is the result of low pressure cells that move in an easterly direction from the south-west of the state, whereas, summer rain is often from thunderstorms that move in from either the west or the north-west.





2.3 Land use history

The dominant land uses in this bioregion are pastoralism, crown reserves and mining. Mining is evident in many areas around Southern Cross, Yellowdine and Koolyanobbing, with numerous small abandoned mines and open shafts throughout the Yilgarn landscape. Many of the larger trees in the bioregion were removed decades ago to support the mining and power generation industries and these trees have often not been replaced by replanting programs.

2.4 Previous biological surveys in the region

The frogs, reptiles, mammals and birds in the vicinity of the project area have been previously surveyed. Surveys in the vicinity of the project area that have been reviewed as part of this assessment include:



- Bell, D. T., Bell, R. C. and Loneragan, W. A. (2007) Winter bird assemblages across an arid gradient in southwest Western Australia. *Journal of the Royal Society of Western Australia*, 90, 219-227.
- Dell, J. and How, R. A. (1985) Vertebrate fauna. In Dell; J; How; RA; Newbey K.R. and Hnatiuk RJ. The Biological Survey of the Eastern Goldfields of Western Australia Part 3; Jackson - Kalgoorlie. *Records of the Western Australian Museum*, Supplement No 23, pp. 39-66.
- Dickman, C.R., Henry-Hall, N.J., Lloyd, H. and Romanow, K.A. (1991) A survey of the terrestrial vertebrate fauna of Mount Walton, western goldfields, Western Australia. *Western Australian Naturalist*, 18, 200-206.
- Ecologia Environmental Consultants (2001) Koolyanobbing Expansion Project Fauna Assessment Survey. Unpublished report for Portman Iron Ore Limited, Perth.
- Ecologia Environmental Consultants (2003) Koolyanobbing Expansion Project Transport Corridor Fauna Assessment Survey. Unpublished report for Portman Iron Ore Limited, Perth.
- Lyons, M.N. and Chapman, A. (1997) A Biological Survey of the Helena and Aurora Range; Eastern Goldfields Western Australia. Unpublished report for Environment Australia, Canberra.
- McKenzie, N.L. and Rolfe, J.K. (1995a) Vertebrate fauna. In: Keighery GJ, McKenzie NL and Hall NJ. The Biological Surveys of the Eastern Goldfields of Western Australia. Part 11 Boorabbin-Southern Cross Study Area. *Records of the Western Australian Museum*, Supplement No. 49, pp 31-65.
- Ninox Wildlife Consulting (2008) Interim Report on the first field survey of the Carina Prospect, Yilgarn Iron Ore Project. Unpublished report for Polaris Metals NL, Perth.
- Ninox Wildlife Consulting (2009b) Interim report on the first field survey of the Chamaeleon Prospect, Yilgarn Iron Ore Project. Unpublished report for Polaris Metals NL, Perth.
- Ninox Wildlife Consulting (2009a) A Fauna Survey of the Carina Prospect; Yilgarn Iron Ore Project. Unpublished report for Polaris Metals NL, Perth.

In addition, unpublished data from Jason Fraser's PhD project on the sand plain north of Bungalbin Hill and Western Australian Museum records contained in Terrestrial Ecosystems' fauna survey database have also been used.

The Dell and How (1985) fauna survey data are from a Western Australian Museum (WAM) survey of the Jackson-Kalgoorlie area which was part of the Eastern Goldfields biological regional survey. Their survey sites were to the north of the project area. The Dickman et al. (1991) data are from a survey near Mt Walton which is less than 10km from the project area in similar habitat. The Ecologia Environmental Consultants (2001, 2003) data for the Koolyanobbing project areas are for sites to the south-west of the project area. Some of the habitat types surveyed were similar to those in the project area. The Lyons and Chapman (1997) data for the Helena and Aurora Range includes survey sites on the sand plain that are similar to those in the project area. The McKenzie and Rolfe (1995a) data from the Boorabbin-Southern Cross survey, which was part of the Eastern Goldfields biological regional surveys, is for an area to the east and south-east of the project area. Much of the habitat surveyed was similar to that in the project area. The Ninox Wildlife Consulting (2008, 2009b, a) surveys for Carina and Chamaeleon are just to the south of the project area and Jason Fraser's data are for areas to the north-west of the project area and include habitat similar to that in the project area. Prof. H. Recher provided access to his bird survey data for areas around Yellowdine which were useful when commenting on the potential impacts on conservation significant bird species.

The location of survey sites associated with these fauna surveys are shown in Plate 1.



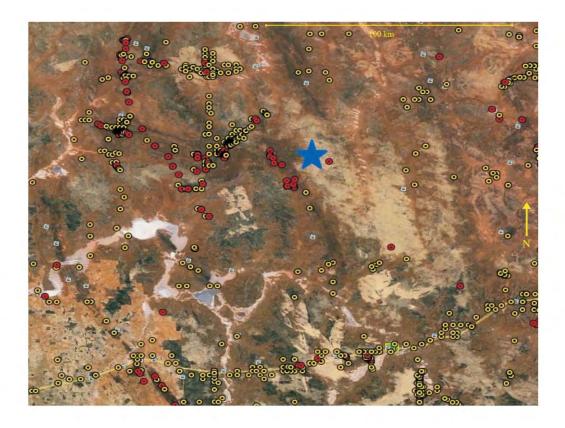


Plate 1. Location of regional survey sites and individual fauna records available in Terrestrial Ecosystems' fauna survey database. Survey sites shown as red dots with a black centre, individual records as yellow dots and the project area as a blue star.

2.5 Great Western Woodlands

The Sandy Ridge project area is part of the Great Western Woodlands (Watson et al. 2008, pp. vi) that is being promoted by the Wilderness Society because the area contains the 'largest and healthiest temperate woodland remaining on our planet'. The Wilderness Society argued the fauna and flora diversity in the area has evolved with the landscape during an unbroken biological lineage stretching back 250 million years.

There is pressure from numerous conservation groups for the preservation of the Great Western Woodlands, and it is likely that the DPaW will progressively become more involved in the protection of this areas.



3 METHODOLOGY

3.1 Database searches

A review of the *EPBC Act 1999* Threatened Species Database was undertaken to identify species of conservation interest to the Commonwealth Government. The search coordinates were 30.33549°S and 120.10354°E with a 100km buffer (Appendix C). In addition, a point search of the Terrestrial Ecosystems' fauna survey database was used to develop an appreciation of the vertebrate fauna assemblages in the vicinity of the project area. The DPaW threatened and priority species database was searched within the vicinity of the project area via the records in NatureMap to identify threatened species of interest to the DPaW. The search areas varied but were chosen to allow for similar habitat types so that representative fauna assemblages were collated.

Other more general texts were also used to provide supplementary information on vertebrates in the bioregion, including; Tyler *et al.* (2000) for frogs; Storr *et al.* (1983, 1990, 1999, 2002) and Thompson and Thompson (2006) for reptiles; Johnstone and Storr (1998, 2004) for birds, and Van Dyck and Strahan (2008) for mammals.

Collectively these sources of information were used to create lists of species expected to utilise the project area and similar habitats in the vicinity of the project area. It should be noted that these lists will include species that have been recorded in the subregion but are possibly vagrants and they will not generally be found in the project area due to a lack of suitable habitat (e.g. wetland and water birds). Vagrants can be recorded almost anywhere. Many of the bird, mammal, reptile and amphibian species have specific habitat requirements that may be present in the subregion but not in a particular subsection of the subregion because of a lack of suitable habitat. Also, the ecology of many species is often not well understood and it can sometimes be difficult to indicate those species whose specific habitat requirements are not present in subsection of the subregion, again because of differences in habitat. As a consequence many species will be included in the lists produced from database searches but will not be present in the actual project area.

3.2 Reconnaissance survey

The project area was visited in 22 April 2015 as part of the preparation of this assessment. The purpose of the reconnaissance survey was to determine fauna habitats and habitat condition.

The project area was searched on foot and in an all-terrain vehicle (ATV) for evidence of malleefowl, conservation significant fauna and to record fauna habitat types and their condition. Malleefowl is listed as Vulnerable under the *EPBC Act 1999* and a Schedule 1 species under the WA *Wildlife Conservation Act (1950)* and government regulators typically wish to know whether malleefowl are present, and if so, how abundant and where they are located in a project area.

Searches for Major Mitchells Cockatoo and Western Rosella nests can only be done during the breeding season and are not normally included in a Level 1 vertebrate fauna assessment. A trapping program is required to determine the presence of Chuditch and it is difficult to determine the presence of Woma and Carpet Pythons, as they are seldom seen in targeted searches and are normally recorded incidentally during a Level 2 vertebrate fauna survey and at night.

The reconnaissance survey was undertaken by zoologists; Dr Scott Thompson and Andrew Hide.

3.3 Fauna habitat assessment

A fauna habitat assessment was undertaken for the project area. This field assessment had two foci:

- assessing fauna habitat types and their condition; and
- assessing the possible presence of, and recording evidence of, conservation significant fauna so that mitigation and management strategies might be implemented to reduce potential impacts.

Zoologists stopped at multiple locations within the project area and recorded a suite of data about the fauna habitat and its condition. This information included a description of the habitat structure, habitat condition,



landform, soils and vegetation and time since last fire. The following data were recorded at each location as part of the habitat assessment:

<i>Coordinates</i> of the location as UTM (WGS 84)	
Fire history – options	
> 5 years	
1-5 years	
< 1 year	
Landform – options	
Beach Lake / lake edge	
Clay plain Lower slope	
Cliff Mid slope	
Creek line Ridge	
Dam River	
Drainage line Rocky outcrop / breakaway	
Dune crest Salt lake	
Dune slope Sand dune	
Dune swale Sand plain	
Escarpment Stony plain	
Flat Swamp	
Gorge Undulating	
Gully Upper slope	
Intertidal / mangrove Wetland	
Water hole	

Habitat quality – options

- *High quality fauna habitat* These areas closely approximate the vegetation mix and quality that would have been in the area prior to any disturbance. The habitat has connectivity with other habitats and is likely to contain the most natural vertebrate fauna assemblage.
- Very good fauna habitat These areas show minimal signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be minimally effected by disturbance.
- *Good fauna habitat* These areas showed signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be affected by disturbance.
- Disturbed fauna habitat- These areas showed signs of significant disturbance. Many of the trees, shrubs and undergrowth are cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, containing weeds or have been damaged by vehicle or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.
- *Highly degraded fauna habitat* These areas often have a significant loss of vegetation, an abundance of weeds, and a large number of vehicle tracks or are completely cleared. Limited or no fauna habitat connectivity. Fauna assemblages in these areas are likely to be significantly different to what might have been in the area pre-disturbance.

Habitat structure - options

Upper stratum

Tall open woodland Tall woodland Open woodland Woodland Open forest Closed forest Tall closed forest Tall open forest *Middle stratum* Shrubland Scattered tall trees Scattered trees Scattered low trees Low closed forest Low open forest Low woodland Low open woodland

Open heath



Lower s	Tall shrubland Tall open shrubland Low shrubland Scattered low shrubs Low open shrubland Scattered tall shrubs Closed heath <i>tratum</i> Closed hummock grassland	Low closed heath Low open heath Tall closed scrub Tall open scrub Scattered tall shrubs Open shrubland Scattered shrubs Closed tussock grassland / sedgeland / herbland
	Mid-dense hummock grassland Hummock grassland Open hummock grassland Scattered hummock grassland	Tussock grass land / sedgeland / herbland Open tussock grassland / sedgeland / herbland Scattered tussock / grasses / sedges / herbs Very open tussock grassland / herbland
Soil Type – option	•	· · · · · · · · · · · · · · · · · · ·
Sand		Clay loam
Loamy s	and	Silty clay loam
Clayey s		Clay
Sandy lo		Rock
Loam		Peat / organic
Silty loa	m	Stony
Sandy cl		2
Soil Colour -opti		
Black		Red
Brown		White
Grey		Yellow
Orange		
Surface stones - c	options	
None		Boulders (>250mm)
Pebbles	(0-50mm)	Rocks
Cobbles	(51-250mm)	
Potential for cons	servation significant species to be	
found in the area		
Yes		
No		
	g on conservation significant	
species-options		
Low		Moderate - high
Low - m	oderate	High
Moderat		Extreme
	conservation significant fauna	
required:		
No		
Yes		

3.3.1 Report preparation

This report has been prepared by Drs Scott and Graham Thompson, both of whom have substantial field fauna survey experience and are familiar with the fauna habitats in the vicinity of the project area.

3.4 Limitations

This fauna risk assessment is based on information contained in the Commonwealth Government's *EPBC Act* 1999 Threatened Species database and other published and unpublished fauna survey data for the bioregion and a reconnaissance survey. It is acknowledged that multiple surveys conducted in different seasons, repeated over several years are necessary to fully appreciate the fauna assemblage in the project area.



The EPA Guidance for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56 (2004) suggested that fauna surveys may be limited by many variables. Limitations associated with each of these variables are assessed in Table 1.

Possible limitations	Constraint (yes/no); significant, moderate or negligible	Comment
Competency and experience of the consultant carrying out this assessment	No	The environmental scientists that undertook the field survey and prepared this assessment are familiar with the vertebrate fauna of this bioregion and are experienced in these types of assessments.
Scope	No	All aspects of the scope of works have been addressed.
Proportion of fauna identified, recorded and/or collected	No	Not applicable.
Accuracy of previous survey work	Yes, negligible	Terrestrial Ecosystems has reported fauna survey data recorded by various authors, but is not in a position to vouch for the accuracy of this information. It is acknowledged that the taxonomy of Western Australian vertebrates is continually being revised and the nomenclature of some of the species listed in the appendices may have changed since publication by the authors.
Sources of information	Yes, negligible	Vertebrate fauna information was available from on-line databases and unpublished and published reports of surveys conducted in the bioregion in a variety of habitat types. Many of these surveys employed a low level of trapping effort which significantly impacts on the capacity of these data to represent the fauna assemblages in the areas surveyed.
Timing/weather/ season/ cycle	No	Weather was suitable for a site visit.
Disturbances which affected results of the survey	No	The project area contained tracks and there was evidence of recent exploration activity in some areas. This minor level of disturbance has been taken into account in this assessment.
Intensity of survey effort	No	Not applicable.
Resources	No	Adequate resources were available.
Remoteness and/or access problems	No	There was a vehicle access track to some sections of the project area. Other sections of the project area were searched on foot or by ATV. Access was not a limitation or constraint.
Availability of contextual information on the region	No	There is a substantial quantity of fauna survey data available for the Southern Cross IBRA bioregion.

Table 1. Fauna survey limitations and constraints

Negligible = less than 20%.



4 **RESULTS**

4.1 Fauna habitats

There were two broad habitats available in the project area. These are an open eucalypt woodland with an open understorey of shrubs over ephemeral grasses or scattered spinifex on red sandy clay soils; and a moderately dense to dense sand plain shrubland varying in height from 0.5-1.8m on yellow sandy soils.

The areas outlined in purple and blue in inset A of Figure 2 are a moderately dense to dense sand plain shrubland and the areas outlined in blue and green in insets B and C of Figure 2 are an open eucalypt woodland with an open understorey of shrubs over ephemeral grasses or scattered spinifex on red sandy clay soils. Plates 2-5 provide an indication of the habitat types available and Appendix D has many more images.



Plate 2. Open Eucalypt woodland over shrubs and ephemeral grasses



Plate 4. Sand plain shrubland (low)

4.2 Fauna habitat condition



Plate 3. Open Eucalypt woodland over shrubs and scattered spinifex



Plate 5. Sand plain shrubland (high)

The project area contains a few vehicle tracks and there has been some exploration drilling and associated access tracks in the project area. Other than this disturbance, the habitat in the project area is in very good to excellent condition.

Appendix D provides the results of the fauna habitat assessment. These data and images indicate the range of fauna habitats present in the project area.

There was evidence of fox activity in the project area but no cat or dog tracks were observed. A large area adjacent to the project area has been burnt >5 years ago, however, there was no evidence that the project area had been recently burnt.



The open woodland of tall eucalypts contained trees with hollows suitable as nesting sites for Major Mitchell's Cockatoo, Western Rosellas and other birds and arboreal mammals.

4.3 Malleefowl

The project area was searched for Malleefowl mounds and tracks. Malleefowl are predominantly a ground dwelling species and walk a considerable distance each day foraging for insects and seeds. Their tracks are distinctive, and in areas of soft sand or on sand tracks their presence is often easily detected. No Malleefowl mounds or tracks were observed during the site visit.

4.4 Bioregional vertebrate fauna

Appendix A provides a summary of the fauna survey data that are available in the vicinity of the project area. There are appreciable differences in the recorded fauna assemblages within and among fauna surveys shown in Appendix A. These differences are partially due to the low survey effort often deployed and they also reflect variations in soils and vegetation as well as temporal variations in the fauna assemblages.

Tables 2-5 provide a list of vertebrate species potentially found in the vicinity of the project area that have been compiled based on the fauna survey reports listed in section 2.4.



Family	Species	Common Name
Accipitridae	Hamirostra melanosternon	Black-breasted Buzzard
	Accipiter fasciatus	Brown Goshawk
	Accipiter cirrocephalus	Collared Sparrowhawk
	Aquila audax	Wedge-tailed Eagle
	Hieraaetus morphnoides	Little Eagle
Anatidae	Chenonetta jubata	Australian Wood Duck
	Anas gracilis	Grey Teal
Aegothelidae	Aegotheles cristatus	Australian Owlet-nightjar
Podargidae	Podargus strigoides	Tawny Frogmouth
Casuariidae	Dromaius novaehollandiae	Emu
Charadriidae	Vanellus tricolor	Banded Lapwing
Turnicidae	Turnix varius	Painted Button-quail
	Turnix velox	Little Button-quail
Columbidae	Phaps chalcoptera	Common Bronzewing
	Ocyphaps lophotes	Crested Pigeon
Alcedinidae	Todiramphus pyrrhopygius	Red-backed Kingfisher
Meropidae	Merops ornatus	Rainbow Bee-eater
Cuculidae	Chalcites basalis	Horsfield's Bronze-Cuckoo
	Chalcites osculans	Black-eared Cuckoo
	Cacomantis pallidus	Pallid Cuckoo
	Cacomantis flabelliformis	Fan-tailed Cuckoo
Caprimulgidae	Eurostopodus argus	Spotted Nightjar
Falconidae	Falco cenchroides	Nankeen Kestrel
	Falco berigora	Brown Falcon
	Falco longipennis	Australian Hobby
	Falco peregrinus	Peregrine Falcon
Megapodiidae	Leipoa ocellata	Malleefowl

Family	Species	Common Name
Otididae	Ardeotis australis	Australian Bustard
Rallidae	Fulica atra	Eurasian Coot
Acanthizidae	Calamanthus cautus	Shy Heathwren
	Calamanthus fuliginosus	Striated Fieldwren
	Pyrrholaemus brunneus	Redthroat
	Smicrornis brevirostris	Weebill
	Gerygone fusca	Western Gerygone
	Acanthiza robustirostris	Slaty-backed Thornbill
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill
	Acanthiza apicalis	Inland Thornbill
	Aphelocephala leucopsis	Southern Whiteface
	Acanthiza uropygialis	Chestnut-rumped Thornbill
Artamidae	Artamus personatus	Masked Woodswallow
	Artamus cinereus	Black-faced Woodswallow
	Artamus cyanopterus	Dusky Woodswallow
	Artamus minor	Little Woodswallow
	Cracticus torquatus	Grey Butcherbird
	Cracticus nigrogularis	Pied Butcherbird
	Cracticus tibicen	Australian Magpie
	Strepera versicolor	Grey Currawong
Campephagidae	Coracina maxima	Ground Cuckoo-Shrike
	Coracina novaehollandiae	Black-faced Cuckoo-Shrike
	Lalage sueurii	White-winged Triller

TERRESTRIAL

Rufous Treecreeper

Australian Raven

Torresian Crow

Little Crow

Table 2. Birds potentially found in the vicinity of the project area

Climacteridae

Corvidae

Climacteris rufa

Corvus bennetti

Corvus orru

Corvus coronoides

Family	Species	Common Name
Estrildidae	Taeniopygia guttata	Zebra Finch
Eupetidae	Cinclosoma castanotum	Chestnut Quail-thrush
	Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush
Hirundinidae	Cheramoeca leucosterna	White-backed Swallow
	Hirundo neoxena	Welcome Swallow
	Petrochelidon nigricans	Tree Martin
Maluridae	Malurus splendens	Splendid Fairy-wren
	Malurus leucopterus	White-winged Fairy-wren
	Malurus lamberti	Variegated Fairy-wren
	Malurus pulcherrimus	Blue-breasted Fairy-wren
Meliphagidae	Certhionyx variegatus	Pied Honeyeater
	Lichenostomus virescens	Singing Honeyeater
	Lichenostomus leucotis	White-eared Honeyeater
	Lichenostomus flavicollis	Yellow-throated Honeyeater
	Lichenostomus cratitius	Purple-gaped Honeyeater
	Lichenostomus ornatus	Yellow-plumed Honeyeater
	Lichenostomus plumulus	Grey-fronted Honeyeater
	Purnella albifrons	White-fronted Honeyeater
	Manorina flavigula	Yellow-throated Miner
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater
	Anthochaera carunculata	Red Wattlebird
	Epthianura tricolor	Crimson Chat
	Epthianura albifrons	White-fronted Chat
	Glyciphila melanops	Tawny-crowned Honeyeater
	Lichmera indistincta	Brown Honeyeater
	Melithreptus brevirostris	Brown-headed Honeyeater
Monarchidae	Grallina cyanoleuca	Magpie-Lark
	Anthus novaeseelandiae	Australasian Pipit

Family	Species	Common Name
Nectariniidae	Dicaeum hirundinaceum	Mistletoebird
Neosittidae	Daphoenositta chrysoptera	Varied Sittella
Pachycephalidae	Pachycephala inornata	Gilbert's Whistler
	Pachycephala pectoralis	Golden Whistler
	Pachycephala rufiventris	Rufous Whistler
	Colluricincla harmonica	Grey Shrike-thrush
	Oreoica gutturalis	Crested Bellbird
Pardalotidae	Pardalotus striatus	Striated Pardalote
Petroicidae	Microeca leucophaea	Jacky Winter
	Petroica goodenovii	Red-capped Robin
	Melanodryas cucullata	Hooded Robin
	Eopsaltria griseogularis	Western Yellow Robin
	Drymodes brunneopygia	Southern Scrub-robin
Pomatostomidae	Pomatostomus superciliosus	White-browed Babbler
Rhipiduridae	Rhipidura fuliginosa	New Zealand Fantail
	Rhipidura albiscapa	Grey Fantail
	Rhipidura leucophrys	Willie Wagtail
Podicipedidae	Tachybaptus novaehollandiae	Australasian Grebe
	Poliocephalus poliocephalus	Hoary-headed Grebe
Cacatuidae	Calyptorhynchus banksii	Red-tailed Black-Cockatoo
	Lophochroa leadbeateri	Major Mitchell's Cockatoo
	Eolophus roseicapillus	Galah
	Nymphicus hollandicus	Cockatiel
Psittacidae	Glossopsitta porphyrocephala	Purple-crowned Lorikeet
	Polytelis anthopeplus	Regent Parrot
	Platycercus icterotis xanthogenys	Western Rosella
	Barnardius zonarius	Australian Ringneck
	Psephotus varius	Mulga Parrot



F	amily	Species	Common Name
		Melopsittacus undulatus	Budgerigar
		Neophema elegans	Elegant Parrot

Family	Species	Common Name
Strigidae	Ninox novaeseelandiae	Southern Boobook
Tytonidae	Tyto alba	Barn Owl

Table 3. Mammals potentially found in the vicinity of the project area

Family	Species	Common Name
Bovidae	Capra hircus	Goat
Camelidae	Camelus dromedarius	Dromedary
Canidae	Canis lupus	Dingo/dog
	Vulpes vulpes	Red Fox
Felidae	Felis catus	House Cat
Molossidae	Austronomus australis	White-striped Freetail Bat
	Mormopterus planiceps	Southern Freetail-bat
Vespertilionidae	Chalinolobus gouldii	Gould's Wattled Bat
	Chalinolobus morio	Chocolate Wattled Bat
	Nyctophilus geoffroyi	Lesser Longeared Bat
	Nyctophilus major	Western Longeared Bat
	Scotorepens balstoni	Inland Broadnosed Bat
	Vespadelus baverstocki	Inland Forest Bat
	Vespadelus regulus	Southern Forest Bat
Dasyuridae	Antechinomys laniger	Kultarr
	Ningaui ridei	Wongai Ningaui
	Ningaui yvonneae	Mallee Ningaui
	Pseudantechinus woolleyae	Woolley's False Antechinus

Family	Species	Common Name
	Sminthopsis crassicaudata	Fat-tailed Dunnart
	Sminthopsis dolichura	Little Long-tailed Dunnart
	Sminthopsis gilberti	Gilbert's Dunnart
	Sminthopsis granulipes	White-tailed Dunnart
	Sminthopsis hirtipes	Hairy-footed Dunnart
Burramyidae	Cercartetus concinnus	Southwestern Pygmy Possum
Macropodidae	Macropus fuliginosus	Western Grey Kangaroo
	Macropus robustus	Wallaroo or Euro
	Macropus rufus	Red Kangaroo
Leporidae	Oryctolagus cuniculus	European Rabbit
Tachyglossidae	Tachyglossus aculeatus	Short-beaked Echidna
Muridae	Mus musculus	House Mouse
	Notomys alexis	Spinifex Hopping Mouse
	Notomys mitchellii	Mitchell's Hopping Mouse
	Pseudomys albocinereus	Ash-grey Mouse
	Pseudomys bolami	Bolam's Mouse
	Pseudomys hermannsburgensis	Sandy Inland Mouse



Table 4. Amphibians potentially found in the vicinity of the project area

Family	Species	Common Name
Limnodynastidae	Neobatrachus albipes	White-footed Trilling Frog
	Neobatrachus kunapalari	Kunapalari Frog
	Neobatrachus pelobatoides	Humming Frog

Family	Species	Common Name
	Neobatrachus sutor	Shoemaker Frog
Myobatrachidae	Pseudophryne guentheri	Crawling Toadlet
	Pseudophryne occidentalis	Western Toadlet

Table 5. Reptiles potentially found in the vicinity of the project area

Family	Species	Common Name
Agamidae	Ctenophorus adelaidensis	Southern Heath Dragon
	Ctenophorus cristatus	Bicycle Dragon
	Ctenophorus fordi	Mallee Sand Dragon
	Ctenophorus isolepis	Crested Dragon
	Ctenophorus maculatus	Spotted Military Dragon
	Ctenophorus ornatus	Ornate Crevice Dragon
	Ctenophorus reticulatus	Western Netted Dragon
	Ctenophorus salinarum	Salt Pan Dragon
	Ctenophorus scutulatus	
	Moloch horridus	Thorny Devil
	Pogona minor	Bearded Dragon
	Tympanocryptis cephalus	Pebble Dragon
Boidae	Antaresia stimsoni	Stimson's Python
	Aspidites ramsayi	Woma
	Morelia spilota imbricata	Carpet Python
Carphodactylidae	Nephrurus stellatus	
	Underwoodisaurus milii	Barking Gecko
Diplodactylidae	Crenadactylus ocellatus	Clawless Gecko
	Diplodactylus granariensis	

Family	Species	Common Name			
	Diplodactylus pulcher				
	Lucasium maini				
	Lucasium stenodactylus				
	Oedura reticulata				
	Strophurus assimilis	Goldfields Spiny-tailed Gecko			
	Strophurus elderi				
	Strophurus intermedius				
	Strophurus wellingtonae				
Elapidae	Acanthophis antarcticus	Southern Death Adder			
	Brachyurophis fasciolata				
	Brachyurophis semifasciata				
	Demansia psammophis				
	Echiopsis curta	Bardick			
	Furina ornata	Moon Snake			
	Neelaps bimaculatus	Black-naped Snake			
	Parasuta gouldii				
	Parasuta monachus				
	Pseudechis australis	Mulga Snake			
	Pseudonaja affinis	Dugite			



Family	Species	Common Name
	Pseudonaja mengdeni	Gwardar
	Pseudonaja modesta	Ringed Brown Snake
	Simoselaps bertholdi	Jan's Banded Snake
	Simoselaps semifasciata	
	Suta fasciata	Rosen's Snake
Gekkonidae	Gehyra purpurascens	
	Gehyra variegata	
	Heteronotia binoei	Bynoe's Gecko
	Rhynchoedura ornata	Beaked Gecko
Pygopodidae	Aprasia repens	
	Delma australis	
	Delma butleri	
	Delma nasuta	
	Lialis burtonis	
	Pygopus lepidopodus	Common Scaly Foot
	Pygopus nigriceps	
Scincidae	Cryptoblepharus buchananii	
	Ctenotus atlas	
	Ctenotus brooksi	
	Ctenotus leonhardii	
	Ctenotus mimetes	
	Ctenotus pantherinus	Leopard Skink
	Ctenotus schomburgkii	
	Ctenotus uber	
	Ctenotus xenopleura	
	Cyclodomorphus melanops	Slender Blue-tongue
	Egernia depressa	Pygmy Spiny-tailed Skink
	Egernia formosa	

Family	Species	Common Name
	Egernia richardi	
	Eremiascincus pallidus	Western Sand-swimming Skink
	Hemiergis initialis	
	Lerista gerrardii	
	Lerista kingi	
	Lerista macropisthopus	
	Lerista picturata	
	Lerista rhodonoides	
	Liopholis inornata	
	Menetia greyii	
	Morethia adelaidensis	
	Morethia butleri	
	Morethia obscura	
	Tiliqua occipitalis	Western Bluetongue
	Tiliqua rugosa	
Typhlopidae	Anilios australis	
	Anilios bicolor	
	Anilios bituberculatus	
	Anilios hamatus	
Varanidae	Varanus giganteus	Perentie
	Varanus gouldii	Bungarra or Sand Monitor
	Varanus tristis	Racehorse Monitor



4.5 Conservation significant fauna species

Species listed under the *EPBC Act 1999* or the *Wildlife Conservation Act (1950)* as being of conservation significance or are listed in the DPaW Priority and Threatened Species list and potentially in the vicinity of the project area are shown in Table 6.

Conservation significant fauna are protected by the Commonwealth *EPBC Act 1999*, and this list includes species covered by international treaties such as the Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA) and the Western Australia (WA) *Wildlife Conservation Act (1950)*. The WA *Wildlife Conservation Act (1950)* provides for the publishing of the *Wildlife Conservation (Specially Protected Fauna) Notice* that lists species under multiple categories. In addition, DPaW maintains a list of fauna that require monitoring under five priority headings based on DPaW's knowledge of their distribution, abundance and threatening processes (Appendix B). The *EPBC Act 1999* and *Wildlife Conservation Act (1950)* imply legislative requirements for the management of anthropogenic impacts to minimise the effects of disturbances on species and their habitats. Priority species have no statutory protection, other than the DPaW wishes to monitor potential impacts on these species. Environmental consultants and proponents of developments are encouraged to avoid and minimise impacts on these species. Definitions of the significant fauna under the *WA Wildlife Conservation Act (1950)* are provided in Appendix B.

4.5.1 Significant fauna species recorded or predicted for the project area

Four Threatened species of fauna and two migratory species of birds were identified under the *EPBC Act 1999* as potentially occurring in the project area. There are 11 Schedule species listed under the WA *Wildlife Conservation Act (1950)* and 11 priority species listed on the DPaW's Priority Fauna List that potentially occur in the project area. The following is an assessment of the likelihood of each of the species listed in Table 6 being found in the project area.



Table 6. Species that are potentially found in the vicinity of the project area and that are listed as being of conservation significance under state or commonwealth
government legislation or with DPaW.

Species	Status under the Wildlife Conservation Act / DPaW	Status under the EPBC Act	Comment on potential impact that vegetation clearing will have on conservation significant species
<i>Myrmecobius fasciatus</i> Numbat	Schedule 1	Vulnerable	Not recently recorded in the vicinity of the project area, so it is unlikely to be present in the project area. Impact potential very low.
Calyptorhynchus latirostris Carnaby's Black-Cockatoo	Schedule 1	Endangered	Not recently recorded in the vicinity of the project area, so it is unlikely to be present in the project area. Impact potential very low.
Leipoa ocellata Malleefowl	Schedule 1	Vulnerable	Potentially in the vicinity of the project area, but it was not recorded during the reconnaissance survey. Unlikely to be in the proposed disturbance area. Impact potential very low.
Dasyurus geoffroii Chuditch	Schedule 1	Vulnerable	Not recently recorded in the vicinity of the project area, so it is unlikely to be present in the project area. Impact potential very low.
Merops ornatus Rainbow Bee-eater	Schedule 3	Migratory	It has been recorded in numerous fauna surveys in the vicinity of the project area and could therefore be seen and breed in the project area. However, these birds will readily move out of the area if disturbed, so there is unlikely to be a significant impact. It could potentially breed in the sandy areas. Impact potential low.
Apus pacificus Fork-tailed Swift	Schedule 3	Migratory	The the Fork-tailed Swift may infrequently be seen in the vicinity of the project area, but is unlikely to be impacted as it is predominantly an aerial species and will readily move away from a disturbance. Impact potential very low.
Platycercus icterotis xanthogenys (Mallee) Western Rosella	Schedule 1		Could be found in the eucalypt woodland. It would readily move to adjacent undisturbed areas once vegetation clearing commences. Impact potential very low in a regional context.
Lophochroa leadbeateri Major Mitchell's Cockatoo	Schedule 4		Major Mitchell's Cockatoo could be in the general area. It would readily move to adjacent undisturbed areas once clearing commences. Impact potential very low in a regional context.
<i>Falco peregrinus</i> Peregrine Falcon	Schedule 4		The Peregrine Falcon may infrequently be observed in the project area, however, vegetation clearing is unlikely to have a significant impact on this species as there are plenty of similar habitats in adjacent areas and it will readily move from a disturbance area. Impact potential very low.
Aspidites ramsayi Woma	Schedule 4		Possibly in the project area, but based on the size of the areas to be disturbed, the impact potential is very low in a regional context.
Morelia spilota imbricata Carpet Python	Schedule 4		Not recently recorded in the vicinity of the project area, so it is unlikely to be present in the project area. Impact potential very low in a regional context.



Species	Status under the Wildlife Conservation Act / DPaW	Status under the EPBC Act	Comment on potential impact that vegetation clearing will have on conservation significant species
Acanthophis antarcticus Southern Death Adder	Priority 3		Unlikely to be in the project area. Impact potential very low in a regional context.
Hylacola cauta whitlocki Shy Heathwren	Priority 4		Could be found in the project area, however, it would readily move to adjacent undisturbed areas once clearing commences. Overall potential for impact is low, however, there may be localised impacts if a nest was disturbed.
Pseudomys occidentalis Western Mouse	Priority 4		Not recently recorded in the vicinity of the project area, so it is unlikely to be present in the project area. Impact potential very low.
<i>Oreoica gutturalis</i> Crested Bellbird	Priority 4		The Crested Bellbird could be seen in the project area, however, the clearing of vegetation in a section of the project area is unlikely to have a significant impact on this species. If present it will move to more suitable habitat in adjacent areas once vegetation clearing commences. Impact potential very low.
Burhinus grallarius Bush Stone-curlew	Priority 4		Very low possibility that it is in the general area and will readily move to an adjacent area if disturbed. Impact potential very low in a regional context.
<i>Nyctophilus(timoriensis)</i> sp. 1 Central Long-eared Bat	Priority 4		The project area is on the north-western boundary of its known distribution so it is potentially present in the area. The proposed clearing of vegetation in the project area is unlikely to have a significant impact on this species as it will readily move when disturbed, and they are likely to be in a similar abundance in adjacent areas. Impact potential very low.
Ardeotis australis Australian Bustard	Priority 4		Could occasionally be present. The proposed clearing of vegetation in the project area is unlikely to have a significant impact on this species as it will readily move when disturbed, and they are likely to be in a similar abundance in adjacent areas. Impact potential very low.
Charadrius rubricollis Hooded Plover (western subspecies)	Priority 4		Unlikely to be seen in the project area due to a lack of suitable habitat. Impact potential very low.
Calamanthus camestris montananellus Rufous Fieldwren	Priority 4		It was not reported in any of the other surveys in the vicinity of the project area, so it is unlikely to be present in the project area. Will readily move to an adjacent area if disturbed so impact potential is very low.
Macropus irma Western Brush Wallaby	Priority 4		Unlikely to be in the project area and if it was, it is unlikely that vegetation clearing will significantly impact on this species because it can easily move to adjacent undisturbed areas once clearing commences. Impact potential very low.
Isoodon obesulus fusciventer Quenda Priority 5			Unlikely to be in the project area and if it was, it is unlikely that vegetation clearing will significantly impact on this species because it can easily move to adjacent undisturbed areas once clearing commences. Impact potential very low.



4.5.2 Conservation significant species and potential impact on species of conservation significance

Numbat (*Myrmecobius fasciatus*) - Schedule 1 under the *Wildlife Conservation Act (1950)* and Vulnerable under the *EPBC Act 1999*.

Numbats were once present across southern semi-arid and arid Australia, including parts of NSW, SA and southern NT, as well as the south-west of Western Australia. In Western Australia, there are small residual populations at Dryandra and Perup, with recent translocations at Boyagin Nature Reserve, Tutanning Nature Reserve, Batalling block and Karroun Hill Nature Reserve (Friend 2008). Numbats are essentially solitary, forage during the day in winter and in the early morning and late afternoon in summer.

There is a very old record of a Numbat being found south of the project area, however, it is highly unlikely that they are now present in the project area. Therefore there is a very low possibility of impacting on this species.

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris***)** – Schedule 1 under the *Wildlife Conservation Act* (1950) and Endangered under the *EPBC Act* 1999.

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) is a large, pied, cockatoo. Garnett et al. (2011) and the DSEWPaC (2011) reported that Carnaby's Black-Cockatoo inhabits the south-west of Western Australia, from Kalbarri to as east on the south coast as Esperance. It breeds inland and moves to the coastal areas when chicks have fledged (Saunders et al. 1985). Carnaby's Black-Cockatoos are highly gregarious, usually seen in trios, small parties or large flocks (up to 5000 birds; Perry 1948). These flocks usually contain males, females and immature birds.

In some locations, breeding populations have decreased or become locally extinct (Saunders 1986, Saunders and Ingram 1987). For example, in the Coomallo Creek area north of Perth, Black-Cockatoos laid 74 clutches in 1973, 75 in 1974, 82 in 1975 but only 20 in 1994 and 19 in 1996 (Saunders and Ingram 1987). Saunders (1986) reported finding 13 nests at Manmanning in 1969 but by 1977, the species had stopped breeding in the area. Saunders (1990) reported failed nestings due to predation by a cat, galahs broke Carnaby's Black-Cockatoo eggs and took over nests, while other adult birds were killed by vehicles and Wedge-tailed Eagles (*Aquilla audax*).

Carnaby's Black-Cockatoos are partly migratory and partly sedentary (Higgins 1999). In the drier regions of their geographic range where most of the native vegetation has been cleared (e.g. wheatbelt), Carnaby's Black-Cockatoos are postnuptial migrants (Saunders 1980, Saunders and Ingram 1995). After breeding, individuals in these areas migrate to feed in higher rainfall areas including the Swan Coastal Plain, and to a lesser extent, forests dominated by *E. marginata* (Jarrah), *C. calophylla* (Marri) and *E. diversicolor* (Karri; Saunders 1980).

Garnett et al. (2011) estimated there were between 10,000 and 60,000 birds in the population.

Carnaby's Black-Cockatoo breed between July and November mostly in eucalypt woodland (Saunders 1980, 1986). Carnaby's Black-Cockatoo nest in tree hollows that are created by fire, fungi, termites or old age, with hollows between 2.5 and 12m above the ground (Saunders 1979, Higgins 1999). Hollows are large, ranging from 10 to over 250cm in depth (Higgins 1999). These hollows are usually in live or dead smooth-barked *Eucalyptus salmonophloia* (Salmon Gum) or *Eucalyptus wandoo* (Wandoo). However, Carnaby's Black-Cockatoo will also nest in *E. longicornis* (Red Morrell), *E. loxophleba* (York Gum), *E. gomphocephala* (Tuart), *E. rudis* (Flooded Gum), *E. salubris* (Gimlet), *E. occidentalis* (Swamp Yate) and *C. calophylla* (Higgins 1999). Eggs are laid on a mat of wood chips chewed from the sides of the hollow. Clutches are 1-2, but most often only one chick is raised. Incubation takes 29 days, and only the female incubates and broods (Johnstone and Kirkby 2011). Initially the female will return to the nest mid-morning to feed the chick, but after about 2-3 weeks both parents leave in the early morning and return late evening.



Young remain with their parents until the parents return to the breeding area in the following year (Saunders 1980). Immature birds probably do not move into the breeding areas until they are ready to breed, although little is known of the movements of immature Carnaby's Black-Cockatoo until they are ready to breed (Saunders 1977).

Saunders (1980) reported Carnaby's Black-Cockatoo at Coomallo Creek (breeding area) foraged mostly on native plants, with the only exception being *Erodium* sp.. Higgins (1999) reported the habitat of Carnaby's Black-Cockatoo was uncleared or remnant woodlands dominated by *Eucalyptus*, particularly *E. wandoo* and *E. salmonophloia* and often in shrubland or kwongan heathland dominated by *Hakea*, *Dryandra*, *Banksia* and *Grevillea* and seasonally in *Pinus* plantations and less often in *C. calophylla*, *E. diversicolor* or *E. marginata*.

The project area is outside the eastern fringe of their normal geographic distribution (Johnstone and Storr 1998), however, Davies (1966) reported Carnaby's Cockatoo as far east as Norseman, but this was a rare occurrence and given the recently reported reduction in the population and contraction in its range (Department of Sustainability Environment Water Population and Communities 2012), it is unlikely to be seen this far east again. Terrestrial Ecosystems' assessment is that they are unlikely to be present in the vicinity of the project area.

Malleefowl (*Leipoa ocellata*) - Schedule 1 under the *Wildlife Conservation Act (1950)* and Vulnerable under the *EPBC Act 1999*.

Malleefowl are relatively large, mostly terrestrial birds that tend to be sedentary, nesting in the same general area year after year (Frith 1962a, Priddel and Wheeler 2003). Density of the birds is generally highest in areas of higher rainfall and on more fertile soils (Frith 1962a, Copley and Williams 1995, Benshemesh 2007) and where shrub diversity is greatest (Woinarski 1989). Malleefowl are now primarily found in semi-arid and arid shrublands and low woodlands dominated by mallee (*Eucalyptus* sp.) in the more temperate areas (Frith 1962b, a). Grazed areas generally have lower densities (Benshemesh 2007).

A sandy or gravelly substrate and abundance of leaf litter are requirements for the construction of the birds' incubator mounds (Frith 1959, 1962a). Jones and Goth (2008) indicated malleefowl mounds were 60-90cm high and 3.7m wide, however, there is considerable variability in the size, which is often influenced by how often the mound has been used. Malleefowl frequently use already constructed mounds instead of building a new mound each year (Priddel and Wheeler 2003). Malleefowl that reuse an existing mound tend to rake more material from the surrounding area each year on to the existing mound, with the consequence that some of the older mounds are higher than 100 cm and wider than 5m. Density of the canopy cover is an important feature associated with high breeding densities (Frith 1962a, Benshemesh 2007) and it is this dense mallee vegetation that can make ground searches for malleefowl mounds difficult.

Malleefowl have been recorded in other fauna surveys in the vicinity of the project area (Appendix A), however, no evidence (e.g. tracks or mounds) of Malleefowl were found in the project area. It is therefore Terrestrial Ecosystems' assessment that the project area does not contain active Malleefowl mounds, although it is possible that Malleefowl are in the general area.

Chuditch (Dasyurus geoffroii) – Schedule 1 under the Wildlife Conservation Act (1950) and Vulnerable under the EPBC Act 1999.

The Chuditch is the largest carnivorous marsupial in Western Australia (WA). It is usually active from dusk to dawn. Formally known from over 70% of Australia, the Chuditch now has a patchy distribution throughout the Jarrah forest and mixed Karri/Marri/Jarrah forest of south-west WA and other isolated areas (Serena and Soderquist 2008). Chuditch are solitary animals for most of their life and den in hollow logs, burrows, culverts, etc and have also been recorded in tree hollows and rock cavities. Chuditch are opportunistic feeders, and forage primarily on the ground at night. Their diet can include other mammals, birds, lizards, bird and reptile eggs but the majority is a mixture of large invertebrates (e.g. spiders, scorpions and crickets; Serena and Soderquist 2008).

The Terrestrial Ecosystems fauna survey database has historical records of a Chuditch west of the project area. They have been recorded in similar habitat around Forrestania, but there are no recent records in the vicinity of the project



area. Based on the available data it is Terrestrial Ecosystems assessment that Chuditch is unlikely to be found in the project area as it is now outside its known geographical distribution.

Rainbow Bee-eater (Merops ornatus) - Migratory under the EPBC Act 1999.

The Rainbow Bee-eater is widespread during late spring and summer in the southern section of WA, particularly in sandy areas that have access to water. This migratory bird inhabits open woodlands and forests, semi-arid scrub, grasslands but avoids dense forests (Morcombe 2003). This species was recorded in numerous fauna surveys in the vicinity of the project area (Appendix A), and could therefore be seen and breed in the Sandy Ridge project area if conditions were suitable. However, these birds will readily move out of the area if disturbed, so there is unlikely to be a significant impact. It could potentially breed in the sandy areas.

Fork-tailed Swift (Apus pacificus) - Migratory under the EPBC Act 1999 and Schedule 3 under the Wildlife Conservation Act (1950).

The Fork-tailed Swift breeds in north-east and mid-east Asia and winters in Australia and New Guinea. It arrives in the Kimberley in late September and in central and southern WA in November and leaves in late April. The Fork-tailed Swift may be an infrequent visitor to the area although it has not been recorded in previous surveys. This swift is found in a variety of habitats from rainforest to semi-desert and is often recorded ahead of a major summer storm (Morcombe 2003).

It is Terrestrial Ecosystems' assessment that the Fork-tailed Swift may infrequently be seen in the vicinity of the project area, but is unlikely to be impacted by the proposed mine as it is predominantly an aerial species and will readily move away from a disturbance.

Western Rosella (Platycercus icterotis xanthogenys) - Priority 4 with DPaW.

The mallee form of the Western Rosella is found mostly in Eucalypt and Casuarina woodland and shrublands, especially Wandoo, Flooded Gums and Salmon Gums. This species was sighted by McKenzie and Rolfe (1995b) during the Boorabbin-Southern Cross biological survey, but it was not seen in any of the other fauna surveys around the Sandy Ridge project area (Appendix A). Based on his surveys around Yellowdine, Prof. H. Recher (pers. comm.) suggested that this species is sparse throughout the Great Western Woodland and they probably nested in the woodlands. Johnstone and Storr (1998) indicate that the project area is north of its known distribution, so it is unlikely to breed in the project area. Given that the proposed clearing represents a very small fraction of similar habitat in the area, it is Terrestrial Ecosystems' assessment that the proposed clearing in the project area is unlikely to have a significant impact on this species.

Major Mitchell's Cockatoo (Lophochroa leadbeateri) – Schedule 4 under the Wildlife Conservation Act (1950)

Major Mitchell's Cockatoo's geographic distribution includes some of the semi-arid and arid zones of Australia. It has a disjunct geographic distribution in WA with a population in the semi-arid area east of Geraldton to include Lake Moore and Lake Barlee. Major Mitchell's Cockatoo is most often seen high in the branches of Salmon Gums (*Eucalyptus salmonophloia*) and other large eucalypts, in heavily timbered creek-lines or roadside verges in various parts of the WA wheatbelt. Major Mitchell's Cockatoo breeds in the hollows of large eucalypts (Rowley and Chapman 1991). It is scarce throughout most of WA and the primary cause for its decline is land clearing for agriculture and subsequent fragmentation of remaining habitat. There is a small population that is seen around Southern Cross, and they are frequently seen north of Southern Cross. Based on numerous surveys around Yellowdine, Prof. H Recher (pers. comm.), suggested that they forage in the agricultural areas and the kwongan.

The most significant potential impact on this species would be the removal of trees that contained nests with eggs or chicks. However, there is no evidence to indicate that it nests in the vicinity of the project area. Clearing of trees outside of the breeding period (August – October) will minimise the potential impact on this species. It is Terrestrial Ecosystems' assessment that the proposed vegetation clearing in the project area is unlikely to have a significant impact on this species.



Peregrine Falcon (Falco peregrinus) - Schedule 4 Wildlife Conservation Act (1950).

The Peregrine Falcon is uncommon, although widespread throughout much of Australia excluding the extremely dry areas and has a wide and patchy distribution. It favours hilly or mountainous country and open woodlands and may be an occasional visitor to the project area. Nesting sites include ledges along cliffs, granite outcrops and quarries, hollow trees near wetlands and old nests of other large bird species (Johnstone and Storr 1998). There is no evidence to suggest any change in status in the last 50 years. Peregrine Falcons were recorded during numerous fauna surveys in the bioregion (Appendix A), so they are in the area.

It is Terrestrial Ecosystems' assessment that the Peregrine Falcon may infrequently be observed in the project area, however, vegetation clearing is unlikely to have a significant impact on this species as there are plenty of similar habitats in adjacent areas and it will readily move from a disturbance area.

Woma (southern form: Aspidites ramsayi) – Schedule 4 under the Wildlife Conservation Act (1950).

This python was once common in a crescent shaped distribution from Shark Bay through the wheatbelt to Kitchener. The Western Australian Museum has records of them being caught in the vicinity of the Great Eastern Highway from around Southern Cross and east toward Coolgardie (Thompson and Thompson 2006). The published literature indicates it is now only found around Shark Bay and east of Kalgoorlie.

Terrestrial Ecosystems is aware of another small population on the sand plain near the project area, in habitat similar to that in the project area. It is therefore potentially in the project area in low numbers, but because of the abundance of similar habitat in adjacent areas, any impacts on this species are unlikely to be significant in a regional context.

Carpet Python (Morelia spilota imbricata) - Schedule 4 under the Wildlife Conservation Act (1950).

The Carpet Python is a large snake found across the south-west of WA, north to Geraldton and Yalgoo, and east of Kalgoorlie, Fraser Range and Eyre (Thompson and Thompson 2006, Browne-Cooper 2007). It inhabits forest, heath or wetland areas and shelters in hollow logs or in branches of large trees. It feeds on a variety of vertebrates including small mammals and reptiles. Carpet Python assemblages are generally found in low numbers and are dispersed across a relatively large area, except during the breeding season when aggregations have been recorded.

There are old records in Terrestrial Ecosystems fauna survey database of Carpet Pythons being found in the vicinity of the project area. However, they have not been found during any recent surveys (see Appendix A), so if they are present, then its numbers are likely to be very low. Given its wide distribution and the abundance of similar habitat in adjacent areas, any impacts on this species are unlikely to be significant in a regional context.

Southern Death Adder (Acanthophis antarcticus) - Priority 3 with DPaW

The Southern Death Adder is a very cryptic snake that is found from the Darling Range, central wheatbelt and from Esperance across the Nullarbor Plain to the South Australian border (Cogger 2014). It is rarely caught in fauna surveys and only opportunistically encountered on roads and in undisturbed bushland at night. Jason Fraser caught a single specimen north of Bungalbin Hill on the sand plain, in habitat similar to that in the project area. They are rarely encountered in the Southern Cross bioregion, and therefore unlikely to be seen in the project area.

Shy Heathwren (Hylacola cauta whitlocki) – Priority 4 with DEC.

The Shy Heathwren is a small ground species that is found in the semi-arid interior of WA, including much of the southern wheatbelt. Its habitat includes dense shrub and heathlands in the understorey of eucalypt woodlands, often on sandy soils. Johnstone and Storr (2004) recorded it as locally moderately common or common, but generally scarce or uncommon and patchily distributed, and reported that the project area is within its geographic distribution.

The Shy Heathwren was recorded during surveys by McKenzie and Rofle (1995) and Lyons and Chapman (1997) and could be expected across the region, however, it is likely to be confined to very specific habitats.



Given that the proposed land clearing represents a very small fraction of similar habitat in the area, it is Terrestrial Ecosystems' assessment that the proposed clearing in the project area is unlikely to have a significant impact on this species. If it is in the area then it will move once vegetation clearing commences.

Western Mouse (Pseudomys occidentalis) is classified as Priority 4 under the WA Wildlife Conservation Act 1950.

Kitchener and Chapman (1977) described the Western Mouse's preferred habitat as tall shrub land with mallee eucalypts and a heath understorey on a substrate of gravelly loam. Van Dyck and Strahan (2008) reported its geographic distribution to being confined to unburnt areas on sandy clay loam or sandy loam in dense vegetation.

There is a very old record of the Western Mouse in the vicinity of the project area in the DPaW's threatened and priority species database, however, it has not been recorded in any of the more recent surveys, so it is Terrestrial Ecosystems' view that it is unlikely to be in the project area. Potential impacts on this species are therefore likely to be very low.

Crested Bellbird (Oreoica gutturalis gutturalis) - Priority 4 with DPaW

Johnstone and Storr (2004) reported the geographic distribution for the Crested Bellbird to include the greater part of WA. Its preferred habitat is scrub and thickets (but not near edges). In the south-west of WA it is found mostly in wooded areas, including open Banksia scrub and heathland. It has been recorded in numerous fauna surveys in the bioregion (Appendix A). It is Terrestrial Ecosystems' assessment that the Crested Bellbird could be seen in the project area.

It is Terrestrial Ecosystems' assessment that the proposed clearing of vegetation in a section of the project area is unlikely to have a significant impact on this species. If the Crested Bellbird is in the area then it will move to more suitable habitat in adjacent areas and will not be significantly impacted on by small scale vegetation clearing.

Bush Stone-curlew (Burhinus grallarius) - Priority 4 species with DPaW

The Bush Stone-curlew is a large bird that is often found in lightly wooded areas (Johnstone and Storr 1998). The Bush Stone-curlew demonstrates some site fidelity but its home range appears quite large. There are no records of the Bush Stone-curlew in any of the other fauna surveys in the vicinity of the project area, however, it is a very cryptic species and often not recorded in surveys when present in the area. It is Terrestrial Ecosystems' view that the Bush Stone-curlew may be seen infrequently in the project area, but will readily move away from a disturbance and is unlikely to be impacted by the proposed development.

Central Long-eared Bat (Nyctophilus (timorensis) sp.) - Priority 4 with DPaW

This species is probably the species referred to by Churchill (2008) as the Central Long-eared Bat (*Nyctophilus* sp. 1). This species is distributed across the southern and central wheatbelt, southern part of the Great Victoria Desert and the Nullarbor coast. The project area is on the north-western boundary of its known distribution. It roosts in tree cavities, foliage and under loose bark.

It is Terrestrial Ecosystems' assessment that the proposed clearing of vegetation in the project area is unlikely to have a significant impact on this species as it will readily move when disturbed, and they are likely to be in a similar abundance in adjacent areas.

Australian Bustard (Ardeotis australis) – Priority 4 with DPaW

The Australian Bustard is a large, long-lived, sexually dimorphic bird with males standing 110-120cm tall and females 80-90cm tall with large birds weighing up to 10kg (Ziembicki 2010). It is widely distributed on mainland Australia except for most of Victoria and eastern NSW. This bird has a broad habitat preference for open areas ranging from grassland and treeless plains, savannah, croplands, golf courses and airfields. Is partially



migratory/nomadic moving around the Australian continent is search of resources (Ziembicki 2010). Although not previously recorded in fauna survey in the vicinity of the project area it could occasionally be present.

It is Terrestrial Ecosystems' assessment that the proposed clearing of vegetation in the project area is unlikely to have a significant impact on this species as it will readily move when disturbed, and they are likely to be in a similar abundance in adjacent areas.

Hooded Plover (Charadrius rubricollis) - Priority 4 species with DPaW

This species frequents the margins and shallows of salt lakes, and also along coastal beaches, where it forages for invertebrates. It is found along the southern coast and salt lakes north to Port Gregory, Three Springs, Mt Gibson, Lake Brown, Lake Barlee, Lake Cowan and Eyre (Johnstone and Storr 1998). It is an uncommon to common resident on the southern sea beaches from Cape Naturaliste east to Eyre. It probably breeds in the samphire habitat along the boundary of some of the salt lakes in the bioregion.

It is Terrestrial Ecosystems' assessment that it is unlikely to be seen in the project area due to a lack of suitable habitat.

Rufous Fieldwren (Calamanthus camestris montananellus) - Priority 4 with DPaW

The Rufous Fieldwren's geographic distribution extends from Exmouth south to Dongara along the coast and then in the eastern part of the wheatbelt and along the southern coast to Eyre (Johnstone and Storr 2004). Its known geographical distribution includes the Sandy Ridge Project. It has a preference for heaths and other low shrubland on sand plains and lateritic ridges, shrub steppes (Maireana, Atriplex and Halosarcia samphires) on limestone plains and around salt lakes (Johnstone and Storr 2004). It was not reported in any of the other surveys in the vicinity of the project area, so it is unlikely to be present in the project area.

Western Brush Wallaby (Macropus irma) - Priority 4 species with DPaW

Western Brush Wallabies distribution once extended to near the project area, but there are no recent records around the project area. It has a preference for open forests or woodlands, often near a water source and scrubby thickets. It was found in mallee and heathland in the wheatbelt (Morris and Christensen 2008). There is a lack of recent records in the vicinity of the project area indicating it is no longer present, and therefore unlikely to be present in the project area. It is Terrestrial Ecosystems' view, the Western Brush Wallaby is unlikely to be seen in the project area and therefore not impacted by the proposed development.

Southern Brown Bandicoot or Quenda (Isoodon obesulus fusciventer) - Priority 5 species with DPaW

Quenda prefer dense scrub (up to one metre high), often in or near swampy or wetland vegetation. It will often feed in adjacent forest and woodland that is burnt and in areas of pasture and cropland lying close to dense cover (Paull 2008). Southern Brown Bandicoots have not been recorded in the vicinity of the project area for a long time, so, it is Terrestrial Ecosystems' view that Southern Brown Bandicoots are unlikely to be in the project area, and thus impacted by the proposed development.

4.6 Risk assessment

Fauna surveys to support Environmental Impact Assessments (EIA) are part of the environmental risk assessment undertaken to consider what potential impacts a development might have on the biodiversity of a particular area and region. Potential impacts on fauna from the proposed development are identified and briefly described above. Tables 7, 8 and 9 provide a summary of the risk assessment associated with this project.

The assessment contained in Table 9 is supported by more detail discussion in sections above and the management recommendations below.



Table 7. Fauna impact risk assessment descriptors

Any risk assessment is a product of the likelihood of an impact occurring and the consequences of that impact. Likelihood and consequences are categorised and described below. These criteria do not fit all circumstances (e.g. adequacy of fauna survey data), however, they are useful in providing the reader with an appreciation of the level of likelihood and consequences of an event. The assessed risk level (likelihood x consequences) is then calculated as the overall risk for the development. This is followed by an assessment of the acceptability of the risk associated with each of the events or impacts. Disturbances and vegetation clearing have an impact on the fauna at multiple scales – site, local, landscape and regional. Each of these is considered in the risk assessment. This assessment should be considered in the context of the summary in Table 9.

			Likelihood			
Level	Des	scription Criteria				
A Rare The environmental event may occur or one or more conservation significant species may be present in exceptional circumstances.						
В	U	nlikely	The environmental event could occur or one or more conservation significant species could be present at sometime.			
С	M	oderate	The environmental event should occur or one or more conservation significant species should be present at sometime.			
D	Ι	Likely	The environmental event will probably occur or one or more conservation significant species will be present in most circumstances.			
E	Almo	ost certain	The environmental event is expected to occur or one or more conservation significant species is expected be present in most circumstances.			
Conseque	ences					
Level	Des	scription	Criteria			
1	Insi	gnificant	Insignificant impact on fauna of conservation significance or regional biodiversity, and the loss of individuals will be insignificant in the contex of the availability of similar fauna or fauna assemblages in the area.			
2	N	Minor	Impact on fauna localised and no significant impact on species of conservation significance in the project area. Loss of species at the local scale.			
3		oderate	An appreciable loss of fauna in a regional context or a limited impact on species of conservation significance in the project area.			
4	Ν	Major	Significant impact on conservation significant fauna or their habitat in the project area and/or regional biodiversity and/or a significant loss in the biodiversity at the landscape scale.			
5	Cata	astrophic	Loss of species at the regional scale and/or a significant loss of species categorised as 'vulnerable' or 'endangered' under the <i>EPBC Act 1999</i> at a regional scale.			
			Acceptability of Risk			
Level o	of risk	Managemen	nt of risk			
Low		No action re	equired.			
Moderate	;		ssible, routine management with internal audit and review of monitoring results annually.			
High			pproved management plan to reduce risks, monitor major risks annually with external audit and review of management plan outcomes annually. a referral to the Commonwealth under the <i>EPBC Act 1999</i> .			
Extreme						



				Likelihood			
		Rare or very low (A)	Unlikely or low (B)	Moderate (C)	Likely (D)	Almost certain (E)	
	Insignificant (1)	Low	Low	Low	Low	Low	
SS	Minor (2)	Low	Low	Low	Moderate	Moderate	
Consequences	Moderate (3)	Moderate (3) Low		Moderate	High	High	
C	Major (4) Moderate		Moderate	High High		Extreme	
	Catastrophic (5) Moderate		High	High	Extreme	Extreme	

Table 8. Levels of acceptable risk



Table 9. Risk assessment

			Before Management				With Management		
Factor	Potential Impact		Inherent Risk		Risk Controls / Management		Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance	
Inadequate fauna survey data.	Unknown loss of fauna, fauna of conservation significance, fauna assemblage(s) in project area.	С	2	Low					
Inadequate knowledge of potential impacts.	Unknown or poorly assessed impact(s) on fauna assemblage and conservation significant species.	В	2	Low					
Inadequate bioregional data for contextual purposes.	Incomplete analysis of data and appreciation of impacts on biodiversity values in a regional context.	В	2	Low					
Removal of habitat – site scale.	Almost complete loss of terrestrial fauna in cleared areas, severe impact on local fauna assemblage.	Е	1	Low					
Significant reduction of habitats – local scale.	Loss of fauna and fauna habitat and impacts on local fauna assemblage (excluding conservation significant species).	В	1	Low					
Significant reduction of habitats – landscape scale.	Loss of fauna and fauna habitat and impacts on fauna in a landscape context (excluding conservation significant species).	A	1	Low					
Significant reduction of habitats – regional scale.	Loss of fauna and fauna habitat and impacts on fauna in a bioregional context (excluding conservation significant species).	А	1	Low					



		Before Management				With Management		
Factor	Potential Impact	Inherent Risk			Risk Controls / Management	Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
Loss of conservation significant species	Loss of a localised population or a few individuals – <i>Leipoa ocellata</i> .	А	3	Low				
	Loss of a localised population or a few individuals – <i>Platycercus icterotis xanthogenys</i> .	А	3	Low				
	Loss of a localised population or a few individuals – <i>Lophochroa leadbeateri</i> .	А	3	Low				
	Loss of a localised population or a few individuals – <i>Morelia spilota imbricata</i> .	Α	2	Low				
	Loss of a localised population or a few individuals – <i>Pseudomys occidentalis</i> .	А	2	Low				
	Loss of a localised population or a few individuals – <i>Acanthophis antarcticus</i> .	В	2	Low				
	Loss of a localised population or a few individuals – <i>Aspidites ramsayi</i> .	С	2	Low				
	Loss of a localised population or a few individuals – Oreoica gutturalis gutturalis.	В	2	Low				
	Loss of a localised population or a few individuals – <i>Nyctophilus(timoriensis)</i> sp.	А	2	Low				
	Loss of a localised population or a few individuals – <i>Macropus irma</i> .	А	2	Low				



		Before Management				With Management		
Factor	Potential Impact	Inherent Risk		ent Risk	Risk Controls / Management	Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
	Loss of a localised population or a few individuals – <i>Isoodon obesulus</i> <i>fusciventer</i>	А	2	Low				
	Loss of a localised population or a few individuals – <i>Calamanthus camestris montananellus</i> .	А	2	Low				
	Loss of a localised population or a few individuals – <i>Falco peregrinus</i> .	А	2	Low				
	Loss of a localised population or a few individuals – <i>Dasyurus geoffroii</i> .	А	2	Low				
	Loss of a localised population or a few individuals – <i>Hylacola cauta whitlocki</i>	Α	2	Low				
	Loss of a localised population or a few individuals – <i>Burhinus grallarius</i> .	А	2	Low				
Nomadic avian species	Loss of a localised population or a few individuals – <i>Ardeotis australis</i> .	А	2	Low				
Migratory avian species.	Loss of a localised population or a few individuals – <i>Merops ornatus</i> .	В	2	Low				
	Loss of a localised population or a few individuals – <i>Apus pacificus</i> .	А	2	Low				
Anthropogenic activity	Altered fire regimes adversely affecting fauna assemblages.	В	2	Low				
	Introduced fauna populations increasing.	С	2	Low				
	Road kills.	E	2	Low				



5 **DISCUSSION**

5.1 Adequacy of available vertebrate fauna data

The EPA Terrestrial Biological Surveys as an Element of Biodiversity Protection: Position Statement No. 3 (EPA 2002), Guidance Statement for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia No. 56 (EPA 2004) and the Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA / DEC 2010) are the three relevant regulatory documents to assess the adequacy of the available information and reporting for vertebrate fauna surveys in Western Australia.

Tellus proposes to develop a kaolin mine with complimentary storage and waste isolation facilities at its Sandy Ridge Project. There is an abundance of similar fauna habitat in very good to excellent condition in adjacent areas. Fauna survey data for Jackson-Kalgoorlie and the Boorabbin-Southern Cross sections of the Eastern Goldfields biological surveys (Dell and How 1985, McKenzie and Rolfe 1995a), plus fauna survey data from other surveys to support mining proposals (Ecologia Environmental Consultants 2001, 2003, Ninox Wildlife Consulting 2008, 2009b, a) and for research purposes (Dickman et al. 1991, Lyons and Chapman 1997) provide an adequate indication of the fauna assemblages likely to be encountered in the project area.

5.2 Biodiversity values of the project area

The EPA Position Statement No. 3 indicates an ecological assessment of a project must consider its biodiversity value at the genetic, species and ecosystem levels, and its ecological functional value at the ecosystem level (EPA 2002). There are insufficient data available to consider biodiversity at the genetic level.

Fauna habitat types represented in the project area are abundant and in very good condition in adjacent areas. Therefore, the fauna assemblage that is present in the project area will also be present and abundant in the adjacent areas. The available fauna survey data (Appendix A) provides a good indication of the vertebrate fauna that are potentially in the project area.

5.2.1 Condition of fauna habitat and extent of habitat degradation

There were two broad habitats available in the project area. These are an open eucalypt woodland with an open understorey of shrubs over ephemeral grasses or scattered spinifex on red sandy clay soils, and a moderately dense to dense sand plain shrubland varying in height from 0.5-1.8m on yellow sandy soils. Both habitats are in very good to excellent condition. Small sections have been degraded by exploration tracks and activity, and the presence of foxes and possibly cats will have impacted on the small vertebrate fauna.

5.2.2 Ecological linkages

The project area currently does not provide any important ecological linkages or fauna movement corridors, as it is part of a large and relatively undisturbed area. There are exploration tracks that dissect the project area, but all are relatively narrow and are unlikely to provide a barrier that would inhibit the movement of fauna within the general area.

5.2.3 Conservation significant species

The listed avian species of conservation significance potentially seen in the project area are the Major Mitchell's Cockatoo, Western Rosella, Peregrine Falcon, Australian Bustard, Crested Bellbird, Shy Heathwren, Bush Stonecurlew, Malleefowl, the migratory Rainbow Bee-eater and the Fork-tailed Swift. These birds would readily move from the area if disturbed by vegetation clearing. The only potential impact would be clearing a tree that contained eggs or chicks, and the likelihood of this happening is assessed as very low.

The Western Brush Wallaby, Southern Brown Bandicoot, Chuditch, Western Mouse and Carpet Python are unlikely to be in the project area and thus impacted by the proposed development. There is a possibility that the Woma Python is present in low numbers, but it will also be present in adjacent areas, so any impacts are likely to be non-significant in a regional context.



5.2.4 Great Western Woodland

The project area is within the Great Western Woodland (Department of Environment and Conservation 2010) which is an area of special interest to the Wilderness Society and the DPaW. Currently, there are no specific management strategies in place that focus on the vertebrate fauna, however, the proposed state government management strategies for pest and fire will have an indirect impact if and when they are implemented.

Conservation groups are keen for the Great Western Woodland to be preserved and will continually put pressure on DPaW and environmental regulators to limit development in this area.

5.3 Potential impacts on fauna

Clearing of vegetation will potentially affect vertebrate fauna in a number of ways, including:

- Death/injury of fauna during clearing, grading and impacts with vehicles;
- Loss of habitat;
- Fragmentation of habitat;
- Increase in feral fauna around the mining development; and
- Disturbance of fauna in nearby areas from light, noise and dust.

These impacts are discussed below.

5.3.1 Direct impacts

5.3.1.1 Animal deaths during the clearing process and displacement of fauna

Clearing vegetation and construction activities will result in the loss of most small fauna that retreat to burrows, such as reptiles and mammals. Nocturnal species are unlikely to be active when most of the land clearing and construction work is taking place which will inevitably result in these individuals being killed or injured in their burrows or as they attempt to escape. Larger terrestrial animals and avian species will most often move to adjacent areas. These species will be required to establish new activity areas and home ranges, and this could result in the temporary displacement of resident species. However, long-term impacts are likely to be low.

5.3.1.2 Reduction or loss of activity areas and closure of burrows

Clearing vegetation and associated construction activities are likely to destroy reptile and mammal burrows or foraging habitat that are currently in use, or could be used again. Clearing vegetation that forms part of the activity area of individuals has the potential to force these animals into adjacent areas. These areas may offer fewer resources placing individuals under survival pressure. It could also cause individuals to move into the territories of other individuals increasing competition for resources. Forced relocations could increase the possibility of predation.

5.3.2 Indirect impacts

In addition to the obvious impact of vegetation clearing there can be an equally significant or greater impact in the adjacent areas because of 'edge effects'. Edge effects include disruption to ecological processes such as predation and dispersal, animal movements and can change assemblage structure. The consequence is that the impact area will always be much larger than the cleared area. Vehicle tracks also have the propensity to develop weed infestations which can impact on natural fauna habitats. Cleared corridors can also provide improved predator access to areas, enhance the invasion of pest species into areas and may act as inhibitors or disrupt fauna migration and movement patterns.

There are numerous potential threats associated with vegetation clearing and the construction of infrastructure that could have a significant impact on the vertebrate fauna in the project area. Some of these are discussed below.

5.3.2.1 Habitat fragmentation



In addition to vegetation clearing, infrastructure including tracks, has the potential to fragment habitat. Cleared linear tracks of land are 'unnatural' in much of the habitat. These linear structures that partition existing activity areas, isolate sections of established communities and may alter long and medium-term patterns of movement around established home ranges particularly for small mammals and reptiles. A reduction in the population as a result of this infrastructure would be difficult to detect given our current knowledge of the spatial ecology for most of the small mammals known to be in the area.

As most of the tracks within the project area will be relatively narrow, the potential impact associated with habitat fragmentation is likely to be low.

5.3.2.2 Introduced fauna

An increase in human activity is often associated with an increase in the abundance of introduced species such as the house mouse (*Mus musculus*), cat (*Felis catus*) and wild dogs (*Canis lupus*). This increase may be due to a decline in habitat health, increased road kills, poor disposal of waste and easier access to areas via tracks.

House mice, cats and wild dogs are known to be established in the area. In many situations they have become a 'naturalised' species in the Australian bush. Increases in dog or cat numbers can have a detrimental impact on native fauna because they predate on and compete with native species, severely disrupting the natural balance.

Infrastructure known to support feral species, such as rubbish disposal sites and bins, should be managed to minimise increases in these populations.

5.3.2.3 Road fauna deaths

An increase in road fauna deaths is likely to occur where new roads are constructed or upgraded, in particular, affecting kangaroos, nocturnal birds and ground dwelling large carnivorous predators. Species such as goannas and raptors are attracted to carrion on road verges. Therefore, there is an increased propensity for these species to be killed by vehicles.

5.3.2.4 Anthropogenic activity

Unnatural noises, vibrations, artificial light sources and vehicle and human movement in an area may be sufficient to force individuals or fauna species to move from an area, or alter their activity periods.

5.4 Native vegetation clearing principles

The *Environmental Protection Act (1986)* provides criteria to judge the potential impact of a development on clearing native vegetation on flora and fauna. These criteria have been listed below with a response to indicate how clearing of the vegetation at the Sandy Ridge Project might be judged against these principles as they relate to fauna and fauna assemblages.



Table 10. Assessment of impact on fauna and fauna assemblages using the Native Vegetation Clearing Principles

Principle	Response
It comprises a high level of biological diversity.	Clearing vegetation will not compromise a high level of biodiversity.
It comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	The project area does not contain habitat that is necessary for fauna indigenous to Western Australia
It includes, or is necessary for the continued existence or, rare flora.	Not applicable.
It comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	The area does not contain a threatened ecological community.
It is significant as a remnant of native vegetation in an area that has been extensively cleared.	The area is not a remnant nor will the proposed clearing create a remnant.
It is growing in, or in association with, an environment associated with a watercourses or wetland.	The proposed impact area does not contain a wetland.
The clearing of the vegetation is likely to cause appreciable land degradation.	Not applicable.
The clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby	Clearing of vegetation is unlikely to impact on the environmental values of the
conservation area. The clearing of the vegetation is likely to cause deterioration	bioregion. Not applicable.
in the quality of surface or underground water. The clearing of the vegetation is likely to cause, or exacerbate the incidence of flooding.	Not applicable.



6 MANAGEMENT STRATEGIES

6.1.1 Induction and awareness

All contractors and people involved in vegetation clearing, construction and operation of the facilities should be made aware of the possible presence and issues associated with terrestrial fauna in the area through the induction process.

Recommendation 1: Information on protecting fauna and reporting deaths and sightings of Malleefowl and other conservation significant species should be incorporated into the Sandy Ridge Project induction program.

6.1.2 Minimising habitat fragmentation

Loss of vegetation and habitat may contribute to the decline in the number of fauna on and in the vicinity of project area. Where possible, access routes should be aligned to existing tracks and other barriers or follow the boundaries of broad-scale vegetation associations in the area to minimise the impact on the terrestrial fauna, which are often dependent upon specific habitat types. Clearing should be minimised wherever possible and remnant vegetation fragmentation should be avoided wherever possible. Once areas are no longer required then they should be rehabilitated.

Recommendation 2: All areas disturbed during mining are rehabilitated as soon as practical after they are no longer required.

Recommendation 3: Where possible, access routes are aligned to existing roads, tracks and other barriers or follow the boundaries of broad-scale vegetation associations in the area.

6.1.3 Minimising secondary impacts to the habitat

Pets and feral animals have the potential to impact on conservation significant species. Pets should not be permitted on the project and feral animal numbers monitored and controlled. All rubbish likely to attract animals should be suitably contained and disposed of so as not to encourage the feeding of fauna around the project.

Recommendation 4:	Pets are not permitted on the project.
Recommendation 5:	All waste and rubbish be contained in bins and regularly removed from the project or placed in land fill.

Recommendation 6: Feeding of native fauna is prohibited.

6.1.4 Uncapped drill holes

Uncapped drill holes can pose a serious threat to small animals, including ground dwelling reptiles, frogs and small mammals. A log of all on-site drill holes should be maintained detailing when they were capped, how and by whom. All drill holes should be temporarily capped on completion of drilling and permanently capped or closed as soon as possible after exploration activities have ceased.

Recommendation 7: A log of all on-site drill holes be maintained detailing when they were capped, how and by whom.

6.1.5 Fauna management plan

Fauna management plans describe the procedures and protocols that must be implemented to avoid, mitigate and minimise impacts on fauna during the vegetation clearing, infrastructure development and operational stages of a project. Such plans, deal with the method of vegetation clearing, reducing fauna deaths on the roads, the impacts



of artificial light spill, vibration, dust, feral species management, monitoring and recording conservation species, monitoring impacts on fauna in adjacent areas, staff inductions, etc.

Recommendation 8: A fauna management plan is prepared and implemented for the life of the project.



7 SUMMARY AND CONCLUSIONS

Tellus is proposing to develop a kaolin mine with complimentary storage and waste isolation facilities at its Sandy Ridge Project. Fauna survey data from other projects in the bioregion (e.g. Boorabbin–Southern Cross and Kalgoorlie-Jackson bioregional surveys, mining development proposals at Carina and Chamaeleon, and research survey data from the Bungalbin sand plain, Mt Walton and the Helena and Aurora Range plus the records from NatureMap and the Western Australian Museum) provide an adequate indication of the fauna assemblages likely to be encountered in the project area. These data are adequate to assess potential impacts on the vertebrate fauna potentially found in the project area.

No conservation significant vertebrate fauna were assessed as being likely to be significantly impacted by the proposed development. There is a possibility that Major Mitchell's Cockatoo, Western Rosella, Woma Rainbow Bee-eater, Fork-tailed Swift, Peregrine Falcon, Crested Bellbird, Bush Stone-curlew, Australian Bustard and the Central Long-eared Bat are in the project area. However, the proposed impact area is relatively small, so the probability of significantly impacting on any of these species is very low. The project area was searched for Malleefowl tracks and mounds and none were found. Therefore there is a very low probability of impact on this species.

Vegetation clearing will result in the loss of numerous small vertebrates in the project area and indirect impacts such as a reduction or loss of activity areas and closure of burrows, habitat fragmentation, increased presence of feral predators, road deaths and unnatural noises, vibrations, artificial light sources and vehicle and human movement in an area may force animals into adjacent areas.

The implementation of the recommended management strategies will mitigate or minimise potential impacts on the vertebrate fauna in the project area.

As there is an abundance of similar fauna habitat in very good to excellent condition in adjacent areas, the project area does not provide an important ecological linkage or fauna movement corridor, there is limited potential for impacting on conservation significant fauna in a regional context and there are data available from multiple locations in the vicinity of the project area to provide an adequate indication of the fauna assemblages likely to be encountered in the project area (Plate 1), there is limited value in undertaking a Level 2 detailed or comprehensive survey. The fauna data collected during a Level 2 survey, if undertaken, is unlikely to provide any additional information which would alter the analysis of potential impacts on fauna and fauna assemblages during the environmental impact assessment process.



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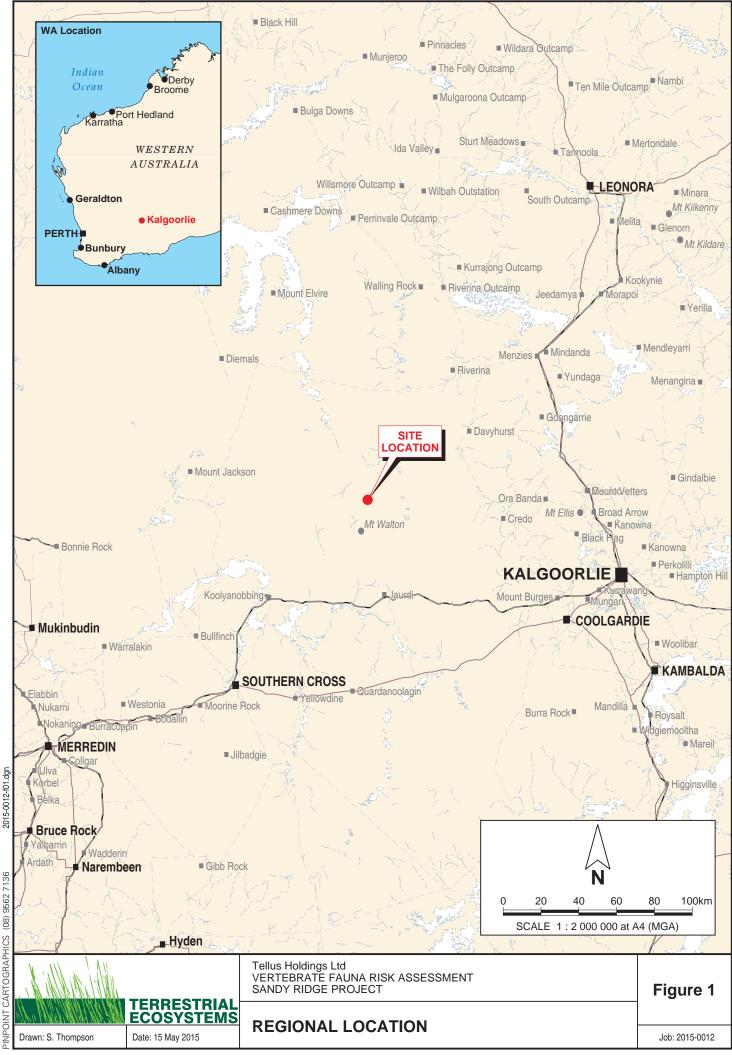
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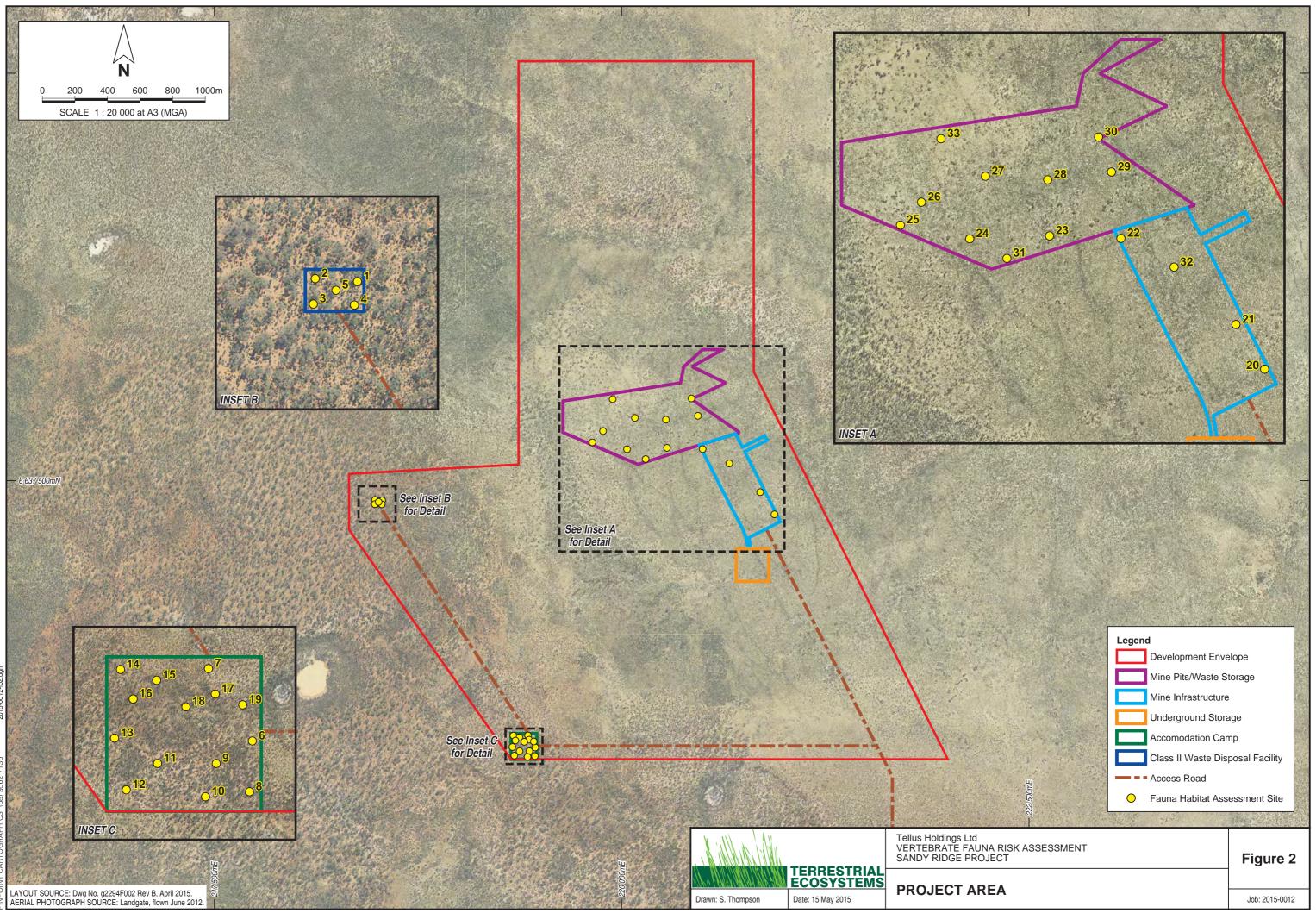
Figures

Vertebrate Fauna Assessment – Sandy Ridge Project





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Appendix A Vertebrate Fauna Recorded in Biological Surveys in the Region Vertebrate Fauna Assessment – Sandy Ridge Project



Appendix A(1) Fauna survey data in the vicinity of the project area

		Survey Name														А													
Family	Species	Common Name	Koorarawalyee Dam	Pools on aranite	Site 7F	Site 7F01A	Site 7E02	Site 7E03	Site 7F03A	Site 7F04	Site 7E05	Site 7E06	Site 7F06A	Site 7W/02	Site 7W04	Site 7W06	Site BN	Site RN1	Site RN7	Site RN4	Site RN6	South 6 5km 7E	West 1 9km 7W03	West 1 9km 7W04	West 1 9km 7W05	West 2 9km 7Wo3	West 2 9km 7Wo4	West 2 9km 7Wo6	West 2 9km 7Wo7
Birds																													
Accipitridae	Lophoictinia isura	Square-tailed Kite											Х																
	Hamirostra melanosternon	Black-breasted Buzzard											Х																
	Accipiter cirrocephalus	Collared Sparrowhawk						1	1																				
	Aquila audax	Wedge-tailed Eagle															Х												
	Hieraaetus morphnoides	Little Eagle								1																			
Anatidae	Chenonetta jubata	Australian Wood Duck															Х												
	Anas gracilis	Grey Teal															Х												
Aegothelidae	Aegotheles cristatus	Australian Owlet-nightjar								1							Х												
Podargidae	Podargus strigoides	Tawny Frogmouth					1										Х												
Casuariidae	Dromaius novaehollandiae	Emu					2							1															
Charadriidae	Vanellus tricolor	Banded Lapwing															Х												
Turnicidae	Turnix varius	Painted Button-quail																			1								
Columbidae	Phaps chalcoptera	Common Bronzewing					2			3											2								
	Ocyphaps lophotes	Crested Pigeon															Х												
Alcedinidae	Todiramphus pyrrhopygius	Red-backed Kingfisher					1		2											4									
Meropidae	Merops ornatus	Rainbow Bee-eater				:	5	13 1	19	30																			
Cuculidae	Chalcites basalis	Horsfield's Bronze-Cuckoo			Х												Х												
	Cacomantis pallidus	Pallid Cuckoo					2										Х												
	Cacomantis flabelliformis	Fan-tailed Cuckoo																											
Caprimulgidae	Eurostopodus argus	Spotted Nightjar					1								2														\square
Falconidae	Falco cenchroides	Nankeen Kestrel			Х												Х												
	Falco berigora	Brown Falcon			Х												Х							Τ				T	



		Survey Name													A	L													
Family	Species	Common Name	Koorarawalyee Dam	Pools on aranite	Site 7F	Site 7F01A	Site 7/E07	Site 7E03 Site 7E03 A	SITE / FU3A 614 - 7E04	Site 71404 Site 71505	Site 7E06	Site 7E06A	Site 7W	Site 7W03	Site 7W04	Site 7W06	Site BN	Site RN1	Site RN2	Site RN4	Site RN6	South 6 5km 7F	West 1 9km 7W03	West 1 9km 7W04	West 1 9km 7W05	West 2 9km 7Wo3	West 2 9km 7Wo4	West 2 9km 7Wod	
	Falco peregrinus	Peregrine Falcon											Х																
Megapodiidae	Leipoa ocellata	Malleefowl											Х		Х														
Rallidae	Fulica atra	Eurasian Coot														Σ	K												
Acanthizidae	Calamanthus cautus	Shy Heathwren				1													67	3									
	Pyrrholaemus brunneus	Redthroat				6	1								1		4	1	2	2									
	Smicrornis brevirostris	Weebill			4	4 35	29)	11	21				26	8				9	9	8								
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill					10)								λ	Κ												
	Acanthiza apicalis	Inland Thornbill				6	4		5	4				22 1	8		9	9 20	0	,	7								
	Aphelocephala leucopsis	Southern Whiteface											Х			Σ	K												
	Acanthiza uropygialis	Chestnut-rumped Thornbill				24	4							1					e	5 1	3								
Artamidae	Artamus personatus	Masked Woodswallow		Σ	K									52															
	Artamus cinereus	Black-faced Woodswallow							1							Σ	K												
	Artamus cyanopterus	Dusky Woodswallow				3			21	3									3	5									
	Cracticus torquatus	Grey Butcherbird				1											1	l	1	l									
	Cracticus nigrogularis	Pied Butcherbird					1	6	1							χ	K												
	Cracticus tibicen	Australian Magpie		Σ	K											Х	K												
	Strepera versicolor	Grey Currawong					1									Σ	K												
Campephagidae	Coracina maxima	Ground Cuckoo-Shrike														Х	K												
	Coracina novaehollandiae	Black-faced Cuckoo-Shrike			3	3 5	1	2	1												1								
	Lalage sueurii	White-winged Triller		9) 4	1																							
Climacteridae	Climacteris rufa	Rufous Treecreeper							29	39									2	0									\square
Corvidae	Corvus coronoides	Australian Raven																	2	2			Τ						\square
	Corvus bennetti	Little Crow														Х	ζ												\square
Eupetidae	Cinclosoma castanotum	Chestnut Quail-thrush								1			Х										Τ						



		Survey Name	:												Α													
Family	Species	Common Name	Koorarawalyee Dam	Pools on aranite	Site 7F	Site 7E01A	Site 7E02	Site 7E03 A	Site 7E04	Site 7E05	Site 7E06	Site 7E06A	Site 7W	Site 7W03	Site 7W04	Site DM	Site BN1	Site BN2	Site BN4	Site BN6	South 6 5km 7E	West 1 9km 7W03	West 1 9km 7W04	West 1 9km 7W05	West 2 9km 7Wo3	West 2 9km 7Wo4	West 2 9km 7Wo5	West 7 9km 7Wo6 West 2 0km 7Wo7
Hirundinidae	Petrochelidon nigricans	Tree Martin				7													48									
Maluridae	Malurus leucopterus	White-winged Fairy-wren		2	K																							
	Malurus pulcherrimus	Blue-breasted Fairy-wren											1	4 2														
Meliphagidae	Certhionyx variegatus	Pied Honeyeater											Х															
	Lichenostomus virescens	Singing Honeyeater				2	2									Х												
	Lichenostomus leucotis	White-eared Honeyeater				7	5							4 1						5								
	Lichenostomus flavicollis	Yellow-throated Honeyeater					12		1	1								1	4									
	Lichenostomus ornatus	Yellow-plumed Honeyeater				31			102	54									125	6								
	Lichenostomus plumulus	Grey-fronted Honeyeater																										
	Purnella albifrons	White-fronted Honeyeater				6	12		3	3			2	10)					1								
	Manorina flavigula	Yellow-throated Miner																										
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater				2	1	1									1	1	23	11								
	Anthochaera carunculata	Red Wattlebird					2		3	1										1								
	Epthianura tricolor	Crimson Chat											Х															
	Epthianura albifrons	White-fronted Chat		2	Κ								Х			Х												
	Glyciphila melanops	Tawny-crowned Honeyeater				2											5	2										
	Lichmera indistincta	Brown Honeyeater				8										2			1	1								
	Melithreptus brevirostris	Brown-headed Honeyeater				4								2		Х												
Monarchidae	Grallina cyanoleuca	Magpie-Lark														Х												Τ
Motacilidae	Anthus novaeseelandiae	Australasian Pipit			7	7	1					1	Х				3									\Box		
Nectariniidae	Dicaeum hirundinaceum	Mistletoebird												1					1									Γ
Neosittidae	Daphoenositta chrysoptera	Varied Sittella		У	Κ																							Τ
Pachycephalidae	Pachycephala inornata	Gilbert's Whistler				8				7									7									Τ
	Pachycephala pectoralis	Golden Whistler						1						1														1



		Survey Name														A													
Family	Species	Common Name	Koorarawalyee Dam	Pools on oranite	Site 7F	Site 7E01 A	Site 7E07	Site 7E03 Site 7E03 A		Site 7E05 Site 7E05	Site 7E06	Site 7E06A	Site 7W	Site 7W03	Site 7W04	Site 7W06	Site BN	Site BN1	Site RN2	Site BN4	Site RN6		West 1 9km 7W03	<u>West 1 9km 7W04</u>	West 1 00 mm 2002	West 2 9km 7Wo4	West 2 9km 7Wo5	West 2 9km 7Wa6	West 2 9km 7Wo7
	Pachycephala rufiventris	Rufous Whistler			Х												Х									Π			
	Colluricincla harmonica	Grey Shrike-thrush				2	3	9	4					1	1			1	1	7						Π			
	Oreoica gutturalis	Crested Bellbird				4	1	7	3					2	2					3 1						Π			
Pardalotidae	Pardalotus striatus	Striated Pardalote				12	7		8	16									2	8 1'	7					Π			
Petroicidae	Microeca leucophaea	Jacky Winter				2	1			7										3 1									
	Petroica goodenovii	Red-capped Robin				7	7		1					3				4		1									
	Melanodryas cucullata	Hooded Robin				4											Х												
	Drymodes brunneopygia	Southern Scrub-robin				2								4	6														
Pomatostomidae	Pomatostomus superciliosus	White-browed Babbler				12									18			5											
Rhipiduridae	Rhipidura leucophrys	Willie Wagtail					2	12	8										4	2									
Podicipedidae	Tachybaptus novaehollandiae	Australasian Grebe															Х												
	Poliocephalus poliocephalus	Hoary-headed Grebe															Х												
Cacatuidae	Nymphicus hollandicus	Cockatiel		2	Х												Х												
Psittacidae	Glossopsitta porphyrocephala	Purple-crowned Lorikeet			1	1	8	6									Х												
	Polytelis anthopeplus	Regent Parrot					1	14						3					2	2									
	Platycercus icterotis xanthogenys	Western Rosella							1						1														
	Barnardius zonarius	Australian Ringneck				6	14	5	1										1	. 1									
	Psephotus varius	Mulga Parrot																	2	0									
	Neophema elegans	Elegant Parrot							1																				
Strigidae	Ninox novaeseelandiae	Southern Boobook			Х								Х				Х										Ш		
Mammals																											Ш		
Canidae	Canis lupus	Dog					Х	5																			Ш		
Felidae	Felis catus	House Cat			X Z	x																					Ш		
Molossidae	Austronomus australis	White-striped Freetail Bat	Х	X	7				1					1	2	1	3	Τ	1		Х	X	:		Х	7	ΗT	Т	



		Survey Name	;													Α													
Family	Species	Common Name	Koorarawalyee Dam	Pools on aranite	Site 7F	Site 7F01A	Site 7E02	Site 7E03	Site 7F03A	Site 7F04	Site 7E05	Site 7F06	Site 7F06A	Site 7W	Site 7W03	Site 7.W04	site DNI	Site RN1	Site BN2	Site BN4	Site BN6	South 6 5km 7E	West 1 9km 7W03	West 1 9km 7W04	West 1 9km 7W05	West 2 9km 7Wo3	West 2 9km 7Wo4	West 2 9km 7Wo5	West 2 0km 7Wo6
	Mormopterus planiceps	Southern Freetail-bat							1	2																		Τ	
Vespertilionidae	Chalinolobus gouldii	Gould's Wattled Bat	Х		13				1	3				2	ŀ	1	5							Х			Х	Τ	
	Chalinolobus morio	Chocolate Wattled Bat			3				1	3												Х					Σ	(
	Nyctophilus geoffroyi	Lesser Longeared Bat			1									1														Х	-
	Nyctophilus major	Western Longeared Bat		Х	Х								2	ζ															
	Scotorepens balstoni	Inland Broadnosed Bat							1																				
	Vespadelus regulus	Southern Forest Bat	Х	Х	11					5				1			3					Х			Х				Х
Dasyuridae	Antechinomys laniger	Kultarr												2	2	1													
	Ningaui yvonneae	Mallee Ningaui				1		3	1	1						2			2										
	Sminthopsis crassicaudata	Fat-tailed Dunnart				8															1							Τ	
	Sminthopsis dolichura	Little Long-tailed Dunnart					1		2	1	4	1		1	2	2				1									
	Sminthopsis granulipes	White-tailed Dunnart												2	2	6													
	Sminthopsis hirtipes	Hairy-footed Dunnart										1	1															Τ	
Burramyidae	Cercartetus concinnus	Southwestern Pygmy Possum				1					1																	Τ	
Macropodidae	Macropus fuliginosus	Western Grey Kangaroo			6	1			2		2			1															
Leporidae	Oryctolagus cuniculus	European Rabbit			Х	Х	Х	Х	Х	Х																			
Tachyglossidae	Tachyglossus aculeatus	Short-beaked Echidna			Х					Х																		Τ	
Muridae	Mus musculus	House Mouse				10				1		1			1		6	6	2	3								Τ	
	Notomys mitchellii	Mitchell's Hopping Mouse						1	1					1	1	2												Τ	
	Pseudomys albocinereus	Ash-grey Mouse								1								5	9									Τ	
	Pseudomys bolami	Bolam's Mouse				2	2	2					1																
Amphibians																												T	
Limnodynastidae	Neobatrachus kunapalari	Kunapalari Frog												1					Х	х	Х								
	Neobatrachus pelobatoides	Humming Frog																		Х									



		Survey Name	:												А													
Family	Species	Common Name	Koorarawalyee Dam	Pools on aranite	Site 7F	Site 7F01A	Site 7E07	Site 7E03 Site 7E03 A	SIE /FU3A 6:4- 7E04	Site 7E05	Site 7E06	Site 7F06A	Site 7W	Site 7W03	Site 7W04	Site 7W06	Nite BN1 Site BN1	Site BN7	Site BN4	Site BN6	South 6 5km 7E	West 1 9km 7W03	West 1 9km 7W04	West 1 9km 7W05	West 2 9km 7Wo3	West 2 9km 7Wo4	West 7 9km 7Wo6 West 2 9km 7Wo6	West 2 9km 7Wo7
Myobatrachidae	Pseudophryne occidentalis	Western Toadlet		Х	Κ															Х								
Reptiles																												
Agamidae	Ctenophorus adelaidensis	Southern Heath Dragon														Х												
	Ctenophorus cristatus	Bicycle Dragon		У	ζ	3	3	16	8				Х						Х	Х								
	Ctenophorus isolepis										2						Х	Х										
	Ctenophorus maculatus	Spotted Military Dragon		Σ	K								Х	1 1	3 3	Х												
	Ctenophorus ornatus	Ornate Crevice Dragon														Х												
	Ctenophorus reticulatus	Western Netted Dragon		Σ	Κ								Х						Х									
	Ctenophorus salinarum	Salt Pan Dragon		У	K 13	3					1		X	2 2	2 7		Х	Х										
	Ctenophorus scutulatus												Х				Х		Х									
	Moloch horridus	Thorny Devil		У	K	1	2	1					X	2 1				Х										
	Pogona minor	Bearded Dragon		У	K	1	1				1			2 3	3		Х	Х										
Carphodactylidae	Nephrurus stellatus													2														
Diplodactylidae	Crenadactylus ocellatus	Clawless Gecko		Σ	Κ															Х								
	Diplodactylus granariensis								1										Х	Х								
	Diplodactylus pulcher													1		Х		Х	Х									
	Lucasium maini			У	Κ	2			2				X	2					Х									
	Oedura reticulata			У	Κ				1	Х										Х								
	Strophurus assimilis	Goldfields Spiny-tailed Gecko		Σ	Κ						1						Х											
Elapidae	Echiopsis curta	Bardick														Х												
	Parasuta gouldii																	Х										
	Pseudechis australis	Mulga Snake															Х											
	Pseudonaja affinis	Dugite		Σ	ζ												Х											
	Pseudonaja modesta	Ringed Brown Snake		2	Κ																							



		Survey Name													А													
Family	Species	Common Name	Koorarawalyee Dam	Pools on oranite	Site 7E01 A	Site 7E02	Site 7E03	Site 7F03A	Site 7E04	Site 7E05	Site 7E06	Site /HU6A	Site 7W03	Site 7W04	Site 7W06	Site BN	Site RN1	Site RN2	Site RN4	Site RN6	South 6 5km 7F.	West 1 9km 7W03	West 1 9km 7W04	West 1 9km 7W05	West 2 9km 7Wo3	West 2 9km 7Wo4 West 2 9km 7Wo5	West 2 9km 7Wo6	West 2 9km 7Wo7
	Simoselaps bertholdi	Jan's Banded Snake				2													Х									
	Simoselaps semifasciata											Х																
	Suta fasciata	Rosen's Snake		X																								
Gekkonidae	Gehyra variegata			Х		Х		2									Х		Х	Х								l
	Heteronotia binoei	Bynoe's Gecko		Х								Х					Х		Х									l
Pygopodidae	Delma australis			Х			1	Х						Х					Х	Х								l
	Delma butleri			Х													X	Х										
	Lialis burtonis			X													Х											
	Pygopus lepidopodus	Common Scaly Foot								1									Х									
Scincidae	Cryptoblepharus buchananii			X					1	1										Х								
	Ctenotus atlas			X			5											Х										
	Ctenotus pantherinus	Leopard Skink		X								Х					Χ	Х										
	Ctenotus schomburgkii			X		1	2						6	1		Х												
	Ctenotus uber																			Х								
	Ctenotus xenopleura											Х			1		X	Х										
	Cyclodomorphus branchialis			Х								Х					X	Х										l
	Egernia formosa					Х																						l
	Egernia richardi			Х								Х		1	4	Х												I
	Hemiergis initialis					Х			х	1																		l
	Lerista picturata					1				2																		
	Lerista sp.			X		8				2		Х							Х									
	Liopholis inornata			Х								Х				Х												
	Menetia greyii			Х		Х	1	1	Х										Х	Х								
	Morethia adelaidensis										T							Τ							T			



		Survey Nam	ne												L	А													
Family	Species	Common Name	Koorarawalyee Dam	Pools on granite	Site 7F	Site 7E01 A	Site 7E02	Site 7E03	Site 7F03A	Site 7E04 Site 7E05	Site 7F06	Site 7E06A	Site 7W	Site 7W03	Site 7W04	Site 7W06	Site RN	Site BN1	Site BN7	Site BN4		ξ	Ξ	West 1 9km / W04	8 8	E	R	West 2 9km 7Wa6	West 2 9km 7Wo7
	Morethia butleri				Х		Х	1	1										2	K									
	Morethia obscura				Х			1					Х	Х				Х	K										
	Tiliqua occipitalis	Western Bluetongue												2	1														
	Tiliqua rugosa				Х		1												2	X Z	K								_
Typhlopidae	Ramphotyphlops australis							1																					
Varanidae	Varanus gouldii	Bungarra or Sand Monitor			Х			1 1	1																			T	
A McKei	nzie NL and Rolfe JK (1995) Verteb	rate fauna. In: Keighery GJ, McKer	nzie N	L ar	nd H	all N	IJ. T	he E	Biolo	ogica	l Su	rvey	's of	the	Eas	sterr	Go	ldfie	lds	of	Wes	tern	Aus	stral	ia. P	art 1	1 Bo	oora	bbi

McKenzie NL and Rolfe JK (1995) Vertebrate fauna. In: Keighery GJ, McKenzie NL and Hall NJ. The Biological Surveys of the Eastern Goldfields of Western Australia. Part 11 Boorabbin-Southern Cross Study Area. *Records of the Western Australian Museum* Supplement No. 49. pp 31-65.



Appendix A(2) Fauna survey data in the vicinity of the project area

		Surveys	Α				H	3							C	2						Ι)		
Family	Species	Common Name	Bungalbin	CR1	CR2	CR3	CR4	CR5	CR6	Opportunistic	Polaris Dam	CRI	CR2	CR3	CR4	CR5	CR6	Opportunistic	Polaris Dam	CMI	CM2	CM3	CM4	CM5	CM6
Birds			_								I			<u> </u>				<u> </u>	_	<u> </u>	0				
Accipitridae	Accipiter fasciatus	Brown Goshawk													1										
<u>^</u>	Aquila audax	Wedge-tailed Eagle			1																				
Casuariidae	Dromaius novaehollandiae	Emu		1									2										1		1
Columbidae	Phaps chalcoptera	Common Bronzewing								1		1					1	1							
	Ocyphaps lophotes	Crested Pigeon																							6
Alcedinidae	Todiramphus pyrrhopygius	Red-backed Kingfisher						1					1		2	1									
Meropidae	Merops ornatus	Rainbow Bee-eater										1	2												
Cuculidae	Chalcites basalis	Horsfield's Bronze-Cuckoo											1	1											
	Cacomantis pallidus	Pallid Cuckoo												3											
Falconidae	Falco berigora	Brown Falcon										2	2	1							3				
	Falco longipennis	Australian Hobby																				1			
Megapodiidae	Leipoa ocellata	Malleefowl																			2				
Otididae	Ardeotis australis	Australian Bustard																2							
Acanthizidae	Pyrrholaemus brunneus	Redthroat		1		1																			
	Smicrornis brevirostris	Weebill		10	4	10			2			30	4	12						16	10	12	8	16	6
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill		7																10				5	
	Acanthiza apicalis	Inland Thornbill		4		6						8		3						5	2			2	
	Aphelocephala leucopsis	Southern Whiteface															3								
	Acanthiza uropygialis	Chestnut-rumped Thornbill				6						6		6						4	2		4		
Artamidae	Artamus personatus	Masked Woodswallow																80							
	Artamus cyanopterus	Dusky Woodswallow													2	2	4								
	Artamus minor	Little Woodswallow														2	1								
	Cracticus torquatus	Grey Butcherbird		2	1		1	1				2	1	1	1	2	2			1				1	1
	Cracticus nigrogularis	Pied Butcherbird		2				2	1				1									1			
	Cracticus tibicen	Australian Magpie			1				2				2		1										
	Strepera versicolor	Grey Currawong		2																					
Campephagidae	Coracina maxima	Ground Cuckoo-Shrike						1																	
	Coracina novaehollandiae	Black-faced Cuckoo-Shrike		1									2	2	1	1	1								
	Lalage sueurii	White-winged Triller												2			2								
Climacteridae	Climacteris rufa	Rufous Treecreeper			1		4	10	2				2		8	6	6								3
Corvidae	Corvus coronoides	Australian Raven				4	1					1													
	Corvus orru	Torresian Crow		4																					
Estrildidae	Taeniopygia guttata	Zebra Finch												6											
Eupetidae	Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush										1													
Hirundinidae	Petrochelidon nigricans	Tree Martin													6	1									



		Surveys	Α				I	В							(2						Ι	D		
Family	Species	Common Name	Bungalbin	CR1	CR2	CR3	cR4	CR5	CR6	Opportunistic	Polaris Dam	CRI	CR2	CR3	CR4	CR5	CR6	Opportunistic	Polaris Dam	CMI	CM2	CM3	CM4	CM5	CM6
Maluridae	Malurus splendens	Splendid Fairy-wren	_			8								3										Ŭ	
	Malurus lamberti	Variegated Fairy-wren		6		4						3								4	1				1
Meliphagidae	Lichenostomus virescens	Singing Honeyeater			1	3						2	1	6	1					1	2	2			1
	Lichenostomus leucotis	White-eared Honeyeater		1								2								8	3	2			2
	Lichenostomus ornatus	Yellow-plumed Honeyeater		2	8	8	8	6	5	6		2	10	4	10	20		6			8	6	4	4	8
	Lichenostomus plumulus	Grey-fronted Honeyeater		2					1	2								2				2			
	Purnella albifrons	White-fronted Honeyeater										10	2	2											
	Manorina flavigula	Yellow-throated Miner		2			1	4						1		5	4					8	2		13
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater				2						4	2	2	4	6	6								1
	Anthochaera carunculata	Red Wattlebird		2	2		2		1	4		2	6	6	4	2	2	4		2	2	3	1	7	10
	Lichmera indistincta	Brown Honeyeater										4		8	2		28								
	Melithreptus brevirostris	Brown-headed Honeyeater		6		8			19	8		8		12	3		3	8		12	9	9			
Pachycephalidae	Pachycephala inornata	Gilbert's Whistler						1							2	2	2								
, , , , , , , , , , , , , , , , , , ,	Pachycephala rufiventris	Rufous Whistler		1		1		1				2	1	2						1	1	1			
	Colluricincla harmonica	Grey Shrike-thrush					4	1	2					2	2	2	3					1			1
	Oreoica gutturalis	Crested Bellbird				1		1						1	2	1	2			2	1				
Pardalotidae	Pardalotus striatus	Striated Pardalote		4	10		6	8	2			12	2	2	2	2					2	2	4	2	6
Petroicidae	Microeca leucophaea	Jacky Winter		1																		1			1
	Petroica goodenovii	Red-capped Robin				1								2											1
Pomatostomidae	Pomatostomus superciliosus	White-browed Babbler				4								8						8	9				1
Rhipiduridae	Rhipidura fuliginosa	New Zealand Fantail				1						2	1												1
Rhipiduridae	Rhipidura leucophrys	Willie Wagtail								1							1	1							1
Cacatuidae	Lophochroa leadbeateri	Major Mitchell's Cockatoo												1											1
	Eolophus roseicapillus	Galah											4												1
Psittacidae	Glossopsitta porphyrocephala	Purple-crowned Lorikeet								6					2			6							1
	Polytelis anthopeplus	Regent Parrot										1			7	2									1
	Barnardius zonarius	Australian Ringneck		2	2	2	4	2	4			2			2		2			1			2	2	2
Mammals																									1
Camelidae	Camelus dromedarius	Dromedary						1															Х		Х
Canidae	Canis lupus	Dingo								Х															1
	Vulpes vulpes	Red Fox								Х															1
Molossidae	Austronomus australis	White-striped Freetail Bat				Х	1	1			Х							1	Х			Х			
Vespertilionidae	Chalinolobus gouldii	Gould's Wattled Bat			Х	Х					Х								Х			Х			
	Chalinolobus morio	Chocolate Wattled Bat				Х					Х								Х			Х			
	Mormopterus sp.				Х	Х					Х								Х			Х			
	Nyctophilus sp.																		Х						
	Scotorepens balstoni	Inland Broadnosed Bat																	Х						1



		Surveys	Α]	В							(2						Ι)		
Family	Species	Common Name	Bungalbin	CR1	CR2	CR3	CR4	CR5	CR6	Opportunistic	Polaris Dam	CR1	CR2	CR3	CR4	CR5	CR6	Opportunistic	Polaris Dam	CMI	CM2	CM3	CM4	CM5	CM6
	Vespadelus baverstocki	Inland Forest Bat																	Χ	-					_
	Vespadelus regulus	Southern Forest Bat				Х					Х								Х			Х			
Dasyuridae	Ningaui sp.		Х																						
	Ningaui yvonneae	Mallee Ningaui		1								2													
	Sminthopsis crassicaudata	Fat-tailed Dunnart																						4	
	Sminthopsis dolichura	Little Long-tailed Dunnart	Х			2								1							1	1			
	Sminthopsis hirtipes	Hairy-footed Dunnart	Х																						
Burramyidae	Cercartetus concinnus	Southwestern Pygmy Possum												1											
Macropodidae	Macropus rufus	Red Kangaroo																1							
Leporidae	Oryctolagus cuniculus	European Rabbit		Х	Х	х	Х	Х	X																
Muridae	Leporillus apicalis	Lesser Stick-nest Rat																	Х						
	Mus musculus	House Mouse	Х																						
	Notomys alexis	Spinifex Hopping Mouse	Х				1																		
	Pseudomys albocinereus	Ash-grey Mouse	X						1																
Reptiles									1																
Agamidae	Ctenophorus cristatus	Bicycle Dragon	Х									1	2		2	2	1								
0	Ctenophorus fordi	Mallee Sand Dragon	Х																						
	Ctenophorus isolepis	Crested Dragon	Х																						
	Ctenophorus maculatus	Spotted Military Dragon	Х																						
	Ctenophorus scutulatus		Х																						
	Moloch horridus	Thorny Devil	X									1													
	Pogona minor	Bearded Dragon	X						1			1													
Carphodactylidae	Nephrurus stellatus	Bemada Bragon	X																						
	Underwoodisaurus milii	Barking Gecko											1	1		1	1								
Diplodactylidae	Diplodactylus granariensis		Х											1	1	1									
	Diplodactylus pulcher		Х									1	1	7	1	1									
	Lucasium maini		Х												5	4	4								
	Lucasium stenodactylus		Х																						
	Oedura reticulata														1	1									
	Strophurus assimilis	Goldfields Spiny-tailed Gecko	Х																						
	Strophurus elderi	1 2	Х																						
Elapidae	Acanthophis antarcticus	Southern Death Adder	Х				İ –	1	1																
4	Brachyurophis fasciolata		Х				1	1	1																
	Brachyurophis semifasciata		X				1	1	1			2				1									
	Neelaps bimaculatus	Black-naped Snake	Х		1		t –	1							5										
	Parasuta monachus		X				1	+	1			1			1	2	1						1		
	Simoselaps bertholdi	Jan's Banded Snake	X				1	1	1						-		-						 		



		Surveys	s A]	В							(2						Γ)		
Family	Species	Common Name	Bungalbin	CR1	CR2	CR3	CR4	CR5	CR6	Opportunistic	Polaris Dam	CR1	CR2	CR3	CR4	CR5	CR6	Opportunistic	Polaris Dam	CMI	CM2	CM3	CM4	CM5	CM6
Gekkonidae	Gehyra variegata											1	Ŭ	1	1	1	1								
	Rhynchoedura ornata	Beaked Gecko	Х																						
Pygopodidae	Aprasia repens		Х																						
	Delma australis		Х																						
	Delma butleri		Х																						
	Delma nasuta		Х																						
	Lialis burtonis		Х																						
	Pygopus lepidopodus	Common Scaly Foot	Х																						
	Pygopus nigriceps		Х																						
Scincidae	Cryptoblepharus buchananii		Х																						
	Ctenotus atlas		Х																						
	Ctenotus brooksi		Х																						
	Ctenotus mimetes		Х																						
	Ctenotus pantherinus	Leopard Skink	Х																						
	Ctenotus schomburgkii	•	Х																						
	Ctenotus xenopleura		Х																						
	Cyclodomorphus branchialis		Х																						
	Cyclodomorphus melanops	Slender Blue-tongue												1		1									
	Egernia formosa												3	1	2										
	Eremiascincus richardsonii	Broad-banded Sand Swimmer	Х																						
	Lerista macropisthopus		Х																						
	Lerista muelleri		Х																						
	Lerista rhodonoides				1												1								
	Liopholis inornata		Х																						
	Menetia greyii		Х									1		1		1									
	Morethia butleri						1						1			1	1								
	Morethia obscura		Х																						
	Tiliqua occipitalis	Western Bluetongue	Х																						
Typhlopidae	Ramphotyphlops australis											2	1	2	3										
	Ramphotyphlops bicolor														2										
Varanidae	Varanus gouldii	Bungarra or Sand Monitor	Х																						

A Terrestrial Ecosystems unpublished data from Jason Fraser's PhD project

B Ninox Wildlife Consulting (2008) Interim Report on the first field survey of the Carina Prospect, Yilgarn Iron Ore Project. Unpublished report for Polaris Metals NL, Perth.

C Ninox Wildlife Consulting (2009) A Fauna Survey of the Carina Prospect; Yilgarn Iron Ore Project. Unpublished report for Polaris Metals NL; Perth.

D Ninox Wildlife Consulting (2008) Interim report on the first field survey of the Chamaeleon Prospect, Yilgarn Iron Ore Project. Unpublished report for Polaris Metals NL, Perth.



Appendix A(3) Fauna survey data in the vicinity of the project area

		Survey Nar	ne											А														В			
Family	Species	Common Name	Dpportunistic	M40-1	Site 1 A	Site 1R	Site 1F	Site 2	Site 2 A	Site 2B	Site 2F	site 3	site 3.B	Site 3F	Site d	Site 4A	Site 4B	Site 5	Site 5B	Site 6	Site 6A	Site 6B	Site 7	Site 7A Site 7B	Site 18	Site 18a	Site 21 Site 25	Site 27	Site 30	Site 40a	Site 44 Site 0a
Birds			Ŭ					<u> </u>			v				<u> </u>						<u> </u>			/							
Accipitridae	Accipiter fasciatus	Brown Goshawk	Х																												
	Aquila audax	Wedge-tailed Eagle	Х					1																		Х				Х	
	Hieraaetus morphnoides	Little Eagle																									Х				1
Aegothelidae	Aegotheles cristatus	Australian Owlet-nightjar	Х	1																						1					1 X
Podargidae	Podargus strigoides	Tawny Frogmouth	Х																												1
Turnicidae	Turnix velox	Little Button-quail																								1					
Columbidae	Phaps chalcoptera	Common Bronzewing	Х																												
Meropidae	Merops ornatus	Rainbow Bee-eater																								2					
Cuculidae	Chalcites basalis	Horsfield's Bronze-Cuckoo	Х														3														
	Chalcites osculans	Black-eared Cuckoo								1																					
Caprimulgidae	Eurostopodus argus	Spotted Nightjar		1																						4					
Falconidae	Falco cenchroides	Nankeen Kestrel																									1		Х	1	Х
	Falco berigora	Brown Falcon																								2					1
	Falco longipennis	Australian Hobby						2																							
	Falco peregrinus	Peregrine Falcon	Х	1																						1					
Megapodiidae	Leipoa ocellata	Malleefowl	Х																											2	1
Acanthizidae	Calamanthus cautus	Shy Heathwren																				:	8					3			
	Calamanthus fuliginosus	Striated Fieldwren																									7		17		
	Pyrrholaemus brunneus	Redthroat						1																	2	10	2	6		20	2
	Smicrornis brevirostris	Weebill	Х					Х		4	. 3						Х	C					1		91	29		27		2 1	33 142
	Gerygone fusca	Western Gerygone																													3
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	Х																						Х		1				7 2
	Acanthiza apicalis	Inland Thornbill		2						4													5		Х	31	20	56	3	45	16
	Acanthiza uropygialis	Chestnut-rumped Thornbill																							13	4	11	24		2 1	15 99
Artamidae	Artamus cinereus	Black-faced Woodswallow																									10) 1	6		
	Artamus cyanopterus	Dusky Woodswallow																													1
	Artamus minor	Little Woodswallow	Х				5																			16		Х			
	Cracticus torquatus	Grey Butcherbird		2										1											3	Х					X 9
	Cracticus nigrogularis	Pied Butcherbird	Х							1							2								17	3				3	35 7
	Cracticus tibicen	Australian Magpie																							6						Х
	Strepera versicolor	Grey Currawong	Х				2			3																					X 4
Campephagidae	Coracina novaehollandiae	Black-faced Cuckoo-Shrike		1																					5	2	Х	Х		3	32 X
Climacteridae	Climacteris rufa	Rufous Treecreeper															2								2			Ι		4	42
Corvidae	Corvus coronoides	Australian Raven																								1					
	Corvus bennetti	Little Crow	Х																									1		11	Х



		Survey Nam	e											A															В				
Family	Species	Common Name	Dpportunistic	Site 1	Site 1 A	Site 1R	Site 1F	Site 7	Site 2 A	Site 7R	site 3	Site 3 A	Site 3B	Site 3F	Site 4	Site 4A	Site 4B	Site 5 A	Site 5B	Site 6	Site 6A	Site 6R	Site 7	Site 7A	Site 7B	Site 18	Site 18a Site 21	Site 35	Site 37	Site 30	Site 40a	Site 44	Site 8a
	Corvus orru	Torresian Crow					<u> </u>	v .					<u> </u>								<u> </u>				<u> </u>		<u>/</u>		1	X		X	
Estrildidae	Taeniopygia guttata	Zebra Finch	Х																														
	Cinclosoma castanotum	Chestnut Quail-thrush	Х																							5			2		1	1	
Hirundinidae	Petrochelidon nigricans	Tree Martin																													2	2	
Maluridae	Malurus splendens	Splendid Fairy-wren																											Х		7		
	Malurus pulcherrimus	Blue-breasted Fairy-wren																											5				
Meliphagidae	Lichenostomus virescens	Singing Honeyeater	Х					1		1															3	X		6	3	3	13	4	6
	Lichenostomus leucotis	White-eared Honeyeater	Х					1		2							2						3			25	5	3	1	1		7 1	6
	Lichenostomus flavicollis	Yellow-throated Honeyeater																								2					i T	57 2	27
	Lichenostomus ornatus	Yellow-plumed Honeyeater									2						2								2							278	-
	Purnella albifrons	White-fronted Honeyeater	Х					2		1					1		1								2			Х	7	3	5	18 1	7
	Manorina flavigula	Yellow-throated Miner								1															1					_			-
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater	Х	1				1							4		2						-		1	X		X	15	2	Х	10	7
	Anthochaera carunculata	Red Wattlebird	X	5													Х						-		4	2		\square				34 1	8
	Epthianura tricolor	Crimson Chat		-																			-			X		H-1	\square		$ \frown $		-
	Lichmera indistincta	Brown Honeveater	Х	1				1						Х	1		2								1	X						20	_
	Melithreptus brevirostris	Brown-headed Honeyeater																							4	10)					2	2
Nectariniidae	Dicaeum hirundinaceum	Mistletoebird	Х																						1			Х			1	1	-
Neosittidae	Daphoenositta chrysoptera	Varied Sittella																					7		2	_							-
Pachycephalidae	Pachycephala inornata	Gilbert's Whistler	-																				÷		T	-		\square			1		-
	Pachycephala pectoralis	Golden Whistler																							1				4				-
	Pachycephala rufiventris	Rufous Whistler	X					2	+														1	-	1	1	-		2		6	6	1
	Colluricincla harmonica	Grey Shrike-thrush	X	7				5	+	1													-	-	-	9	-	1	11			-	5
	Oreoica gutturalis	Crested Bellbird	X	,				-	+	1	1				2		2						-	-	X			6		6	_		2
Pardalotidae	Pardalotus striatus	Striated Pardalote	X				-	1	+	2	2				~		2						-	-		0 X			4	Ť		138 6	_
Petroicidae	Microeca leucophaea	Jacky Winter	X					-	+														+		9		-	┢──┦	Ċ,	\rightarrow		41	_
1 en orenduce	Petroica goodenovii	Red-capped Robin	X				_		+											1			-	-	-	5 15	5	5	14	2		4 2	8
	Melanodryas cucullata	Hooded Robin	X														_			1			+	+		- 10	-	-	<u> </u>	2	\rightarrow	<u> </u>	-
	Eopsaltria griseogularis	Western Yellow Robin					_		+														1	-	-	+	-		3	-	$ \frown $		1
Pomatostomidae	Pomatostomus superciliosus	White-browed Babbler	+														_						+	+	+	6	+		Ť	\rightarrow	5		1
Rhipiduridae	Rhipidura albiscapa	Grey Fantail	+						+														+		+	-		┢──┦		\rightarrow	3	-+	<u>.</u>
inpun nuc	Rhipidura leucophrys	Willie Wagtail	x						+		1			+		_	+	+	+				+	+	+	1	+	X	Ĥ	\rightarrow	-	2	2
Cacatuidae	Calvptorhvnchus banksii	Red-tailed Black-Cockatoo	+						+		-			+		-	+	1	\vdash				+	+	+	+	+		\dashv	┥		6	-
Psittacidae	Glossopsitta porphyrocephala	Purple-crowned Lorikeet	X						+		+			+		+	+	+	\vdash				+	+	+	+	+	\vdash	\square	\rightarrow		17	
1 Smuchuuc	Polytelis anthopeplus	Regent Parrot							+					+		_	2	+	+				+	+	+	+	+	\vdash	\square	\rightarrow	Х		
	Barnardius zonarius	Australian Ringneck	Х						+					1	+	_	-	+	+				+	+	11	1 3	+	\vdash	1	2		41 2	νΔ
	Melopsittacus undulatus	Budgerigar						_	+		Х	-		1		_	X	+		\vdash			+	+		. 5	+-	\vdash	1	~	$ \rightarrow$	-71 2	<u> </u>



		Survey Name	e											А															В			
Family	Species	Common Name	Opportunistic	Site 1	Site 1 A	Site 1R	Site 1F	Site 2	Site 2 A	Site 2B	Nite 2H. Site 3	2: 2 F	Site 3R	Site 3F	Site 4	Site 4A	Site 4B	Site 5	Site 5B	Site 6	Site 6A	Site 6B	Site 7	Site 7A	Site 7B Site 18	Site 18a	Site 21	Site 35	Site 37	Site 39	Site 40a	Site 44 Site 8a
Strigidae	Ninox novaeseelandiae	Southern Boobook	X	1			<u> </u>	v .	ν.	v .	<u>.</u>			. v.	v .	v .		v			v .	<u> </u>	v .	<u> </u>						<u> </u>	2	
Mammals																																
Canidae	Canis lupus	Dingo	Х																								i 🗌					
	Ningaui ridei	Wongai Ningaui																									i	3		4		
	Ningaui yvonneae	Mallee Ningaui																1									i	1		1	_	
	Sminthopsis dolichura	Little Long-tailed Dunnart			1	2										1 1					1	1			2		i	2	2	2	3	3
	Sminthopsis hirtipes	Hairy-footed Dunnart																										1		1		
Burramyidae	Cercartetus concinnus	Southwestern Pygmy Possum			1								1			3	;										i		1		1	2
Macropodidae	Macropus fuliginosus	Western Grey Kangaroo																							Х		i	Х				
^	Macropus robustus	Wallaroo or Euro	Х				1			3				3												Х						
Leporidae	Oryctolagus cuniculus	European Rabbit	Х					1															1							Х		Х
Tachyglossidae	Tachyglossus aculeatus	Short-beaked Echidna	Х							X																						
Muridae	Mus musculus	House Mouse																							3		i T			2	6	2
	Notomvs alexis	Spinifex Hopping Mouse																								+			1	1		
	Notomys mitchellii	Mitchell's Hopping Mouse																					-		-			_	1	_	-	
	Pseudomys albocinereus	Ash-grey Mouse																									i T	5	1	21	1	
	Pseudomys hermannsburgensis	Sandy Inland Mouse										1							1			1					i T	2	2		1	
Amphibians	, ,																									+						
Limnodynastidae	Neobatrachus sutor	Shoemaker Frog																							1		i T					1
Reptiles																										+						
Agamidae	Ctenophorus cristatus	Bicycle Dragon	Х																				1		1		i T				2	1
0	Ctenophorus fordi	Mallee Sand Dragon																							-			1		-		1
	Ctenophorus isolepis	8																										8	4	13		
	Ctenophorus reticulatus	Western Netted Dragon				1																			+		1	1	-	-		1
	Ctenophorus scutulatus					-																	-		-					_	1	1
	Moloch horridus	Thorny Devil																							+		i t	-	1	-		1
	Pogona minor	Bearded Dragon		1																					1	1		3	1	3		1
	Tympanocryptis cephalus	Pebble Dragon	X	-	1		1																-		2	T I		-	-	-		1
Carphodactylidae	Nephrurus stellatus	6																							-			2		2		
	Underwoodisaurus milii	Barking Gecko			1																		1		-		4	_		_	4	
Diplodactylidae	Crenadactylus ocellatus	Clawless Gecko	1								+	1	1						1				+	+	+	\uparrow	T I	+	+	-	3	
7.000000000	Diplodactylus granariensis									1		1	3						2				1	1	2	+ +	3	+	+	-	3	
	Diplodactylus pulcher		1			5			1	8	1		2				1	2					Ť	1	4	\uparrow	T.	2	\uparrow	1	2	
	Lucasium maini					-						5							1				1	1	1	2	T.	\neg	\uparrow	+	9	
	Lucasium stenodactylus											1	1						1				\uparrow	1	1	+	i T	2	\uparrow	1	Ť	1
	Oedura reticulata											1	1						1				1	1	1	+	T.	\neg	\uparrow	+	2	6
	Strophurus assimilis	Goldfields Spiny-tailed Gecko										1	1						1				1	1	1		t	-+	+	-	+	1



		Survey Nam	ie											А														В			
Family	Species	Common Name	Opportunistic	Site 1	Site 1 A	Site 1R	Site 1 F	Site 2	Site 2 A	Site 7B	Site 2F Site 3	Sito 2 A	Site 3R	Site 3F	Site 4 Site 4 A	Site 4B	Site 5	Site 5.A	Site 5B	Site 6	Site 6A	Site 7	Site 7A	Site 7B	Site 18	Site 18a	Site 21	Site 35 Site 37	Site 39	Site 40a	Site 44
	Strophurus elderi							<u>v</u> . (<u>v</u>									v .		<u>, (</u>			<u> </u>		<u> </u>			1		
	Strophurus intermedius																								1						9 10
Elapidae	Demansia psammophis		Х																					_							
1	Parasuta monachus					1													1												-
	Simoselaps semifasciata																														2
Gekkonidae	Gehyra variegata																	1	2	3			1	_	3	1 4	ł	1			11 2
	Heteronotia binoei	Bynoe's Gecko	Х		2											1					1		1			3 1	2				
	Rhynchoedura ornata	Beaked Gecko																						_				2			1
Pygopodidae	Delma australis																							_							8 3
	Delma nasuta																							_					1		
	Pygopus lepidopodus	Common Scaly Foot																					1	_							
Scincidae	Cryptoblepharus buchananii							3	1	1														_		2					3
	Cryptoblepharus ruber					2		2	1	1		4	6		2	1		1		3	1		5	2							
	Ctenotus atlas																							_			4		3		
	Ctenotus schomburgkii																							_			2	7			2
	Ctenotus uber																								2	1					
	Ctenotus xenopleura																										11	1	17		
	Cyclodomorphus branchialis		Х		1																1					4 3	j				
	Egernia formosa											1																			
	Eremiascincus richardsonii	Broad-banded Sand Swimmer										1	2																		
	Hemiergis initialis																								2	13 5	j j				2
	Lerista macropisthopus																										1				1
	Lerista sp.																								3	2					4 2
	Liopholis inornata																														1
	Menetia greyii				1			4																			2	1			3 3
	Morethia butleri							2								1			1												6 2
	Tiliqua occipitalis	Western Bluetongue																										1			
Typhlopidae	Ramphotyphlops australis	• • • • • • • • • • • • • • • • • • •			1						1				1	1			1						1			T			1
	Ramphotyphlops bituberculatus											2						1													
	Ramphotyphlops hamatus										1		1		1													T			1
Varanidae	Varanus giganteus	Perentie	Х								1				1											1 1		T			
	Varanus gouldii	Bungarra or Sand Monitor									1				1													1			
	Varanus tristis	Racehorse Monitor				2						1									1										

A Lyons MN and Chapman A (1997) A Biological Survey of the Helena and Aurora Range; Eastern Goldfields Western Australia. Unpublished report for Environment Australia, Canberra.

B Dell J and How RA (1985) Vertebrate fauna. In Dell; J; How; RA; Newbey K.R. and Hnatiuk RJ. The Biological Survey of the Eastern Goldfields of Western Australia Part 3; Jackson - Kalgoorlie. *Records of the Western Australian Museum*, Supplement No 23, pp. 39-66.



Appendix A(4) Fauna survey data in the vicinity of the project area

FT -		Survey name	1				А													В									C	D	E
Family	Species	Common Name	Opportunistic	Site 16	Site 22	Site 23		Site 25	Site 6	Site 7	Site 8	Opportunistic	Site 16	Site 17	Site 18	Site 19 Site 20	Site 20	Site 21	Site 22 Site 23		Site 25	Site 26	Site 27	Site 28	Site 29	Site 30	Site 31	Site 32		Mt Walton	
Birds													•1	•1					1 0				•1		•1	•1	•1	•1			
Accipitridae	Lophoictinia isura	Square-tailed Kite										1			1																
	Accipiter fasciatus	Brown Goshawk						1													1									Х	
	Aquila audax	Wedge-tailed Eagle								6					2						1									Х	
	Hieraaetus morphnoides	Little Eagle				1													1											Х	
Aegothelidae	Aegotheles cristatus	Australian Owlet-nightjar					1													1											
Podargidae	Podargus strigoides	Tawny Frogmouth	2													1			1	1								\neg		1	
Casuariidae	Dromaius novaehollandiae	Emu	1	1	1			1		Х			1		Σ	XX		1	Х		1						Х	\neg		1	
Columbidae	Phaps chalcoptera	Common Bronzewing				3													3												
	Ocyphaps lophotes	Crested Pigeon																												Х	
Alcedinidae	Todiramphus pyrrhopygius	Red-backed Kingfisher																	5			1									
Meropidae	Merops ornatus	Rainbow Bee-eater					5							2						5											
Cuculidae	Chalcites osculans	Black-eared Cuckoo								4																					
	Cacomantis pallidus	Pallid Cuckoo								1																				Х	
	Cacomantis flabelliformis	Fan-tailed Cuckoo									3																				
Caprimulgidae	Eurostopodus argus	Spotted Nightjar	1											1	1																
Falconidae	Falco cenchroides	Nankeen Kestrel													3										1						
	Falco berigora	Brown Falcon																				1									
	Falco longipennis	Australian Hobby				1								1					1												
	Falco peregrinus	Peregrine Falcon	2																												
Megapodiidae	Leipoa ocellata	Malleefowl					1					1								1											
Otididae	Ardeotis australis	Australian Bustard										1																			
Acanthizidae	Calamanthus cautus	Shy Heathwren					1													2											
	Pyrrholaemus brunneus	Redthroat			3						5							3					2		6	1	1	2			
	Smicrornis brevirostris	Weebill		15	4		10	20	17		3		15		1		19	9 4		10	20	50	9	16	23	16	18	41	7	Х	
	Gerygone fusca	Western Gerygone	1																												
	Acanthiza robustirostris	Slaty-backed Thornbill					5													1											
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	1	5	2		3	1					5					2		3	1	3								Х	
	Acanthiza apicalis	Inland Thornbill		6	8		1			7	21		6				4	8		1		10	13		12	28	37			Х	
	Aphelocephala leucopsis	Southern Whiteface			4													4													
	Acanthiza uropygialis	Chestnut-rumped Thornbill		12	23		5				7		12		1		26	5 2 3		5		50	36		13	18	23			Х	
Artamidae	Artamus cinereus	Black-faced Woodswallow				1							1	2					1												
	Artamus cyanopterus	Dusky Woodswallow																						1						Х	
	Artamus minor	Little Woodswallow													8		2		1	1								\neg	3	1	
	Cracticus torquatus	Grey Butcherbird	1	2				1		2	1		2	2					1		1			2	2	1		\neg		Х	
	Cracticus nigrogularis	Pied Butcherbird	1		1	3		2	13		1				9)			3	1	2		1							Х	1



		Survey name					А													В										С	DE
Family	Species	Common Name	Opportunistic	Site 16	Site 22	Site 23	Site 24	Site 25	Site 6	Site 7	Site 8	Opportunistic	Site 16	Site 1 / Site 18	Site 19	Site 20	Site 2.1	Site 22	Site 23	Site 24	Site 25	Site 26	Site 27	Site 28	Site 29	Site 30	Site 31	Site 32	Site 33	Mt Walton	Kurrawang
	Cracticus tibicen	Australian Magpie							5				1 2											3							X
	Strepera versicolor	Grey Currawong		6			1	1				(5		1		6			1	1		1	1		3	6				
Campephagidae	Coracina maxima	Ground Cuckoo-Shrike																						10							
	Coracina novaehollandiae	Black-faced Cuckoo-Shrike	1	5	2	2	3	6	1	1			5 8	8	7			2	2	3	6		2	6	4			3	2		Х
	Lalage sueurii	White-winged Triller																													Х
Climacteridae	Climacteris rufa	Rufous Treecreeper				4			2						8				4					12							
Corvidae	Corvus coronoides	Australian Raven		4		1			4	1		4	1		5	1			1					i	\square					+	Х
	Corvus bennetti	Little Crow		2				3					2		1	5			1		3			i						\neg	
Estrildidae	Taeniopygia guttata	Zebra Finch	1					-										1	1		-									+	-
Eupetidae	Cinclosoma castanotum	Chestnut Quail-thrush		1									L		1				5			1		1			4			+	
Hirundinidae	Cheramoeca leucosterna	White-backed Swallow		-		12							2		1				12											+	\neg
	Hirundo neoxena	Welcome Swallow	1																						2					-	-
	Petrochelidon nigricans	Tree Martin	-						5				1 ()					1				4	4	<u> </u>					-	
Maluridae	Malurus splendens	Splendid Fairy-wren	3		2				-	13		1	-	-				2	1			7	-	<u> </u>						-	
internet reacto	Malurus leucopterus	White-winged Fairy-wren	2		-					10		1						1	1			,								-	
	Malurus pulcherrimus	Blue-breasted Fairy-wren																									8				Х
Meliphagidae	Lichenostomus virescens	Singing Honeyeater	1	1	3.0			1	1	4	4		1 2	2.8	:		16	30			1	3	3	2	1	9	-	58	42		X
	Lichenostomus leucotis	White-eared Honeyeater	-	-		1	5	-	-	-	2								1	5	-	-	-			-	1	2			X
	Lichenostomus cratitius	Purple-gaped Honeyeater				-	0				-								-	0							-	_			X
	Lichenostomus ornatus	Yellow-plumed Honeyeater		1		37			2.4				1	_	53	4			37					60	3						X
	Purnella albifrons	White-fronted Honeyeater		-	5	51		1	2 1	6	2		·		55	•		5	57		1				<u> </u>						X
	Manorina flavigula	Yellow-throated Miner		1	5		10	19		0	1		1	2	12	1		5		1.0	19			<u> </u>	4						X
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater	1	1	3.0		10	1	1	4	4		3		9	1		37	4	7	13	2		5	1						X
	Anthochaera carunculata	Red Wattlebird	1	1	50	2		2	4 5		11		5	_	28	3		51	2		2	3		1	8				2		X
	Epthianura tricolor	Crimson Chat	1			2		2	ч Ј		1 1		1 (1	2.0	5			2		2	5			0				2	\rightarrow	<u></u>
	Lichmera indistincta	Brown Honeyeater	1		11				6		2		1	8					11					<u> </u>	<u> </u>			2	3	\rightarrow	Х
	Melithreptus brevirostris	Brown-headed Honeyeater	1		1 1				0		2		_	0	-		11		1 1			2		<u> </u>	<u> </u>	10			5		X
Monarchidae	Grallina cyanoleuca	Magpie-Lark												_			11					2		<u> </u>	<u> </u>	10		/	5		X
Monarchiade Motacilidae	Anthus novaeseelandiae	Australasian Pipit								3		+	2	_	-			\vdash							<u>⊢</u>					+	
Nectariniidae	Dicaeum hirundinaceum	Mistletoebird		12						5	-+	1	2	2	+		4	+	-				3	3	1 1	1		6	8	+	+
Neosittidae	Dicaeum nirunainaceum Daphoenositta chrysoptera	Varied Sittella	1	8	8	5					-+		3	2	+		4	8	-				3	3	1 1	1		0	0	+	+
Pachycephalidae	Pachycephala rufiventris	Rufous Whistler	1	0	0	4	1				-+		,		+			0	4	1			1	<u> </u>	3	1	2	$\left \right $		+	+
т испусернинише	Colluricincla harmonica	Grey Shrike-thrush	1	1	5	4	1	3		1	3			4	+		2	5	4	1	3		2	4	5	1	~	5	6	+	Х
	Oreoica gutturalis	Crested Bellbird	1	5	5	2	1	3 4		1	1	-	5 3	4	4		10	5	2	1	4	2	2	4	4	2	1	1	1	\rightarrow	<u>л</u>
Pardalotidae	Pardalotus striatus	Striated Pardalote	1	3	9	2	2		34		1		3 3 1 2	5	4	2	2	9	2	2	4	6	2	'	4	2	1	9	6	+	Х
Paraalottaae Petroicidae			4	4	9		2	2	34				+ 2	5		2	2	9		2	2	0	9	0	1 3		1	9	0	+	Λ
	Microeca leucophaea	Jacky Winter	- 4	- 2	1			Э					4 I	1	1	1		1 1	1	1	13	1 1	1	• '	. 1			1			



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Family	Species	Common Name	Opportunistic	Site 16	Site 22	Site 23	Site 24	Site 25	Site 6	Site 7	Site 8	Opportunistic	Site 16	Site 17	Site 18	Site 19	Site 20	Site 21	Site 22	Site 23	Site 24	Site 25	Site 26	Site 27	Site 28	Site 29	Site 30	Site 31	Site 32	Site 33	Mt Walton	Kurrawang
	Melanodryas cucullata	Hooded Robin		1									1		1				-										1		X	
	Eopsaltria griseogularis	Western Yellow Robin																									2	3	í.	3		
	Drymodes brunneopygia	Southern Scrub-robin																										2				
Pomatostomidae	Pomatostomus superciliosus	White-browed Babbler	5		9														9			1	1								Х	
Rhipiduridae	Rhipidura albiscapa	Grey Fantail										1																				
1	Rhipidura leucophrys	Willie Wagtail						5		1				3	5			2			4	5						-	1	2		
Cacatuidae	Calyptorhynchus banksii	Red-tailed Black-Cockatoo										1																			+	-
	Lophochroa leadbeateri	Major Mitchell's Cockatoo			22	23						1						1	2 2	3											+	-
	Eolophus roseicapillus	Galah									2	-						-												-	+	+
Psittacidae	Glossopsitta porphyrocephala	Purple-crowned Lorikeet	1	48	4	27			138	47	230		48	1	148	3 5	4	4 4	4 2	7		4	5	6 2	2 3	5		3	378	8	X	+
1 smachade	Polytelis anthopeplus	Regent Parrot	2	10		2 /			150	1	1	1	10	-		, ,	<u> </u>	<u> </u>	. 2	. ,						5				_		
	Barnardius zonarius	Australian Ringneck	4	5	8	5		4	2	-	-		5		1	15		3	8 :	5	4	1 1	2	3 8	2 1	1			-	+	X	+
Strigidae	Ninox novaeseelandiae	Southern Boobook	-	1	0	5		-	2				1			1	-	5		5		- 4			, 1	1			-	+		+
Tytonidae	Tyto alba	Barn Owl		-			1					1	-			-				1	-								+	+	+	+
Mammals		Dani Owi					1					1								1			-	_			_			+		+
Bovidae	Capra hircus	Goat																	1		-							-		2	+	+
Canidae	Canis lupus	Dog					1					1	-					_		1										1		
Felidae	Felis catus	House Cat					-					2	-							-										· 1	+	+
Molossidae	Austronomus australis	White-striped Freetail Bat								Х		1	-								-						_		+		+	1 1
moiossiuue	Mormopterus planiceps	Southern Freetail-bat								Λ		1									_				_					+		7
Vespertilionidae	Chalinolobus gouldii	Gould's Wattled Bat									х										-								+	+	+	37
vespermonuue	Chalinolobus morio	Chocolate Wattled Bat									л		-								_			_	_				-	+	+-	2
	Nyctophilus geoffroyi	Lesser Longeared Bat										1									-					_	_			+	-	2
	Scotorepens balstoni	Inland Broadnosed Bat										1									_							—	—	+	+-	1
	1	Southern Forest Bat										1									_							—	—	+	+-	19
Damunidas	Vespadelus regulus Antechinomys laniger	Kultarr										1									_		_		_		_	—	—	—	+-	2
Dasyuridae	Ningaui ridei	Wongai Ningaui																			_				_			—	—	—	+	_
																					_	_		1	_		2	<u> </u>	_	_	+	11
	Ningaui yvonneae	Mallee Ningaui													1						_		_	1			2	—	—	1	+-	20
	Pseudantechinus woolleyae	Woolley's False Antechinus													1			_			_		_					+	+	1	+	
	Sminthopsis crassicaudata	Fat-tailed Dunnart									1					2		_	_	_	_		1	-	_			+	+	+	-	8
	Sminthopsis dolichura	Little Long-tailed Dunnart									1					3		2	_		_		1	2	:		_	2	\rightarrow	1	/	4 2
	Sminthopsis gilberti	Gilbert's Dunnart																	_	_	_	_	_	_	_			+	+	+	+	2
	Sminthopsis granulipes	White-tailed Dunnart									\square								_		_		_				_	\rightarrow	\rightarrow	+	+	2
D 11	Sminthopsis hirtipes	Hairy-footed Dunnart		1				1	-				-								_		_		_	1	_	\rightarrow	_	+ ¹	+	1
Burramyidae	Cercartetus concinnus	Southwestern Pygmy Possum		1				1	2				1					_							_	1		<u> </u>	2	+-	—	+
Macropodidae	Macropus fuliginosus	Western Grey Kangaroo						2				1						1	1									\perp	1	1 3	-	5
	Macropus robustus	Wallaroo or Euro										1																				1



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Family	Species	Common Name	Opportunistic	Site 16	Site 22	Site 23	Site 24	Site 25	Site 6	Site 7	onnortunistic	Site 16	Site 17	Site 18	Site 19	Site 20	Site 21	Site 22	Site 23	Site 24	Site 25	Site 26	Site 27	Site 28	Site 29	Site 30	Site 31	Site 32	Site 33 Mr Walton	Kurrawang
	Macropus rufus	Red Kangaroo									1																			
Leporidae	Oryctolagus cuniculus	European Rabbit	2 1	1								1		1												1	1	1 2		
Tachyglossidae	Tachyglossus aculeatus	Short-beaked Echidna								XX																			1	
Muridae	Mus musculus	House Mouse		1 4	4 1	1 1	2 ′	7 1	7 1	0		1	1	1	2	1	10	4	1	2	7	1	6	14	3	3	2	5 5	2	2 4
	Notomys alexis	Spinifex Hopping Mouse																												4
	Notomys mitchellii	Mitchell's Hopping Mouse																												1 2
	Pseudomys albocinereus	Ash-grey Mouse	1		1																				-		-	-	9	4 2
	Pseudomys bolami	Bolam's Mouse																							_					6
	Pseudomys hermannsburgensis	Sandy Inland Mouse	1		2	2													1					1	-		-	-		1 (
Amphibians		, ,																												
Limnodynastidae	Neobatrachus albipes	White-footed Trilling Frog																												3
	Neobatrachus kunapalari	Kunapalari Frog	10							2 1																				3 (
	Neobatrachus pelobatoides	Humming Frog																												5
	Neobatrachus sutor	Shoemaker Frog		-																										2
Mvobatrachidae	Pseudophryne guentheri	Crawling Toadlet																						-						3
	Pseudophryne occidentalis	Western Toadlet	15																											1 (
Reptiles																														
Agamidae	Ctenophorus adelaidensis	Southern Heath Dragon																												1
0	Ctenophorus cristatus	Bicycle Dragon		-	1	1						1							1			3	1						1	2 3
	Ctenophorus fordi	Mallee Sand Dragon																				-		-					9	2
	Ctenophorus isolepis			-																										6
	Ctenophorus maculatus	Military Dragon																					-			-			-	1 (
	Ctenophorus ornatus	Ornate Crevice Dragon																					-			-			-	4 (
	Ctenophorus reticulatus	Western Netted Dragon	,	1	1			1										1			1	1					1		2	4
	Ctenophorus salinarum	Salt Pan Dragon																1			-	1		_	-		-		- <u>-</u>	3 3
	Ctenophorus scutulatus	Santian Bragon		+																			\rightarrow	-		-	\rightarrow		3	2
	Moloch horridus	Thorny Devil											1																1	1
	Pogona minor	Bearded Dragon					1						1							1							1		2	3
	Tympanocryptis cephalus	Pebble Dragon			_	-	1						1							1			-			1	-			5
Boidae	Aspidites ramsayi	Woma		+																			\rightarrow	-		<u> </u>	\rightarrow			2
Bolade	Morelia spilota imbricata	Carpet Python			_																		-				-+			2
Carphodactylidae	Nephrurus stellatus		-+	+		-			+		-	\vdash				-							\rightarrow	\rightarrow	-+	+	+	+	2.6	
carphotaciynade	Underwoodisaurus milii	Barking Gecko		+											2	1	1						\rightarrow	\rightarrow	-+	-+	+	+	- 20	2
Diplodactylidae	Crenadactylus ocellatus	Clawless Gecko	<u> </u>	+							-			1	5	1	1						\rightarrow	\rightarrow	\rightarrow	+	+	+		2
Dipiouuciyiuue	Diplodactylus granariensis	Clawless GURU	<u> </u>	+						-	1	+		1	5	1		1					\rightarrow	1	\rightarrow	$\frac{1}{1}$	$\frac{1}{1}$	1	1	3
	Dipiouuciyius grunumensis										1	1	1					1						1		1	1	1	1	
	Diplodactylus pulcher		1	1 4	4 3	2	1				1	1										4		2	1	1		1 3		2 9



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Family	Species	Common Name	Opportunistic	Site 16	Site 22	Site 23	Site 24	Site 25	Site 6	Site 7	Site 8	Opportunistic	Site 16	Site 17	Site 18	Site 19	Site 20	Site 21	Site 22	Site 23	Site 24	Site 25	Site 26	Site 27	Site 28	Site 29	Site 30	Site 31	Site 32	Site 33	Mt Walton	Kurrawang
	Lucasium stenodactylus																															22
	Oedura reticulata			1		2						1	1			5	1			2												29
	Strophurus assimilis	Goldfields Spiny-tailed Gecko																									2				1	44
	Strophurus elderi																															3
	Strophurus wellingtonae																															1
Elapidae	Brachyurophis fasciolata																															1
Î	Brachyurophis semifasciata																															8
	Demansia psammophis																															1
	Echiopsis curta	Bardick																														1
	Furina ornata	Moon Snake																									1					1
	Parasuta gouldii																										-					2
	Parasuta monachus										1							-											-		-	1
	Pseudechis australis	Mulga Snake			1			1			-							-	1			1										11
	Pseudonaja affinis	Dugite			1			-										-	1			-										3
	Pseudonaja mengdeni	Gwardar			-													-	-												1	5
	Pseudonaja modesta	Ringed Brown Snake																-											-		-	9
	Simoselaps bertholdi	Jan's Banded Snake																-					1			1			-		-	7
	Suta fasciata	Rosen's Snake	1															-					-			-						5
Gekkonidae	Gehyra purpurascens		-								-																			\rightarrow	+	1
Gennomune	Gehyra variegata										-	1	1	1		3			4	3	1	1	6		1	1	5	3		1	+	104
	Heteronotia binoei	Bynoe's Gecko					2		2		3	1	1	1	3	5		1		1	2	1	0	6	1	1	5	5		1	+	4 0
	Rhvnchoedura ornata	Beaked Gecko		1			2		2		5	1	1	1	5			1		1	2			0	1	1				-		9
Pygopodidae	Delma australis	Beaked Geeko		1						-	-	1	1					-					1		1	1			\rightarrow	\rightarrow	-+	2 5
1 ygopouidde	Delma butleri			1			2				_		1							-	2		1							\rightarrow	-+	1 8
	Lialis burtonis			1			2				-										2									\rightarrow		6
	Pygopus lepidopodus	Common Scaly Foot																								1				\rightarrow	—	4
-	Pygopus nigriceps	Common Scary Poor									_									-						1				\rightarrow	-+	3
Scincidae							1									3					1						1		1	\rightarrow	—	23
Scinciade	Cryptoblepharus buchananii Ctenotus atlas						2	1								3					2	1					1		1			37
	Ctenotus brooksi						2	1													2	1										10
											_									_											\rightarrow	10
	Ctenotus leonhardii Ctenotus mimetes										+	1						-+											\rightarrow	+	+	3
		L compand Circuit	+			<u> </u>				_		1																	\rightarrow	+	+	
	Ctenotus pantherinus	Leopard Skink	+			<u> </u>								1															\rightarrow	+	1.2	8
	Ctenotus schomburgkii			1				_		_		1	1	1								~	1	1	2	1		2	_	-+	13	
	Ctenotus uber			1				2	2			1	1									2	I	I	3	1	6	3	2	1	+	
	Ctenotus uber uber																												\rightarrow	\rightarrow	+	32
	Ctenotus xenopleura																															66



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Family	Species	Common Name	Opportunistic	Site 16	Site 22	Site 23	Site 24	Site 25	Site 6	Site 7	Site 8	Opportunistic	Site 10	Site 18	Site 19	Site 20	Site 21	Site 22	Site 23	Site 24	Site 25	Site 26	Site 27	Site 28	Site 29	Site 30	Site 31	Site 32	Site 33 Mr Walton	Kurrawang	
	Cyclodomorphus melanops	Slender Blue-tongue		1				1				1		3			1				1							1			29
	Egernia depressa	Pygmy Spiny-tailed Skink																							1	1			-		\square
	Egernia formosa														4														-		7
	Egernia richardi																														4
	Eremiascincus richardsonii	Broad-banded Sand Swimmer			1	2		2										1	2		2	1							-		4
	Hemiergis initialis													1									1					1	-		40
	Lerista gerrardii								1							1													-		3
	Lerista macropisthopus																												1		12
	Lerista muelleri																												-		45
	Lerista picturata																												-		7
	Lerista sp.				1	2		1						1				1	2		1		3		2	1		2	-		\square
	Liopholis inornata				2								1					2											3		22
	Menetia greyii																1							3				1 4	3		36
	Morethia adelaidensis																												-		3
	Morethia butleri							1													1		1		1	1			-		31
	Morethia obscura																												1		22
	Tiliqua occipitalis	Western Bluetongue																											2		3
	Tiliqua rugosa	-				1												1	1										-		4
Typhlopidae	Ramphotyphlops australis			1								1																	1		4
	Ramphotyphlops bicolor																												-		2
	Ramphotyphlops bituberculatus																						1				1		-		5
	Ramphotyphlops hamatus		\square																										1		1
Varanidae	Varanus giganteus	Perentie									1														1						
Varanidae	Varanus gouldii	Bungarra or Sand Monitor			1	3	1				1		1	1				1	3	1									2		7
Varanidae	Varanus tristis	Racehorse Monitor													1													1	1		3

A Ecologia Environmental Consultants (2001) Koolyanobbing Expansion Project - Fauna Assessment Survey. Unpublished report for Portman Iron Ore Limited.

B Ecologia Environmental Consultants (2003) Koolyanobbing Expansion Project - Transport Corridor Fauna Assessment Survey. Unpublished report for Portman Iron Ore Limited, Perth.

C Dickman, C.R., Henry-Hall, N.J., Lloyd, H. and Romanow, K.A. (1991) A survey of the terrestrial vertebrate fauna of Mount Walton, western goldfields, Western Australia. *Western Australian Naturalist*, 18, 200-206.

D Bell, D. T., Bell, R. C. and Loneragan, W. A. (2007) Winter bird assemblages across an arid gradient in south-west Western Australia. Journal of the Royal Society of Western Australia 90, 219-227.

E Western Australian Museum records



Appendix B Definitions of Significant Fauna under the WA Wildlife Conservation Act 1950

Vertebrate Fauna Assessment – Sandy Ridge Project



APPENDIX B DEFINITIONS OF SIGNIFICANT FAUNA UNDER THE WESTERN AUSTRALIAN WILDLIFE CONSERVATION ACT 1950

In Western Australia, all native fauna species are protected under the Western Australian *Wildlife Conservation Act 1950-1979*. Fauna species that are considered rare, threatened with extinction or have a high conservation value are specially protected under the Act. In addition, some species of fauna are covered under the 1991 ANZECC convention, while certain birds are listed under the Japan and Australian Migratory Bird Agreement (JAMBA) and the China and Australian Migratory Bird Agreement (CAMBA).

Classification of rare and endangered fauna under the *Wildlife Conservation (Specially Protected Fauna) Notice* recognises four schedules of taxa. These are:

- Schedule 1 fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection;
- Schedule 2 fauna which are presumed to be extinct and are declared to be fauna in need of special protection;
- Schedule 3 birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction which are declared to be fauna in need of special protection; and
- Schedule 4 fauna that are in need of special protection, for reasons other than mentioned in Schedules 1, 2 or 3.

In addition to the above classifications, DPaW also classifies fauna under five different Priority codes:

- Priority one Taxa with few, poorly known populations on threatened lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
- Priority two Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat from habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
- **Priority three** *Taxa with several, poorly known populations, some on conservation lands*. Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
- **Priority four** *Taxa in need of monitoring*. Taxa which are considered to have been adequately surveyed or for which sufficient knowledge is available and which are not considered currently threatened or in need of special protection, but could if present circumstances change. These taxa are usually represented on conservation lands. Taxa which are declining significantly but are not yet threatened.
- **Priority five** *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



Appendix C Results of the *EPBC Act* Protected Matters Search Vertebrate Fauna Assessment – Sandy Ridge Project





Australian Government

EPBC Act Protected Matters Report

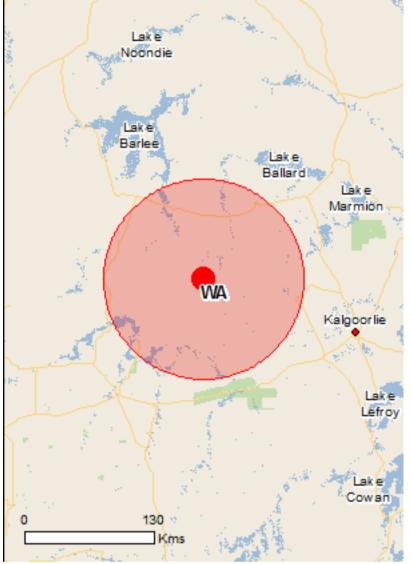
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about <u>Environment Assessments</u> and the EPBC Act including significance guidelines, forms and application process details.

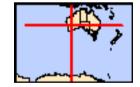
Report created: 11/05/15 22:08:13

Summary Details Matters of NES Other Matters Protected by the EPBC Act Extra Information Caveat Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates Buffer: 100.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the <u>Administrative Guidelines on Significance</u>.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	14
Listed Migratory Species:	4

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

A <u>permit</u> may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	5
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	11
Regional Forest Agreements:	None
Invasive Species:	14
Nationally Important Wetlands:	2
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	Status
Historic		
Goldfields Water Supply Scheme, Western Australia	WA	Listed place

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Dasyurus geoffroii		
Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Plants		
Acacia lobulata		
Chiddarcooping Wattle [55567]	Endangered	Species or species habitat may occur within area
Eremophila virens		
Campion Eremophila, Green-flowered Emu bush [21433]	Endangered	Species or species habitat may occur within area
Eremophila viscida		
Varnish Bush [2394]	Endangered	Species or species habitat may occur within area
Frankenia parvula		
Short-leaved Frankenia [20872]	Endangered	Species or species habitat known to occur within area
Gastrolobium graniticum		
Granite Poison [14872]	Endangered	Species or species habitat likely to occur within area

Leucopogon spectabilis Ironstone Beard-heath [83012]

Critically Endangered

Species or species habitat known to occur within area

Myriophyllum lapidicolaEndangeredSpecies or species habitat
known to occur within areaRicinocarpos brevis
[82879]EndangeredSpecies or species habitat
known to occur within areaRoycea pycnophylloides
Saltmat [21161]EndangeredSpecies or species habitat
known to occur within area

Name	Status	Type of Presence
<u>Tetratheca aphylla</u> Bungalbin Tetratheca [2915]	Vulnerable	Species or species habitat likely to occur within area
<u>Tetratheca harperi</u> Jackson Tetratheca [6251]	Vulnerable	Species or species habitat likely to occur within area
<u>Tetratheca paynterae</u> Paynter's Tetratheca [66451]	Endangered	Species or species habitat known to occur within area
Listed Migratory Species * Species is listed under a different scientific name on	the EPBC Act - Threatener	[Resource Information]
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
<u>Merops ornatus</u> Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
<u>Ardea ibis</u> Cattle Egret [59542]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

[Resource Information]

Name

Commonwealth Land -

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<u>Ardea alba</u> Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
<u>Ardea ibis</u> Cattle Egret [59542]		Species or species habitat may occur within area
<u>Merops ornatus</u> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<u>Thinornis rubricollis</u> Hooded Plover [59510]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Boorabbin	WA
Clear And Muddy Lakes	WA
Credo	WA
Goldfields Woodlands	WA
Goldfields Woodlands	WA
Mount Manning - Helena And Aurora Ranges	WA
Mount Manning Range	WA
Rowles Lagoon	WA
Unnamed WA36918	WA
Wallaroo Rock	WA
Yellowdine	WA

h	nvasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area

Streptopelia chinensis Spotted Turtle-Dove [780]

Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]

Mammals	
Camelus dromedarius	
Dromedary, Camel [7]	Species or species habitat likely to occur within area
Canis lupus familiaris	
Domestic Dog [82654]	Species or species habitat likely to occur within area
Capra hircus	
Goat [2]	Species or species habitat likely to occur within area
Equus asinus	
Donkey, Ass [4]	Species or species habitat likely to occur

Species or species habitat likely to occur within area

Species or species habitat likely to occur within area

Name	Status	Type of Presence
		within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Carrichtera annua		On a size, an an a size, habitat
Ward's Weed [9511]		Species or species habitat likely to occur within area
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Nationally Important Wetlands		[Resource Information]
Name		State
Lake Barlee		WA
Rowles Lagoon System		WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Department of Environment, Climate Change and Water, New South Wales
- -Department of Sustainability and Environment, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment and Natural Resources, South Australia
- -Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
- -Environmental and Resource Management, Queensland
- -Department of Environment and Conservation, Western Australia
- -Department of the Environment, Climate Change, Energy and Water
- -Birds Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -SA Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Atherton and Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- -State Forests of NSW
- -Geoscience Australia
- -CSIRO
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the <u>Contact Us</u> page.

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Appendix D Fauna habitat assessment results Vertebrate Fauna Assessment – Sandy Ridge Project



Zone: 51

Habitat Assessment #: 1

Easting: 218530mE

Landform: Flat

Observer: ST and AH Northing: 6637379mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grasses

Soil Colour: Orange

Fire History: > 5 years





Zone: 51

Habitat Assessment #: 2

Easting: 218487mE

Landform: Flat

Observer: ST and AH Northing: 6637382mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grasses

Soil Colour: Orange

Fire History: > 5 years





Date: 22/04/2015Habitat Assessment #: 3Observer: ST and AHZone: 51Easting: 218485mENorthing: 6637356mNFire History: > 5 yearsLandform: FlatHabitat Quality: High QualityHabitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grassesSoil Colour: OrangeSurface Stone: None





Habitat Assessment #: 4

Zone: 51

Easting: 218527mE Landform: Flat Observer: ST and AH Northing: 6637355mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grasses

Soil Colour: Orange

Fire History: > 5 years





Zone: 51

Habitat Assessment #: 5

Landform: Flat

Easting: 218508mE

Observer: ST and AH Northing: 6637370mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grasses

Soil Colour: Orange

Fire History: > 5 years





Zone: 51

Habitat Assessment #: 6

Easting: 219470mE

Landform: Flat

Observer: ST and AH Northing: 6635863mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grasses

Soil Colour: Orange

Fire History: > 5 years





Zone: 51

Habitat Assessment #: 7

Easting: 219425mE

Landform: Flat

Observer: ST and AH Northing: 6635937mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over scattered spinifex

Soil Colour: Orange

Fire History: > 5 years





Date: 22/04/2015Habitat Assessment #: 8Observer: ST and AHZone: 51Easting: 219467mENorthing: 6635811mNFire History: > 5 yearsLandform: FlatHabitat Quality: High QualityHabitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grassesSoil Colour: OrangeSoil Colour: OrangeSurface Stone: None





Date: 22/04/2015Habitat Assessment #: 9Observer: ST and AHZone: 51Easting: 219433mENorthing: 6635840mNFire History: > 5 yearsLandform: FlatHabitat Quality: High QualityHabitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grassesSoil Colour: OrangeSoil Colour: OrangeSurface Stone: None





Zone: 51

Habitat Assessment #: 10

Landform: Flat

Easting: 219422mE

Observer: ST and AH Northing: 6635806mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grasses

Soil Colour: Orange

Fire History: > 5 years





Habitat Assessment #: 11 Easting: 219373mE

Zone: 51

Landform: Flat

Observer: ST and AH Northing: 6635840mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grasses

Soil Colour: Orange

Fire History: > 5 years





Zone: 51

Habitat Assessment #: 12

Landform: Flat

Easting: 219341mE

Observer: ST and AH Northing: 6635813mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grasses

Soil Colour: Orange

Fire History: > 5 years





Zone: 51

Habitat Assessment #: 13

Landform: Flat

Easting: 219329mE

Observer: ST and AH Northing: 6635866mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over emphemeral grasses

Soil Colour: Orange

Fire History: > 5 years





Date: 22/04/2015Habitat Assessment #: 14Observer: ST and AHZone: 51Easting: 219335mENorthing: 6635936mNFire History: > 5 yearsLandform: FlatHabitat Quality: High QualityHabitat Structure: Open Eucalypt woodland with an open understorey of shrubs over scattered spinifexSoil Colour: OrangeSoil Colour: OrangeSurface Stone: None





Habitat Assessment #: 15 Easting: 219372mE

Zone: 51

Fire History: > 5 years Landform: Flat

Observer: ST and AH Northing: 6635925mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over scattered spinifex

Soil Colour: Orange





Date: 22/04/2015Habitat Assessment #: 16Observer: ST and AHZone: 51Easting: 219348mENorthing: 6635906mNFire History: > 5 yearsLandform: FlatHabitat Quality: High QualityHabitat Structure: Open Eucalypt woodland with an open understorey of shrubs over scattered spinifexSoil Colour: OrangeSoil Colour: OrangeSurface Stone: None





Zone: 51

Habitat Assessment #: 17

Easting: 219432mE

Fire History: > 5 years Landform: Flat

Observer: ST and AH Northing: 6635911mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over scattered spinifex

Soil Colour: Orange





Habitat Assessment #: 18

Easting: 219402mE

Zone: 51

Fire History: > 5 years Landform: Flat

Observer: ST and AH Northing: 6635898mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over scattered spinifex

Soil Colour: Orange





Habitat Assessment #: 19

Zone: 51

Easting: 219460mE

Landform: Flat

Observer: ST and AH Northing: 6635900mN Habitat Quality: High Quality

Habitat Structure: Open Eucalypt woodland with an open understorey of shrubs over scattered spinifex

Soil Colour: Orange

Fire History: > 5 years





Habitat Assessment #: 20

Zone: 51

Fire History: > 5 years

Easting: 220938mE

Landform: Flat

Observer: ST and AH Northing: 6637293mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow





Habitat Assessment #: 21 Easting: 220850mE

Landform: Flat

Zone: 51

Fire History: > 5 years

Observer: ST and AH Northing: 6637430mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow





Habitat Assessment #: 22

Easting: 220497mE

Zone: 51

Fire History: > 5 years Landform: Flat

Observer: ST and AH Northing: 6637694mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow





Habitat Assessment #: 23

Zone: 51

Fire History: > 5 years

Easting: 220278mE

Landform: Flat

Observer: ST and AH Northing: 6637702mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow





Habitat Assessment #: 24

Landform: Flat

Zone: 51

Easting: 220033mE

Observer: ST and AH Northing: 6637693mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow

Fire History: > 5 years





Zone: 51

Habitat Assessment #: 25

Landform: Flat

Easting: 219820mE

Observer: ST and AH Northing: 6637735mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow

Fire History: > 5 years





Habitat Assessment #: 26

Zone: 51

Fire History: > 5 years

Easting: 219885mE

Landform: Flat

Observer: ST and AH Northing: 6637805mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow





Zone: 51

Habitat Assessment #: 27

Easting: 220081mE

Landform: Flat

Observer: ST and AH Northing: 6637885mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow

Fire History: > 5 years





Habitat Assessment #: 28

Zone: 51

Fire History: > 5 years

Easting: 220272mE

Landform: Flat

Observer: ST and AH Northing: 6637874mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow





Habitat Assessment #: 29

Zone: 51

Fire History: > 5 years Landform: Flat

Easting: 220468mE

Observer: ST and AH Northing: 6637898mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow





Habitat Assessment #: 30

Zone: 51

Fire History: > 5 years

Easting: 220428mE

Landform: Flat

Observer: ST and AH Northing: 6638005mN Habitat Quality: High Quality

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow





Date: 22/04/2015Habitat Assessment #: 31Observer: ST and AHZone: 51Easting: 220147mENorthing: 6637633mNFire History: > 5 yearsLandform: FlatHabitat Quality: High QualityHabitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8mSoil Colour: YellowSoil Colour: YellowSurface Stone: None





Date: 22/04/2015Habitat Assessment #: 32Observer: ST and AHZone: 51Easting: 220660mENorthing: 6637606mNFire History: > 5 yearsLandform: FlatHabitat Quality: High QualityHabitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8mSoil Colour: YellowSoil Colour: YellowSurface Stone: None





Zone: 51

Habitat Assessment #: 33

Easting: 219945mE

Landform: Flat

Observer: ST and AH Northing: 6638000mN Habitat Quality: Very Good

Habitat Structure: Moderately dense to dense sanplain shrubland varying in height from 0.5-1.8m

Soil Colour: Yellow

Fire History: > 5 years





Terrestrial Fauna Surveys



TELLUS HOLDINGS LIMITED: SANDY RIDGE PROJECT Malleefowl Assessment, January 2016 Tellus Holdings Limited. Prepared for: Level 18, Central Park, 152-158 St George. Terrace, Perth, WA, 6000 Prepared by: M. Bamford M.J. & A.R. BAMFORD CONSULTING ECOLOGISTS. 23 Plover Way, KINGSLEY, WA 6026 3rd February 2016

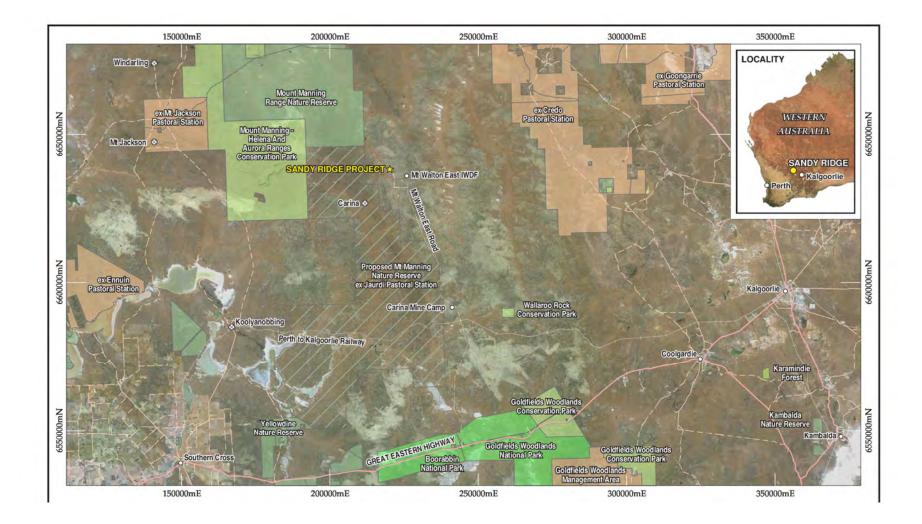
INTRODUCTION

Tellus Holdings Limited (Tellus) is proposing to develop the Sandy Ridge Project, a kaolin clay mining and waste storage project, located approximately 140 km north-west of Kalgoorlie and 120km north-east of Southern Cross, in Western Australia (see Figure 1). The Sandy Ridge Project has a clearing footprint of 276.05ha including pits/cells, mine infrastructure, accommodation camp, Class II landfill, underground storage area, access roads and a water pipeline corridor. Tellus has currently one granted exploration license covering 59 km² over the Sandy Ridge kaolin bed (E16/440) and a mining lease is pending.

The Malleefowl, *Leipoa ocellata*, is a fauna species of high conservation significance, listed as Schedule 3 under the WA *Wildlife Conservation Act (1950)* and as Vulnerable under the Federal *Environment Protection and Biodiversity Conservation Act (1999)*. It is known to occur in areas surrounding the Sandy Ridge Project (Bamford Consulting Ecologists (BCE) records, DPaW, 2016) with recent records within 10km of Sandy Ridge (DPaW, 2016) and numerous records from the Mount Manning-Helena and Aurora Ranges Conservation Park (30km, west of Sandy Ridge) and from the Carina minesite (20km south of Sandy Ridge, BCE database). As a result of the species' potential occurrence within the Sandy Ridge Project, the Department of Parks and Wildlife (DPaW) has requested that a targeted Malleefowl survey be carried out across the proposed disturbance areas to determine the site's importance for this species.

To support the Public Environmental Review for this project, BCE was commissioned by Tellus to carry out this targeted Malleefowl survey of the Sandy Ridge Project development envelope focusing on areas of proposed disturbance. Malleefowl surveys consist of systematic searching for their distinctive breeding mounds, as the birds themselves are cryptic and occur at low densities. In contrast, the mounds are large and provide information on breeding activity and the status of the species in an area. As such, BCE conducted a survey of Malleefowl mounds across the Sandy Ridge Project disturbance areas.

Figure 1. Location of the project.



BACKGROUND

Regional description

The Sandy Ridge Project development envelope is located within the Coolgardie Bioregion and the Southern Cross Subregion (Coolgardie 2, IBRA, 2008). The Southern Cross Subregion is described as having subdued relief, comprising gently undulating uplands dissected by broad valleys with bands of low greenstone hills of the Yilgarn Craton. Vegetation includes diverse Eucalyptus woodlands (*Eucalyptus salmonophloia, E. salubris, E transcontinentalis, E. longicornis, Eucalyptus loxophleba*) rich in endemic eucalypts around these salt lakes, on the low greenstone hills, valley alluvials and broad plains of calcareous earths. Upper levels in the landscape are the eroded remnants of a lateritic duricrust yielding yellow sandplains, gravelly sandplains and laterite breakaways. Mallees (*Eucalyptus leptopoda, E. platycorys* and *E. scyphocalyx*) and scrub-heaths (*Allocasuarina corniculata, Callitris preissii, Melaleuca uncinata* and *Acacia beauverdiana*) occur on these uplands, as well as on sand lunettes associated with playas along the broad valley floors, and sand sheets around the granite outcrops. The scrubs are rich in endemic acacias and Myrtaceae (Cowan, Graham and McKenzie, 2001).

Regional vegetation mapping (Beard, 1979) shows two units across the Sandy Ridge Project development envelope:

- 1. E6, 8, 34Mi (141): Eucalyptus loxophleba / E. salmonophloia / E. salubris Woodland;
- 2. anSc (437): mixed acacia thicket on sandplain.

The south west end of the pipeline route also contains associations 'Eucalyptus open woodland/Triodia open hummock grassland (538)' and a small amount of 'Acacia sparse shrubland/Cryptandra mixed sparse heath (435).

Description of Survey Area

The Sandy Ridge development envelope (see Figure 2) encompasses the project and contains the proposed pit / cell areas (202.3 ha), roads (22.2 ha), water pipeline (27.6 ha), underground storage area (4.0 ha), infrastructure area (17.2 ha), accommodation camp (2.5 ha) and Class II landfill (0.25 ha). Surveying for the Malleefowl concentrated within these proposed areas of disturbance.

A review of previous surveys conducted in the Sandy Ridge area included both flora (PGV Environmental 2016) and fauna (Terrestrial Ecosystems 2015, BCE 2012). PGV Environmental conducted a flora and vegetation survey of the Sandy Ridge area during October 2015.

A range of different vegetation types were described and mapped on the Sandy Ridge lease (E16/440). The survey area was described as dominated by the:

- Acacia resinimarginea Open Heath with variations;
- Acacia resinimarginea / Eucalyptus pileata / Triodia scariosa Open Heath and Open Grassland;

- Mallee shrublands; and
- Eucalyptus woodlands (*E. corrugata, E. salmonophloia, E. salubris*).

However vegetation was observed as a mosaic of types, with many of the vegetation types intergrading and considered variations of the main types noted. Additionally, PGV Environmental (2016) noted the impact of a fire (thought to be approximately 5 years previous) affecting the structure of large parts of the dominant *Acacia resinimarginea* communites. *Callitris preissii* shrubs which were clearly evident as a dead shrub up to 2-3m high were killed by the fire and the regenerating seedlings are growing very slowly at less than 0.3m tall. Overall, fifteen major vegetation types were noted:

- 1. Acacia resinimarginea Open Heath;
- 2. Callitris preissii/Acacia resinimarginea Tall Shrubland;
- 3. Acacia resinimarginea/Allocasuarina acutivalvis Open Heath;
- 4. Acacia resinimarginea/Melaleuca uncinata Open Low Heath;
- 5. Leptospermum roei Open Heath;
- 6. Acacia resinimarginea Open Heath with scattered Eucalyptus pileata over Triodia scariosa Open Grassland;
- 7. *Eucalyptus pileata* Open Shrub Mallee over *Melaleuca uncinata* Open Shrubland over *Triodia scariosa* Open Grassland.
- 8. Eucalyptus gracilis Shrub Mallee over Acacia nigripilosa /Acacia burkittii Low Shrubland;
- 9. Eucalyptus gracilis Open Shrub Mallee over Acacia acuminata/Eremophila oppositifolia Open Shrubland;
- 10. Acacia burkittii Tall Shrubland;
- 11. Eucalyptus rigidula Very Open Shrub Mallee over Melaleuca uncinata/Acacia acuminata Open Low Heath
- 12. Eucalyptus corrugata Low Woodland over Acacia tetragonophylla Tall Open Shrubland;
- 13. Eucalyptus salmonophloia Woodland over Acacia tetragonophylla Tall Open Shrubland
- 14. Eucalyptus salmonophloia Woodland over Eremophila oppositifolia Open Heath;
- 15. Eucalyptus salubris var. salubris Open Shrub Mallee over Melaleuca uncinata Open Shrubland.

<u>Malleefowl</u>

The Malleefowl is listed as Vulnerable under the Environmental Protection and Biodiversity Conservation (EPBC) and Wildlife Conservation Acts (WC Act). In Western Australia, Malleefowl occur mainly in scrubs and thickets of Mallee (*Eucalyptus* spp.), Boree (*Melaleuca pauperiflora*), Bowgada (*Acacia linophylla*), and also other dense litter-forming shrublands including Mulga (*Acacia aneura*) shrublands (Johnstone and Storr, 1998). The species distribution was once larger and less fragmented, but the widespread clearing of suitable habitat, coupled with the degradation of habitat by fire and livestock and fox predation, has reduced Malleefowl numbers considerably (Johnstone and Storr, 1998).

The Malleefowl Mound

Malleefowl have developed a highly sophisticated method of temperature control for egg incubation. They construct distinctive nests that comprise a large mound covering a central core of leaf litter. The mound is constructed out of sand, loam, pebbles or small rocks, depending on the substrate available. Mounds have a large central depression which is filled with leaf litter and covered with soil. Eggs are laid within the mound, buried and left to incubate by the heat generated from decomposing leaf litter (Malleefowl Preservation Group 2013). An adult pair maintains the mound temperature of 32 - 34 °C by adjusting soil cover to either retain or expel heat from the egg chamber (Malleefowl Preservation Group 2013).

Malleefowl are monogamous with pair bonds maintained for life (Priddel and Wheeler 2003). The mound is constructed and maintained by an adult pair over 9 - 11 months of the year. Nest preparation occurs in autumn and the male will tend the nest through summer until temperatures begin to fall (Malleefowl Preservation Group, 2013).

Malleefowl mounds range in size and diameter, depending on age and activity, however mounds commonly span more than five metres and up to one metre high. A pair of Malleefowl will often use the same nest over subsequent seasons however nest fidelity is highly variable. Some Malleefowl pairs have been recorded using the same mound for up to nine years while others relocate seasonally between a cluster of two, three or four mounds (Priddel and Wheeler, 2003). Where Malleefowl mounds are used over many generations, mounds can attain a size of over 20 metres (Malleefowl Preservation Group, 2013).

Mound construction and breeding rely heavily on rainfall. Malleefowl have been recorded abandoning mound construction or failing to use a mound during seasons of low rainfall (Priddel and Wheeler, 2003). Priddel and Wheeler (2003) studied the nesting activity of Malleefowl within an isolated remnant of mallee in central New South Wales. The maximum longevity recorded for breeding adults was 12 years with an average of 7.5 years. Over a twenty year period the population declined, with large population decreases coincident with years of low rainfall and unsuccessful breeding.

Breeding Malleefowl tend to be sedentary, as they nest and roost in the same area year after year. Breeding males do not stray far from the active nest however birds may range over several kilometres outside the breeding season (DPaW, 2016). Malleefowl also require large amounts of leaf litter for egg incubation and so are generally restricted to areas of dense vegetation that have not been burnt for many years. In the Kalgoorlie region, Malleefowl are often associated with dense vegetation on rocky hills, slopes and gravelly rises (BCE records).

Established pairs generally breed annually with eggs laid from September to January. The average clutch size is 16 (but may range from five to 30) and the incubation period lasts for between 62 and 64 days. Malleefowl chicks receive no parental care and as a result chick mortality is high due to predation and exposure (Priddel and Wheeler, 2003).

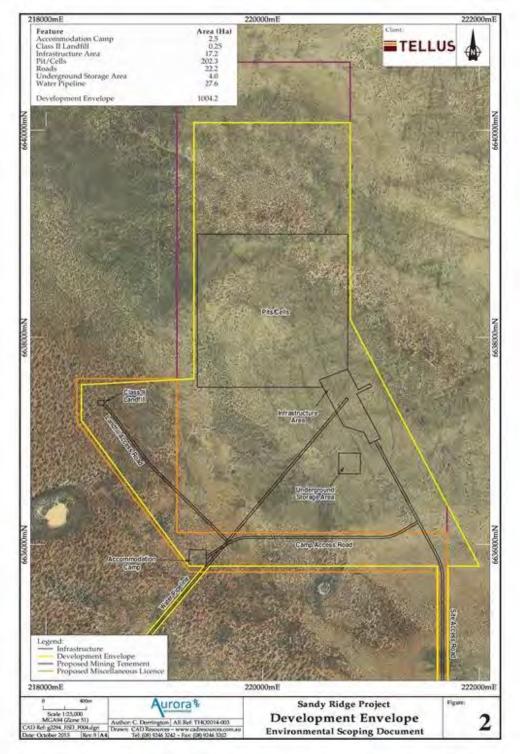


Figure 2. Overview of the development envelope.

METHODS

Dates and Personnel

Field investigations were carried out from 23rd -27th January 2016. The field survey was conducted under DPaW Regulation 17 (Licence to take Fauna for Scientific Purposes) licence number SF010659 by the following personnel:

- Dr Mike Bamford (B.Sc. Hons. Ph.D);
- Mr Robert Browne-Cooper (B. Sc.);
- Mr Jeff Turpin (B.Sc.);
- Mrs Sarah Smith (B.Sc.);
- Mr Peter Smith (Dip. Ag.).

Field assistance was also provided by Nathan Dimer and Wayne O'Sullivan (Millennium Kids). This document was prepared by Dr Mike Bamford and Jeff Turpin.

Survey Approach

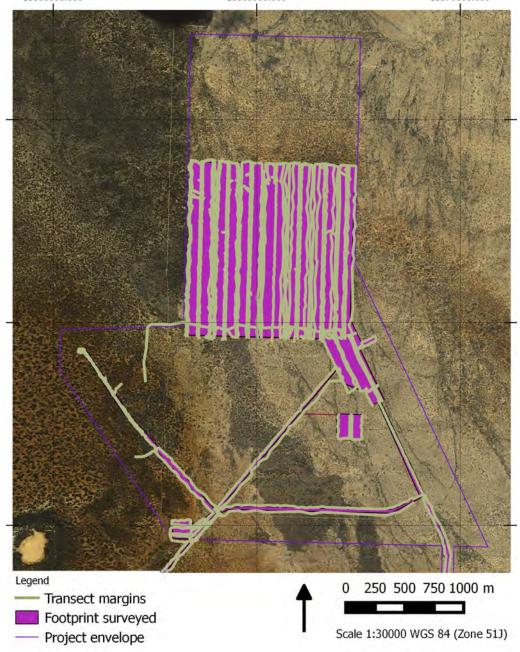
The survey methodology followed the national guidelines for surveying of Malleefowl (Benshemesh *et. al.*, 2000, DEWHA, 2010, Bancroft and Bamford, 2007) and was conducted using a line survey approach within the proposed disturbance areas. This involved a human chain survey with observers walking in a line at about 10-15m intervals, looking for Malleefowl mounds, with the line passing backwards and forwards through the survey area so that the entire site was inspected. Surveying boundaries were defined using hand-held GPS units. In this way, all the impact areas (except for the southern end of the water pipeline alignment) of the Sandy Ridge Project were surveyed for Malleefowl mounds, with the survey extending slightly beyond the boundary of the footprint (Figure 2 and Figure 3). The water pipeline alignment was surveyed to as far south as 214888E, 6630096N (2.4km south-west of Mt Dimer Road). Mt Dimer Road was searched from the access road turnoff to the intersection with Mt Walton Road. As the alignment and the existing road were effectively the same area, this section was searched from slowly moving vehicles with regular stops being made to investigate the roadside for possible mounds that might be affected by road widening and roadworks.

When Malleefowl mounds were detected, the location, vegetation type, physical characteristics (mound width, height, depth, shape / profile and substrate) and mound status (level of activity) was recorded. Note profile is based upon national guidelines (Benshemesh *et. al.*, 2000), while the status categories have been developed by BCE to allow for interpretation of the activity at a mound. Profile and status are defined in Appendix 1.

Other observations

In addition to the survey of Malleefowl mounds, observations on other fauna were maintained opportunistically. This included noting birds, reptiles and mammals seen or indicated by signs such as scats and tracks.

Figure 3. Survey effort conducted at Sandy Ridge – note each survey transect was 60 – 100m wide with personnel on transects margins defining their boundaries.



RESULTS

Site Description

The Sandy Ridge development envelope has low relief and is based on an elevated, undulating sandplain, punctuated by small, lateritic, gravelly rises. On the sandplains, vegetation consists of low mallee over spinifex with areas of Acacia and Allocasuarina shrubland. Lateritic gravelly rises support dense Acacia shrublands and some areas of eucalypt open woodland occur over open shrubs. *Melaleuca* spp. occur on sandy loam, particularly in low lying areas. Small areas of sandy rises support *Callitris* and mallee over spinifex and there is a low-lying area subject to seasonal inundation along the proposed access road between 221648E, 6633000N and 221660E, 6632824N.

The vegetation of the site has been highly affected by recent fire events, particularly on the sandplain. Large areas show evidence of recent fires (within the last approximately 5-10 years), reflected in the reduced height of the *Acacia* shrublands (less than 2m) in areas where burnt shrubs indicate the former height of vegetation was over four metres. As such, much of the vegetation of the site (especially recently burnt areas), is in the early stages of regeneration as the vegetation matures through a succession of stages and heights. Some small areas of long-unburnt vegetation remain, supporting tall *Acacia* and *Allocasuarina* shrublands.

Malleefowl

Sixty-three Malleefowl mounds were found; five of these were large and distinctive although not recently used, while the remaining 58 were little more than circular raised areas of gravel; potentially unused for decades or even centuries and mostly eroded away (see Figures 1-3). Only four mounds had the distinctive raised profile with a central depression shape (profile 1) typical of intact Malleefowl mounds, and even these had large shrubs growing in them, suggesting that it had not been used for many decades (Table 1; see Appendix 2 for location details and descriptions of all mounds).

Table 1. Significant Malleefowl mounds recorded from the project area. Mound dimensions are recorded in metres – width (W), height (H), depth (D). Profile (P) and status are described in Appendix 1).

	Easting	Northing	Habitat / Vegetation	Landform	W	Н	D	Status	Р
								(age)	
1	220065	6636392	Acacia shrubland on gravelly loam	Lateritic gravelly rise	9	0.4	0.2	E (o)	1
2	219444	6638691	Acacia shrubland on gravelly loam	Lateritic gravelly rise	5	0.5	0.2	E (o)	1
3	219862	6638783	Acacia shrubland on gravelly loam	Lateritic gravelly rise	7	0.5	0.3	E (o)	1
4	214993	6630192	Acacia shrubland on gravelly loam	Lateritic gravelly rise	9	0.4	0.2	E (o)	1
5	219851	6638833	Acacia shrubland on gravelly loam	Lateritic gravelly rise	8	0.2		E (vo)	6

The mounds were not evenly distributed across the disturbance areas but were located mostly in the north of the pit/cells area, with one mound near an access track and one mound located along the water pipeline route. Mounds were found where the soils were a gravelly loam, with the mounds themselves being composed largely of lateritic gravel (Appendix 2). In these areas, the vegetation was a shrubland of *Acacia* and *Allocasuarina*. Much of the development envelope has either sandy soils (typically

supporting mallee over spinifex), red loam soils (supporting eucalypt woodland) or pale brown loam-clay soils (supporting a mixed shrubland), and these soil and vegetation types did not support mound construction. In the case of sandy soils, if mounds had been constructed in the past, they would have eroded away very quickly. However, the birds may prefer the gravelly-loam soils for mound construction and this has been observed elsewhere (M. Bamford pers. obs.).

Data on mounds found during transect surveys are presented in Appendix 2 and locations of mounds are given on Figure 4.

Other fauna observations

Fauna recorded within the survey area are listed in Appendix 3, with an annotated species list of fauna observations provided in Appendix 4 (total of 82 vertebrate species comprising 2 frogs, 24 reptiles, 49 birds, four native mammals and three introduced mammals). The project area is of interest because of the unusual richness of reptile species; a tally of 24 species without any systematic sampling suggests that the reptile assemblage is very rich, perhaps in the order of over 50 species. This richness probably reflects the characteristics of the area, with variable soils over short distances, and the sites location which is transitional between the south-west and inland provinces. In contrast, the bird assemblage recorded over several days was poor; likely a result of seasonal conditions and also may be a consequence of fires that burnt across the bulk of the area within approximately the last 10 years.

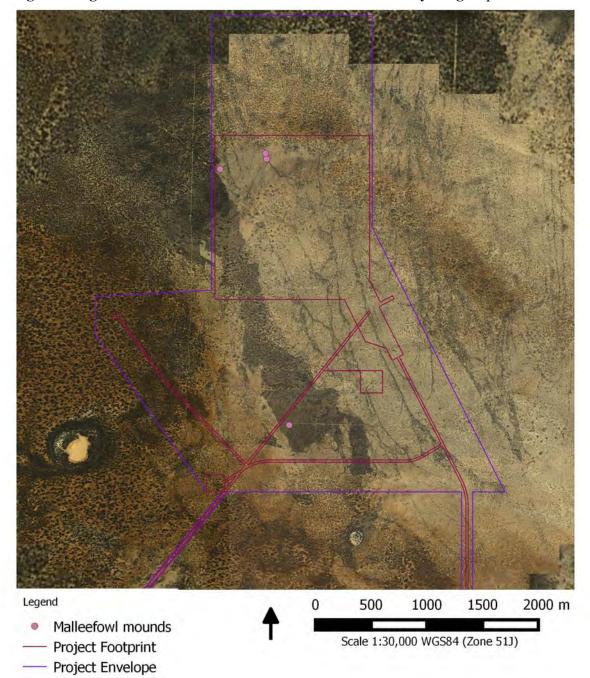


Figure 4. Significant Malleefowl mounds recorded from Sandy Ridge – pit/cells area.

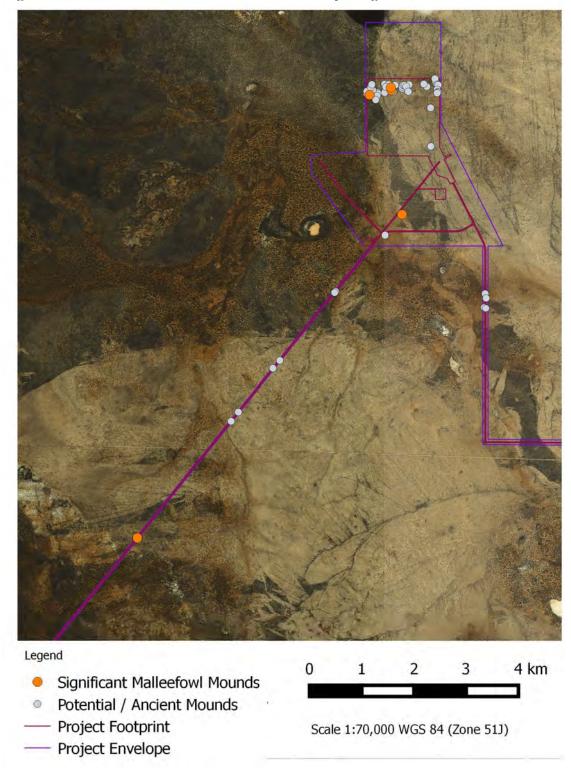


Figure 5. Malleefowl mounds recorded from Sandy Ridge disturbance areas.

DISCUSSION

Malleefowl have previously occurred in the disturbance areas but now appear to be absent as a breeding species, at least from the areas surveyed. This may be a consequence of the extensive recent fires (within approximately the last 10 years) which would have reduced the supply of leaf-litter that is essential for the birds to operate their mounds. While the breeding distribution of the species was limited to areas of gravellyloam soils, the birds probably foraged widely through all vegetation types. Malleefowl will presumably return to the area when the vegetation is sufficiently mature to support breeding, and a few birds may occasionally pass through the site as there are recent records of the species nearby, such as in the vicinity of the Carina North Mine (BCE database).

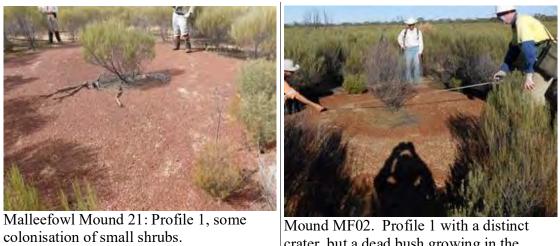
In terms of impact, the risk of the project to Malleefowl is very low with no direct impact upon current breeding sites. Birds are likely to occur in the development envelope only as occasional visitors. Therefore, risk such as from roadkill is low. While Malleefowl can be expected to return to the development envelope and surrounding areas as a breeding species at a low density when the vegetation has matured, it favours gravelly soils for mound construction and these lie mostly outside the development envelope.

The survey did not include the southern end of the water pipeline route (the southern, terminal 4.3 km) as the area could be accessed only on foot and there were concerns with walking long distances away from vehicles in hot weather. This last section of the water pipeline route (4.3 km) could be checked for Malleefowl mounds at the time when the alignment for the pipeline is being surveyed, and any mounds could be avoided as the route has some flexibility. Much of this final section appears to support eucalypt woodland on red loam soils and thus the likelihood of Malleefowl mounds being present is low.

Figure 6. Malleefowl Mounds observed at Sandy Ridge.

Malleefowl Mound 1; raised profile (1) with well defined central depression.

A very old mound; little more than a raised patch of gravel (Malleefowl Mound 18).



Mound MF02. Profile 1 with a distinct crater, but a dead bush growing in the centre.

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APPENDICES

Appendix 1. Definitions of mound profile and status

Mound Profile

The profile of a Malleefowl Mound changes with breeding activity and age (erosion and vegetation growth). Malleefowl mounds should be defined using the following system, obtained from the National Manual for the Malleefowl Monitoring System (Benshemesh 2000):

- <u>Profile 1:</u> Typical crater with raised rims. This is the typical shape of an inactive nest (however the nest may also be active and open);
- <u>Profile 2</u>: Nest fully dugout. The characteristic of this profile is that the crater slopes down steeply and at the base the sides drop vertically to form a box- like structure with side usually 20 to 30 cm deep. Often, litter will have been raked into windrows, and may have started to enter the nest;
- <u>Profile 3</u>: Nest with litter. This is the next stage after profile 2. Litter will have been raked into the nest by Malleefowl, and thick layers of litter are evident on the surface. There may or may not be sand mixed with the litter at this stage.
- <u>Profile 4:</u> Nest mounded up (no crater). This is the typical profile of an active but unopened Malleefowl nest. The active mound is closed and dome shaped.
- <u>Profile 5</u>: Nest a crater with peak in centre. This is a typical profile of an active nest which is in the process of being closed by Malleefowl.
- <u>Profile 6</u>: Nest low and flat without peak or crater. This mound has not been used for some time and weathering and erosion have 'flattened" the original mound.

Examples of each mound profile are displayed below:





Profile 1 Mound

Profile 2 Mound



Profile 3 Mound



Profile 4 Mound



Profile 5 Mound



Profile 6 Mound

(Pictures from the National Manual for the Malleefowl Monitoring System and J. Turpin)

Mound Status

In addition to mound profiles, mound status can be recorded. The mound profiles describe the appearance of the mound and while this is related to activity status, there can be some ambiguity, particularly in the harsh, rocky or gravelly environments. For example, Profiles 1 to 5 may all be mounds that are active in some sense, but only some mounds of Profile 4 are active in the sense of containing eggs that are being incubated. For example, it is possible to have a Profile 4 mound that has been abandoned and does not contain eggs. Statuses A to D all apply to mounds that have been technically active in the current breeding season, but only mounds of status A are active in that they are being used for breeding.

Status A.

Active (Profile 4): Mound almost certainly contains eggs. Mound is covered over, dome-shaped and surface is freshly disturbed (that day), often with small excavations around the lower perimeter where the male has scratched material onto the centre of the mound. There will be no ant-line tracks and very few tracks of small animals present, as the surface of the mound is being worked constantly.

Status B.

Inactive (Profile 4): Mound is covered over and dome-shaped, but surface is not disturbed, having assorted animal tracks and ant-lion traps on it. This is a mound that has been fully-prepared for incubation in that year, but has been abandoned. Note that it may also have been prepared in an earlier year but this will have been recorded.

Status C.

Inactive (Profile 3 or 5): Mound has been excavated and filled with leaf-litter, but has been abandoned.

Status D.

Inactive (Profile 1 or 2): Mound has been excavated but no further progress has been made.

Status E.

Inactive (profile 1 or 6): No recent activity. Profile 1 and 6 grade into each other, but mounds can be roughly aged (i.e. time since last used) by their appearance. For example:

Recently used: Eggshell and plant material in centre still present. It is not known how long it takes for such material to degenerate in the Sandy Ridge region, but such a mound could be >5 years old. If very young, the plant material in the centre is like compost, may contain beetle larvae and termites, and may be excavated by foraging goannas and echidnas.

Not recently used: No eggshell or plant material in centre, but central depression still well-formed, crater still distinct, with central depression often lower than the surrounding soil surface. Such mounds may be decades old. One that has been

observed annually for five years has not changed in appearance at all. Weathering of such mounds and colonisation by plants may be very slow except after rare heavy rainfall events.

Old: Clearly weathered by still distinctly Profile 1. Often with small plants in centre. Probably several decades old or older.

Very Old: Profile 6 or still with a hint of Profile 1. The age of such mounds may be in the order of 50 to 500 years. Shrubs and even trees may be present.

Code	Date	Easting	Northing	Profile	Status	Width	Height		Crater depth	Material	VSA	Notes
Mallee	efowl Mounds											
MF1	23/01/2016	220065	6636392	1	E (o)	9	0.4	2	0.2	gravel	Acacia shrubland on gravelly loam	Last used 20-50 years. Has bush growing in crater
MF2	24/01/2016	219444	6638691	1	E (o)	5	0.5	2	0.2	gravel	Acacia shrubland on gravelly loam	Last used 20-50 years. Has bush growing in crater
MF21	24/01/2016	219862	6638783	1	E (o)	7	0.5	3	0.3	gravel	τ,	Last used 20-50 years. Has bush growing in crater
MF41	27/01/2016	214993	6630192	1	E (o)	9.5	0.4	2	0.2		Acacia and allocasuarina shrubland on gravelly loam	Shrubs in crater
MF23	24/01/2016	219851	6638833	6	E (vo)	8	0.15			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
Potent	ial Ancient Mo	ounds										
MF3	24/01/2016	219392	6638715	6	E (vo)	3	0.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF4	24/01/2016	219410	6638754	6	E (vo)	1.5	0.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF5	24/01/2016	219392	6638762	6	E (vo)	1.5	0.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF6	24/01/2016	219444	6638691		E (vo)	1.5	0.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF7	24/01/2016				E (vo)	1.5	0.1			C	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of
										gruver		Unused for 100+ years. Appears as a bare patch of
MF8	24/01/2016	219579	6638737	6	E (vo)	1.5	0.1			gravel	Acacia shrubland on gravelly loam	gravel Unused for 100+ years. Appears as a bare patch of
MF9	24/01/2016	219500	6638686	6	E (vo)	2	0			gravel	Acacia shrubland on gravelly loam	gravel
MF10	24/01/2016	219580	6638715	6	E (vo)	2.5	0.2			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF11	24/01/2016	219606	6638718	6	E (vo)	2	0.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF12	24/01/2016	5 219489	6638731	7	E (vo)	3	1.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel

Appendix 2. Observations on Malleefowl mounds; January 2016. Mound dimensions in metres.

Code	Date	Easting	Northing	Profile Status	Width	Height		Crater depth	Material	VSA	Notes
								aspin			Unused for 100+ years. Appears as a bare patch of
MF13	24/01/2016	219586	6638674	6 E (vo)	2	2 0.1			gravel	Acacia shrubland on gravelly loam	gravel
MF14	24/01/2016	219560	6638599	6 E (vo)	3	3 0.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF15	24/01/2016	219730	6638899	6 E (vo)	2	2 0	1		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF16	24/01/2016	219775	6638847	6 E (vo)	1.5	5 0.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF17	24/01/2016	219809	6638776	6 E (vo)	2.5	5 0.3			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF18	24/01/2016	219740	6638765	6 E (vo)	2	2 0	1		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF19	24/01/2016	219733	6638735	6 E (vo)	1.5	5 0	1		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF20	24/01/2016	219901	6638748	6 E (vo)	2	2 0.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF22	24/01/2016	219900	6638768	6 E (vo)	1.5	5 0)		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF24	24/01/2016	219806	6638890	6 E (vo)	1.5	5 0.1			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF25	24/01/2016	219933	6638879	6 E (vo)	2	2 0.05			gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF16	24/01/2016	219754	6638846	6 E (vo)	2	2 0)		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
mf	24/01/2016	219504	6638785	6 E (vo)	2	2 0)		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
mf	24/01/2016	219465	6638838	6 E (vo)	2	2 0	1		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
mf	24/01/2016	219486	6638892		1.5	5 0)		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of
MF26					2.5				gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of
IVIT-20	23/01/2010	220000	0030010	0 E (VO)	2	, 0			giavei	Acacia sinuolanu on gravelly loani	Unused for 100+ years. Appears as a bare patch of
MF27	25/01/2016	220068	6638847	6 E (vo)	1.5	5 0.1			gravel	Acacia shrubland on gravelly loam	

Code	Date	Easting	Northing	Profile Status	Width	Height		Crater depth	Material	VSA	Notes
MF28	25/01/2016	220085	6638880	6 E (vo)	3	5 C)		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF29	25/01/2016	220112	6638879		2	2 0.05	5		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF30	25/01/2016	220200	6638887		2	2 0.15	5		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF31	25/01/2016	220144	6638854		2	2 0)		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF32	25/01/2016	220185	6638755		2	2 0.05	5		gravel	Acacia shrubland on gravelly loam	Unused for 100+ years. Appears as a bare patch of gravel
MF37	25/01/2016								gravel	8.	6
MF38	25/01/2016	220483	6638901						gravel		
MF39	25/01/2016	220613	6638444						gravel Gravel.		Boodie warren
MF40	25/01/2016	220618	6637706	6 E (vo)	6	6 0.1			loam gravel	Mallee over shrubs	Unused for 100+ years. A low risse
MF42	27/01/2016	214969	6630187	6 E (vo)	2	2 0.2	2		and loam	Acacia and allocasuarina shrubland on gravelly loam	
Mf50	27/01/2016	220718	6638908	6 E (vo)	3	0.1			gravel	Acacia shrubland on gravelly loam	3 metres diameter, slight mound, gravel, very old
Mf51	27/01/2016	220704	6638957	6 E (vo)	3	0.15	5		gravel	Acacia shrubland on gravelly loam	3 metres diameter, slight mound 150mm high, gravel, very old
Mf52	27/01/2016	220696	6638997	6 E (vo)	2.5	0.15	5		gravel	Acacia shrubland on gravelly loam	2.5 metres diameter, 150mm high, very old
Mf53	27/01/2016	220738	6638890	6 E (vo)	4	0.15	5		gravel	Acacia shrubland on gravelly loam	4 metres across, slight mound, gravel, very old 2 metres across, 50mm high, slight mound, gravel, very
Mf54	27/01/2016				2				gravel	Acacia shrubland on gravelly loam	old.
Mf55 Mf56	27/01/2016				4				gravel	с ,	4 metres across, 100mm high, gravel, very old 3 metres diameter, low mound, gravel, very old
M130 Mf57	27/01/2016				2				gravel gravel	с ,	2 metre diameter, gravel patch, very old.
	2,.01.2010	0	5666715	0 2 (10)	-				0		

Code	Date	Easting	Northing	Profile Status	Width	Height	Crater Cra width dep		VSA	Notes
Mf58	27/01/2016	220755	6638742	6 E (vo)	1.5	0.1		gravel	Acacia shrubland on gravelly loam	1.5 metre diameter gravel patch, very old
Mf59	27/01/2016	220737	6638727	6 E (vo)	2	0.1		gravel	Acacia shrubland on gravelly loam	2 metre diameter, gravel patch, very old.
Mf60	27/01/2016	219741	6635997	6 E (vo)	6	0.2		sand	Acacia shrubland on gravelly loam	6 metre diameter, 300mm high, all sand, old
Mf61	27/01/2016	218791	6634919	6 E (vo)	2	0.2		gravel	Acacia shrubland on gravelly loam	2 metre diameter gravel mound 200mm high, overgrowwwn, ancient
Mf62	27/01/2016	218774	6634897	6 E (vo)	2	0.1		gravel	Acacia shrubland on gravelly loam	2 metre diameter, 100mm high, gravel/loam, ancient
Mf63	27/01/2016	221657	6634875	6 E (vo)	2	0.15		gravel	Acacia shrubland on gravelly loam	2 metre diameter, 50mm high, gravel, very old
Mf64	27/01/2016	221676	6634789	6 E (vo)	2.5	0.1		gravel	Acacia shrubland on gravelly loam	2.5metres diameter, 100mm high, gravel/loam, 2 mounds together like a figure of 8, very old
Mf65	27/01/2016	221638	6634608	6 E (vo)	3	0.1		gravel	Acacia shrubland on gravelly loam	3 metres diameter gravel patch, very old
Mf66	27/01/2016	221670	6634592	6 E (vo)	2.5	0.2		gravel	Acacia shrubland on gravelly loam	2.5 metres diameter, 200mm high, gravel, very old
Mf67	27/01/2016	216790	6632430	6 E (vo)	1	0.2		gravel	Acacia shrubland on gravelly loam	1 metre diameter made of large gravel stones and sand, very slight mound, very old.
Mf68	27/01/2016	216929	6632605	6 E (vo)	3	0.2		gravel	Acacia shrubland on gravelly loam	3 metres diameter, 200mm high, gravel and sand, very old, 2 mounds together like a figure of 8
Mf69	27/01/2016	217591	6633441	6 E (vo)	2	0.1		gravel	Acacia shrubland on gravelly loam	2 metres diameter, 100mm high, gravel/sand, very old
Mf70	27/01/2016	217724	6633589	6 E (vo)	2	0.2		gravel	Acacia shrubland on gravelly loam	2 metres diameter, 200mm high, very fine gravel, very old.

Appendix 3. Fauna recorded or expected to occur in the survey area (Table 1 to Table 4).

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the region. These are:

- Species listed under fauna databases NatureMap (records within 40km on Sandy Ridge, DPaW, 2016), Birdata (BirdLife Australia, 2016), Atlas of Living Australia (ALA, 2016) or EPBC Protected Matters Search (DotE, 2016), or from the literature;
- Local Records (BCE database);
- Species recorded at Sandy Ridge by BCE during the 2016 field survey.
- Note conservation significant fauna are listed under CS.

CS= conservation significance; CS1 = listed under legislation; CS2 = listed a Priority by DPaW; CS3 = locally significant.

FROGS	CS	Databases	Sandy Ridge
Myobatrachidae (ground-frogs)			
Kunapalri Frog Neobatrachus kunapalari		Х	Х
Humming Frog Neobatrachus pelobatoides			
Shoemaker Frog Neobatrachus sutor		Х	Х
Goldfields Bull Frog Neobatrachus wilsmorei			
Western Toadlet Pseudophryne occidentalis		Х	
Total Number of Species Expected: 5		3	2

Table 1. Frog species expected to occur in the survey area.

RE	CS	Databases	Sandy Ridg	
AGAMIDAE				
Crested Dragon	Ctenophorus cristatus		Х	Х
Mallee Military Dragon	Ctenophorus fordi		X	X
Western Netted Dragon	Ctenophorus reticulatus		X	
Military Dragon	Ctenophorus isolepis		X	X
Claypan Dragon	Ctenophorus salinarum			
Lozenge-marked Dragon	Ctenophorus scutulatus		Х	X
Thorny Devil	Moloch horridus		Х	X
Bearded Dragon	Pogona minor		X	X
Pebble Dragon	<i>Tympanocryptis cephalus</i>		X	
DIPLODACTYLIDAE				
Clawless Gecko	Crenadactylus ocellatus		X	
Western Stone Gecko	Diplodactylus granariensis		X	X
Beautiful Gecko	Diplodactylus pulcher		X	X
Main's Ground Gecko	Lucasium maini		X	X
Southern Sandplain Gecko	Lucasium bungabinna		X	
Reticulated Velvet Gecko	Oedura reticulata		X	X
Beaked Gecko	Rhynchoedura ornata		Х	X
Thorn -tailed Gecko	Strophurus assimilis		X	
Jewelled Gecko	Strophurus elderi		Х	
Ring-tailed Gecko	Strophurus strophurus			
CARPHODACTYLIDAE				
Southern Knob-tail	Nephrurus stellatus		Х	
Barking Gecko	Nephrurus milii		X	
GEKKONIDAE				
Marbled Gecko	Christinus marmoratus			
Purplish Dtella	Gehyra purpurascens			X
Tree Dtella	Gehyra variegata		X	X
Bynoe's Gecko	Heteronotia binoei		X	
PYGOPODIDAE				
Marble-faced Delma	Delma australis		Х	
Unbanded Dema	Delma butleri		X	
Fraser's Delma	Delma fraseri			
Burton's Legless-Lizard	Lialis burtonis		X	

Table 2. Reptile species recorded or expected to occur in the survey area.

Bamford Consulting Ecologists

REPT	CS	Databases	Sandy Ridge	
Common Scaly-foot	Pygopus lepidopodus		Х	
Western Scaly-foot	Pygopus nigriceps		Х	
SCINCIDAE				
A skink	Cryptoblepharus australis		X	X
A skink	Cryptoblepharus buchananii		X	
A skink	Ctenotus ariadnae		X	
Southern Mallee Skink	Ctenotus atlas		Х	X
A skink	Ctenotus brooksi		Х	
Leonhardi's Ctenotus	Ctenotus leonhardii		Х	
Barred Wedge-snouted Ctenotus	Ctenotus schomburgkii		Х	X
Leopard Ctenotus	Ctenotus pantherinus		Х	
Wide-striped Ctenotus	Ctenotus xenopleura		Х	X
Spotted Ctenotus	Ctenotus uber		Х	
Spinifex Slender Blue-tongue	Cyclodomorphus melanops		Х	
Pygmy Spiny-tailed Skink	Egernia depressa			
Goldfields Crevice Skink	Egernia formosa			
Desert Skink	Egernia inornata		Х	X
Woodland Crevice Skink	Egernia richardi			
Night Skink	Egernia striata			
Broad-banded Sandswimmer	Eremiascincus richardsonii			
Southern Five-toed Mulch Skink	Hemiergis initialis		Х	
Four-toed Mulch Skink	Hemiergis peronii			
A skink	Lerista gerrardi		Х	
King's Lerista	Lerista kingi		Х	
Goldfields Robust Lerista	Lerista picturata		Х	
Common Mulch Lerista	Lerista timda		Х	
Bull-headed Skink	Liopholis multiscutata			
Common Dwarf Skink	Menetia greyii		Х	Х
Saltbush Flecked Skink	Morethia adelaidensis			
Woodland Dark Fleck Skink	Morethia butleri		X	
Woodland Flecked Skink	Morethia obscura		X	
Western Blue-tongue	Tiliqua occipitalis		X	X
Bobtail	Tiliqua rugosa			
VARANIDAE				
Perentie	Varanus giganteus		X	
Bungarra	Varanus gouldii		X	X

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REPTILE	CS .	CS	Databases	Sandy Ridge
Racehorse Monitor	Varanus tristis tristis		X	X
TYPHLOPIDAE				
Southern Blind Snake	Anilios australis			Х
Dark-spinned Blind Snake	Anilios bicolor			
Prong-snouted Blind Snake	Anilios bituberculatus			
Hook-Snouted Blind Snake	Anilios hamatus			
Common Beaked Blind Snake	Anilios waitii			
BOIDAE				
Stimson's Python	Antaresia stimsoni			
Woma	Aspidites ramsayi	CS2		
Carpet Python	Morelia spilota imbricata	CS3	X	
ELAPIDAE				
Desert Death Adder	Acanthophis pyrrhus			
Narrow-banded Shovel-nosed Snake	Brachyurophis fasciolata		Х	
Southern Shovel-nosed Snake	Brachyurophis semifasciata		Х	Х
Yellow-faced Whipsnake	Demansia psammophis		Х	
Bardick	Echiopsis curta			
Moon Snake	Furina ornata		X	
Black-naped Snake	Neelaps bimaculatus			
Gould's Snake	Parasuta gouldii			
Monk Snake	Parasuta monachus		X	
Black-backed Hooded Snake	Parasuta nigriceps			
Mulga Snake	Pseudechis australis		X	
Dugite	Pseudonaja affinis			
Ringed Brown Snake	Pseudonaja modesta		X	
Western Brown Snake	Pseudonaja mengdeni		X	
Jan's Banded Snake	Simoselaps bertholdi		X	
Rosen's Snake	Suta fasciata			
Total Number of Species		1	60	24

Birds		CS	Databases	Sandy Ridge
CASUARIIDAE				
Dromaius novaehollandiae	Emu		X	Х
PHASIANIDAE				
Coturnix pectoralis	Stubble Quail			
MEGAPODIIDAE				
Leipoa ocellata	Malleefowl	CS1	Х	Х
ANATIDAE				
Cygnus atratus	Black Swan		X	
Tadorna tadornoides	Australian Shelduck		X	
Chenonetta jubata	Australian Wood Duck		X	
Anas superciliosa	Pacific Black Duck		X	
Anas rhynchotis	Australasian Shoveler		X	
Malacorhynchus membranaceus	Pink-eared Duck		X	
Anas gracilis	Grey Teal		X	
Anas castanea	Chestnut Teal			
Aythya australis	Hardhead			
Stictonetta naevosa	Freckled Duck		X	
Biziura lobata	Musk Duck		X	
PODICIPEDIDAE				
Tachybaptus novaehollandiae	Australasian Grebe		X	
Poliocephalus poliocephalus	Hoary-headed Grebe		X	
COLUMBIDAE				
Phaps chalcoptera	Common Bronzewing		X	Х
Ocyphaps lophotes	Crested Pigeon		X	
Geopelia cuneata	Diamond Dove			
PODARGIDAE				
Podargus strigoides	Tawny Frogmouth		X	Х
EUROSTOPODIDAE				
Eurostopodus argus	Spotted Nightjar			
AEGOTHELIDAE				
Aegotheles cristatus	Australian Owlet-nightjar		X	X

Table 3. Bird species recorded or expected to occur in the survey area.

Birc	ls	CS	Databases	Sandy Ridge
Apus pacificus	Fork-tailed Swift	CS1	Х	
ANHINGIDAE				
Microcarbo melanoleucos	Little Pied Cormorant		Х	
Phalacrocorax sulcirostris	Little Black Cormorant			
ARDEIDAE				
Egretta novaehollandiae	White-faced Heron		Х	
Ardea pacifica	White-necked Heron		Х	
Ardea modesta	Eastern Great Egret	CS1		
PLATALEIDAE				
Threskiornis spinicollis	Straw-necked Ibis		Х	
Platalea flavipes	Yellow-billed Spoonbill		Х	
ACCIPITRIDAE				
Elanus axillaris	Black-shouldered Kite		Х	
Lophoictinia isura	Square-tailed Kite	CS3	Х	
Hamirostra melanosternon	Black-breasted Buzzard			
Haliastur sphenurus	Whistling Kite		Х	
Milvus migrans	Black Kite			
Accipiter fasciatus	Brown Goshawk		Х	
Accipiter cirrocephalus	Collared Sparrowhawk		Х	Х
Circus assimilis	Spotted Harrier		Х	
Aquila audax	Wedge-tailed Eagle		Х	
Hieraaetus morphnoides	Little Eagle		Х	
FALCONIDAE				
Falco cenchroides	Nankeen Kestrel		Х	Х
Falco berigora	Brown Falcon		Х	Х
Falco longipennis	Australian Hobby		Х	
Falco peregrinus	Peregrine Falcon	CS1	Х	
RALLIDAE				
Fulica atra	Eurasian Coot		Х	
Rallus philippensis	Buff-banded Rail			
Porzana pusilla	Baillon's Crake			
Porzana tabuensis	Spotless Crake			
Porzana fluminea	Australian Crake			

Birds	5	CS	Databases	Sandy Ridge
Tribonyx ventralis	Black-tailed Native-hen		Х	
RECURVIROSTRIDAE				
Recurvirostra novaehollandiae	Red-necked Avocet		Х	
Himantopus himantopus	Black-winged Stilt		Х	
Cladorhynchus leucocephalus	Banded Stilt			
OTIDIDAE				
Ardeotis australis	Australian Bustard	CS2	Х	
BURHINIDAE				
Burhinus grallarius	Bush Stone-curlew	CS3		
CHARADRIIDAE				
Charadrius ruficapillus	Red-capped Plover		Х	
Elseyornis melanops	Black-fronted Dotterel		Х	
Erythrogonys cinctus	Red-kneed Dotterel			
Thinornis rubricollis	Hooded Plover	CS2	Х	
Charadrius australis	Inland Dotterel			
Vanellus tricolor	Banded Lapwing		Х	
SCOLOPACIDAE				
Tringa nebularia	Common Greenshank	CS1		
Actitis hypoleucos	Common Sandpiper	CS1	Х	
Tringa glareola	Wood Sandpiper	CS1		
Calidris acuminata	Sharp-tailed Sandpiper	CS1		
Calidris ferruginea	Curlew Sandpiper	CS1		
Calidris ruficollis	Red-necked Stint	CS1		
TURNICIDAE				
Turnix velox	Little Button-quail			Х
CACATUIDAE				
Eolophus roseicapillus	Galah		Х	
Cacatua sanguinea	Little Corella			
Nymphicus hollandicus	Cockatiel		X	
Lophochroa leadbeateri	Major Mitchell's Cockatoo	CS3	Х	
PSITTACIDAE				
Glossopsitta porphyrocephala	Purple-crowned Lorikeet	CS3	Х	X
Platycercus icterotis	Western Rosella	CS1		

Bi	rds	CS	Databases	Sandy Ridge
Polytelis anthopeplus	Regent Parrot	CS3	Х	
Barnardius zonarius	Australian Ringneck		X	Х
Psephotus varius	Mulga Parrot		Х	
Melopsittacus undulatus	Budgerigar		Х	
Neophema splendida	Scarlet-chested Parrot	CS3	Х	
CUCULIDAE				
Chalcites basalis	Horsfield's Bronze-Cuckoo		Х	Х
Chalcites osculans	Black-eared Cuckoo		Х	
Cacomantis pallidus	Pallid Cuckoo		Х	
Cacomantis flabelliformis	Fan-tailed Cuckoo		Х	
STRIGIDAE				
Ninox novaeseelandiae	Southern Boobook		X	
TYTONIDAE				
Tyto alba	Eastern Barn Owl		X	
HALCYONIDAE				
Todiramphus pyrrhopygius	Red-backed Kingfisher		X	
Todiramphus sanctus	Sacred Kingfisher		X	
MEROPIDAE				
Merops ornatus	Rainbow Bee-eater	CS1	X	X
CLIMACTERIDAE				
Climacteris affinis	White-browed Treecreeper	CS3		
Climacteris rufa	Rufous Treecreeper	CS3	X	X
MALURIDAE				
Malurus splendens	Splendid Fairy-wren		Х	Х
Malurus leucopterus	White-winged Fairy-wren		Х	
Malurus lamberti	Variegated Fairy-wren			Х
Malurus pulcherrimus	Blue-breasted Fairy-wren		Х	Х
ACANTHIZIDAE				
Sericornis frontalis	White-browed Scrubwren			
Hylacola cauta whitlocki	Shy Heathwren	CS2		
Calamanthus campestri	Rufous Fieldwren			X
Pyrrholaemus brunneus	Redthroat		X	Х
Smicrornis brevirostris	Weebill		X	Х

В	irds	CS	Databases	Sandy Ridge
Gerygone fusca	Western Gerygone		X	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill		Х	Х
Acanthiza uropygialis	Chestnut-rumped Thornbill		X	Х
Acanthiza robustirostris	Slaty-backed Thornbill			
Acanthiza apicalis	Inland Thornbill		Х	Х
Aphelocephala leucopsis	Southern Whiteface		X	
PARDALOTIDAE				
Pardalotus punctatus	Spotted Pardalote			
Pardalotus striatus	Striated Pardalote		X	
MELIPHAGIDAE				
Certhionyx variegatus	Pied Honeyeater		X	
Lichenostomus virescens	Singing Honeyeater		X	X
Lichenostomus leucotis	White-eared Honeyeater		X	X
Lichenostomus cratitius	Purple-gaped Honeyeater	CS3		
Lichenostomus ornatus	Yellow-plumed Honeyeater	CS3	X	Х
Lichenostomus plumulus	Grey-fronted Honeyeater		Х	Х
Purnella albifrons	White-fronted Honeyeater		Х	Х
Manorina flavigula	Yellow-throated Miner		Х	Х
Acanthagenys rufogularis	Spiny-cheeked Honeyeater		X	Х
Anthochaera carunculata	Red Wattlebird		X	Х
Epthianura albifrons	White-fronted Cat		X	
Epthianura tricolor	Crimson Chat		X	
Epthianura aurifrons	Orange Chat			
Sugomel niger	Black Honeyeater		X	
Lichmera indistincta	Brown Honeyeater		X	
Melithreptus brevirostris	Brown-headed Honeyeater		X	
POMATOSTOMIDAE				
Pomatostomus superciliosus	White-browed Babbler		X	X
PSOPHODIDAE				
Cinclosoma castanotus	Copper-backed Quail- thrush	CS3	X	X
NEOSITTIDAE				
Daphoenositta chrysoptera	Varied Sittella		X	

B	Sirds	CS	Databases	Sandy Ridge
CAMPEPHAGIDAE				
Coracina maxima	Ground Cuckoo-shrike		X	
Coracina novaehollandiae	Black-faced Cuckoo-shrike		X	Х
Lalage sueurii	White-winged Triller		Х	
PACHYCEPHALIDAE				
Pachycephala inornata	Gilbert's Whistler	CS3	X	
Pachycephala rufiventris	Rufous Whistler		Х	Х
Pachycephala pectoralis	Golden Whistler		X	
Colluricincla harmonica	Grey Shrike-thrush		X	Х
Oreoica gutturalis	Crested Bellbird	CS3	X	Х
ARTAMIDAE				
Artamus personatus	Masked Woodswallow		X	
Artamus cinereus	Black-faced Woodswallow		X	Х
Artamus cyanopterus	Dusky Woodswallow		X	Х
Artamus minor	Little Woodswallow		X	
Cracticus torquatus	Grey Butcherbird		X	Х
Cracticus nigrogularis	Pied Butcherbird		X	Х
Cracticus tibicen	Australian Magpie		Х	Х
Strepera versicolor	Grey Currawong		X	Х
RHIPIDURIDAE				
Rhipidura albiscapa	Grey Fantail		X	
Rhipidura leucophrys	Willie Wagtail		X	Х
CORVIDAE				
Corvus bennetti	Little Crow		X	Х
Corvus orru	Torresian Crow		X	Х
Corvus coronoides	Australian Raven		X	
MONARCHIDAE				
Grallina cyanoleuca	Magpie-lark		X	
PETROICIDAE				
Petroica goodenovii	Red-capped Robin		X	
Melanodryas cucullata	Hooded Robin		X	
Microeca fascinans	Jacky Winter		X	X
Eopsaltria griseogularis	Western Yellow Robin	CS3	X	

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Birds		CS	Databases	Sandy Ridge
Drymodes brunneopygia	Southern Scrub-robin	CS3	Х	
ZOSTEROPIDAE				
Zosterops lateralis	Silvereye			
MEGALURIDAE				
Cincloramphus mathewsi	Rufous Songlark		Х	
Cincloramphus cruralis	Brown Songlark		Х	
HIRUNDINIDAE				
Cheramoeca leucosterna	White-backed Swallow		Х	
Hirundo neoxena	Welcome Swallow		Х	
Petrochelidon ariel	Fairy Martin		Х	X?
Petrochelidon nigricans	Tree Martin		Х	
NECTARINIIDAE				
Dicaeum hirundinaceum	Mistletoebird		Х	Х
ESTRILDIDAE				
Taeniopygia guttata	Zebra Finch		Х	
MOTACILLIDAE				
Anthus novaeseelandiae	Australasian Pipit		Х	
Total Number of Species Expected: 16	6		128	49

MAMMALS		CS	Databases	Sandy Ridge
Tachyglossidae				
Tachyglossus aculeatus	Echidna			Х
Dasyuridae				
Ningaui ridei	Ride's Ningaui		Х	
Ningaui yvonneae	Mallee Ningaui		Х	
Antechinomys laniger	Kultarr	CS3		
Pseudantechinus woolleyae	Woolley's Pseudantechinus		Х	
Sminthopsis crassicaudata	Fat-tailed Dunnart			
Sminthopsis dolichura	Little Long-tailed Dunnart		Х	
Sminthopsis gilberti	Gilbert's Dunnart			
Burramyidae				
Cercartetus concinnus	Western Pygmy Possum		Х	
Macropodidae				
Macropus fuliginosus	Western Grey Kangaroo			Х
Macropus robustus	Euro		Х	
Macropus rufus	Red Kangaroo			
Molossidae				
Mormopterus sp. 3	Inland Freetail Bat		Х	
Mormopterus sp. 4	Southern Freetail Bat			
Tadarida australis	White-striped Freetail Bat		Х	Х
Vespertilionidae				
Chalinolobus gouldii	Gould's Wattled Bat		Х	Х
Chalinolobus morio	Chocolate Wattled Bat		Х	
Nyctophilus geoffroyi	Lesser Long-eared Bat		Х	
Nyctophilus major tor	Inland Greater Long-eared Bat	CS2	Х	
Scotorepens balstoni	Inland Broad-nosed Bat		Х	
Vespadelus regulus	Southern Forest Bat		Х	
Vespadelus baverstocki	Inland forest bat		Х	
Muridae				
Notomys alexis	Spinifex Hopping Mouse		Х	
Notomys mitchelli	Mitchell's Hopping Mouse		Х	
Pseudomys albocinereus	Ash-Grey Mouse		Х	
	•		I	1

Table 4. Mammal species recorded or expected to occur in the survey area.

Bamford Consulting Ecologists

MAMMALS		CS	Databases	Sandy Ridge
Pseudomys bolami	Bolam's Mouse			
Pseudomys hermannsburgensis	Sandy Inland Mouse		Х	
INTRODUCED MAMMALS				
Canis lupus	Dingo			Х
Vulpes vulpes	European Red Fox			
Felis catus	Feral Cat			
Oryctolagus cuniculus	Rabbit		Х	Х
Mus musculus	House Mouse		Х	
Capra hircus	Goat			
Equus caballus	Horse			
Camelus dromedarius	Dromedary Camel			Х
Bos taurus	Cattle		Х	
Ovis aries	Sheep			
Total Number of Native Species Exp	ected: 26			4
Total Number of Introduced Species	Expected: 10			3

Appendix 4. Annotated Species list – fauna recorded from Sandy Ridge.

- 1. Neobatrachus sutor About 10 found sitting around margins of nearby claypan that flooded on 25/01. They were just sitting in shallow scrapes filled with water in broad daylight! In evening they were found our foraging up to 500m from the claypan, and they were calling from around the wetland.
- 2. Neobatrachus kunapalari. Two very large (60mm+) specimens found at night.
- 3. Diplodactylus granariensis. Found around camp by headtorching.
- 4. Diplodactylus pulcher. Found around camp by headtorching.
- 5. Gehyra purpurascens. Found around camp headtorching.
- 6. Gehyra variegata. Found around camp headtorching.
- 7. Hesperoedura reticulata. Found around camp by headtorching.
- 8. Lucasium maini. Found around camp by headtorching.
- 9. Rhynchoedura ornata. Found around camp by headtorching.
- 10. Ctenotus atlas. One seen in area of mallee over spinifex.
- 11. Ctenotus xenopleura. One caught in area of mallee over spinifex on red sandy-loam.
- 12. Ctenotus schomburgkii. Hatchling seen in pit area and few seen elsewhere.
- 13. Liopholis inornata. Burrows in sandy areas. Immature seen at entrance to a burrow in late afternoon (24/01).
- 14. Tiliqua occipitalis. Skull found in pit area and along access road.
- 15. Cryptoblepharus australis. One on tree near camp.
- 16. Menetia greyii. Several hatchlings seen.
- 17. Ctenophorus cristatus. Several seen along road from highway and in woodland areas of site.
- 18. Ctenophorus fordi. Sympatric with C.isolepis.
- 19. Ctenophorus scutullatus. Few in pit area and around camp in areas of shrubland.
- 20. Ctenophorus isolepis citrinus. Adults and hatchlings in sandy areas of pit area.
- 21. Moloch horridus. Several seen in pit area.
- 22. Pogona minor. One basked in top of tall shrub 2.5m above ground.
- 23. Varanus gouldii. Several recently-hatched animals along road from highway. Tracks and diggings in project area.
- 24. Varanus tristis. Tracks around site going from tree to tree.
- 25. Anilios australis. One active at night near camp (26/01).
- 26. Brachyurophis semifasciata. Found around camp by headtorching.
- 1. Emu. Fresh tracks in accommodation area.
- 2. Malleefowl. Old mounds.
- 3. Common Bronzewing. Several seen in pit area.
- 4. Purple-crowned Lorikeet. Dead juvenile in camp.
- 5. Australian Ringneck. Few around camp on one occasion, and heard along south access road.
- 6. Little Button-quail. Occasional individual flushed during surveys.
- 7. Collared Sparrowhawk. Adult male flew through camp (24/01).
- 8. Brown Falcon. Pair over pit area (24/01) and seen around camp most days.
- 9. Owlet-nightjar. One calling near camp (night of 23/01).
- 10. Tawny Frogmouth. One flushed during the day on walk to claypan and one calling near camp night of 26/01.
- 11. Rainbow Bee-eater. Two near camp (23/01).

- 12. Rufous Treecreeper. Heard just north-west of camp (23/01).
- 13. Blue-breasted Fairy-wren. Group in shrubland on pit area and along southern access road.
- 14. Variegated Fairy-wren. Parties along southern access road and southern pipeline route.
- 15. Splendid Fairy-wren. Party near camp and along southern pipeline route.
- 16. Inland Thornbill. Few in pit area.
- 17. Chestnut-rumped Thornbill. Widespread in project area.
- 18. Weebill. Amongst eucalypts throughout project area.
- 19. Redthroat. Few in project area.
- 20. Rufous Fieldwren. Few calling in heath area.
- 21. Red Wattlebird. Seen occasionally near camp.
- 22. Spiny-cheeked Honeyeater. Small parties throughout.
- 23. Yellow-throated Miner. Party in project area.
- 24. White-eared Honeyeater. Few in pit area.
- 25. Yellow-plumed Honeyeater. Few near camp.
- 26. Grey-fronted Honeyeater. Occasionally in Marri and sand pine areas.
- 27. Singing Honeyeater. Few heard in shrubland areas.
- 28. White-fronted Honeyeater. Heard in pit area.
- 29. White-browed Babbler. Several parties in pit area.
- 30. Willie Wagtail. One near camp (23/01, 26/01).
- 31. Crested Bellbird. Calling around camp.
- 32. Jacky Winter. Few in woodland areas.
- 33. Rufous Whistler. Seen occasionally but not calling. Only female-coloured birds.
- 34. Grey Shrike-thrush. Seen and heard in pit area (24/01).
- 35. Copper-backed Quail-thrush. Party near camp (26/01).
- 36. Black-faced Cuckoo-shrike. Seen near camp (23/01) and group of six flying across pit area (26/01).
- 37. Dusky Woodswallow. Few small groups over pit area most days.
- 38. Black-faced Woodswallow. Few near Mt Dimer Rd (26/01).
- 39. Grey Currawong. Heard near camp.
- 40. Torresian Crow. Several calling around camp at sunrise (24/01).
- 41. Australian Magpie. Small group near camp.
- 42. Grey Butcherbird. Calling around camp at dawn.
- 43. Pied Butcherbird. Heard once in pit area.
- 44. Martin sp. One seen in distance over pit area (24/01).
- 1. Echidna. Fresh tracks at several locations and dead specimen in pit area.
- 2. Tadarida australis. Few calling at night.
- 3. Chalinolobus gouldii. One flushed from tree hollow in accommodation area.
- 4. Camel. Fresh tracks of 2 adults and 2 smaller animals along track near Mt Dimer Rd.
- 5. Kangaroo. Fresh tracks in puddles but species uncertain.
- 6. Rabbit. Diggings and scats along southern pipeline route.
- 7. Dingo. Old tracks around claypan.

At least three species of trapdoor spiders present.

Gaius villosus. Several found and some exceptionally large, with burrow diameter >40mm.

Aganippe sp. Burrow with fan of leaves and thick lid with heavy architecture of twigs, some upright. One found in middle of MF2.

Aganippe? Sp. Burrow with fan of leaves; lid flat and slightly flexible.