Balline Garnet Project -
Fauna Assessment

Project area from the south, showing remnant native vegetation
and extensive paddocks (M. Bamford)

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9th December 2013

Executive summary

As part of Environmental Impact Assessment for the development of the Balline Garnet Project, Bamford Consulting Ecologists (BCE) was commissioned by Pemaco Services to conduct a Level 1 fauna assessment (desktop review and site inspection) within the Balline area (tenement M70/1280 and associated infrastructure footprint) – termed the "project area". BCE uses an impact assessment process with the following components:

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

The fauna investigations were based on a desktop assessment and a site reconnaissance survey in September 2013. The desktop survey identified an assemblage of 187 vertebrate fauna species potentially occurring in the Balline area. This comprised 10 frog, 64 reptile, 87 bird, 14 native mammal and eight introduced mammal species. However, many of these species may be present infrequently because of the condition of the site. A total of 30 fauna species was recorded during the field survey: four reptile, 23 bird, two native mammal and four introduced mammal species. Six vertebrate species of conservation significance fauna species were recorded during the field survey, and three invertebrate species possibly of conservation significance were recorded during the survey or on previous surveys.

Key **fauna values** are:

Fauna assemblage. Depauperate because of extensive clearing. Remnant vegetation on shallow soils over limestone is distinctive, may be regionally uncommon and thus may have a locally unusual (albeit species-poor) fauna assemblage.

Species of conservation significance. These include three reptile species, 17 bird species, one amphibian species and two terrestrial invertebrates. Two species of subterranean fauna were also found in the groundwater of the site, and one probably SRE terrestrial invertebrate was confirmed; these may be of local conservation significance. Vertebrate species of note are the Southern Sandhill Frog, Carpet Python, the skinks *Cyclodomorphus branchialis* and *Lerista axillaris.* However, extensive clearing of the site means that most of these species are expected only rarely and/or as vagrants. The presence of a suite of locally significant birds reliant on remnant native vegetation is of conservation interest.

Vegetation and Substrate Associations. Most of the project area consists of paddocks used for livestock grazing. Remnants of native vegetation can be divided into Acacia Shrubland to Tall Shrubland on yellow-brown sands, and *Melaleuca cardiophylla* Shrubland to tall shrubland on shallow grey sands over limestone, with extensive limestone outcropping. This vegetation associated with limestone close to the surface occurs largely in the west, but also on the hilltop in the southern block. Both these VSAs are extensively cleared to the north and south. Approximately 0.3% of native vegetation within a 15km radius of the centre-point of project area may be cleared as part of the proposed development.

Patterns of biodiversity. Biodiversity is likely to occur in VSA2 and VSA3 which comprise remnant patches of Acacia shrubland and Acacia Melaleuca shrubland, respectively. These VSAs are likely to be important for most of the native fauna assemblage present in the study area.

Key Ecological Processes. Because of extensive clearing, connectivity between remnants of native vegetation is likely to be important for biodiversity maintenance. With regard to connectivity, the project area lies between Kalbarri National Park to the north, and Utcha Well Nature Reserve to the south, so may provide connectivity for wildlife moving between these two conservation areas. The coastal unallocated crown land provides uninterrupted but narrow linkage between the two reserves. Degradation of remnants by domestic livestock is of concern.

Impacts upon fauna include**:**

- Potential loss and further fragmentation of habitat; and
- Possible hydrological change.

In addition, there may be some positive impacts such as reduced grazing in remnants and the potential to enhance linkage through rehabilitation.

Recommendations relate to impacts and include:

- Rehabilitation after mining and possibly improvement of linkage through planting habitat corridors between remnants;
- Restrict access of livestock to remnants where possible;
- Minimising vegetation clearing; and
- Taking a precautionary approach to minimise impacts through changes in hydrology.

Contents

Executive summary i
Contents iii
List of Tables iv
List of Figures v
List of Appendices v
1 Introduction 1
1.1 Introduction 1
1.2 General Approach to Fauna Impact Assessment 1
1.3 Description of Survey Area 2
2 Background 5
2.1 Regional Description 5
2.2 Vegetation Units 6
3 Methods 7
3.1 Overview 7
3.2 Desktop Assessment 8
3.2.1 Sources of information 8
3.2.2 Previous Fauna Surveys 8
3.2.3 Nomenclature and taxonomy 9
3.2.4 Interpretation of species lists 9
3.3 Field survey 10
3.3.1 Overview 10
3.3.2 Dates and Personnel 10
3.3.3 Vegetation and Substrate Associations 10
3.3.4 Targeted searching for conservation significant species 10
3.3.5 Opportunistic observations 10
3.4 Survey limitations 10
3.5 Presentation of results for Impact Assessment 12
3.5.1 Criteria for impact assessment 13
4 Results 15
4.1 Vertebrate Fauna 15

4.1.1 Overview of fauna assemblage 15
Major Mitchell's Cockatoo 17
Cacatua leadbeateri 17
4.1.2 Species of conservation significance 18
4.1.3 Introduced / Feral Species 20
4.2 Summary of species of conservation significance 20
4.3 Vegetation and Substrate Associations (VSAs) 21
4.4 Patterns of biodiversity 26
4.5 Ecological processes 26
4.6 Summary of fauna values 26
5 Impact assessment 28
5.1 Overview of Impacts 28
5.1.1 Loss of habitat leading to population decline 28
5.1.2 Loss of habitat leading to population fragmentation 28
5.1.3 Degradation of habitat due to weed invasion 28
5.1.4 Ongoing mortality 28
5.1.5 Species interactions 28
5.1.6 Hydroecology 29
5.1.7 Altered fire regimes 29
5.1.8 Disturbance 29
5.1.9 Summary of impacts 29
6 Recommendations 31
7 References 32
8 Appendices 35

List of Tables

Table 1. Sources of information used for the desktop assessment. 8
Table 2. Survey limitations as outlined by EPA (2004). 11
Table 3. Assessment criteria of impacts upon fauna. 14
Table 4. Composition of vertebrate fauna assemblage expected to occur within the survey area (Values in parenthesis are numbers of introduced species included in the total. CS – Conservation Significant). 16

Table 5. Conservation status of significant fauna species expected to occur in project area (based on desktop review and field investigation). 17
Table 6. Introduced fauna species expected to occur in project area (based on desktop review and field investigation). 20
Table 7. Summary of potential impacts upon key fauna values that are expected to occur in the survey area. 30

List of Figures

Figure 1. Location of project area. 3
Figure 2. The extent of remnant native vegetation within a 15km radius of the project area. 4
Figure 3. IBRA Subregions in Western Australia. 5
Figure 4. The distribution of Vegetation and Substrate Associations in the project area. 22
Figure 5. Acacia shrubland in remnant in north of project area. 23
Figure 6. Acacia shrubland badly degraded by livestock. 23
Figure 7. Acacia tall shrubland in sheltered valley in southern remnant. 24
Figure 8. Melaleuca shrubland with exposed limestone in western remnant. 24
Figure 9. View across large remnant in south from the west. Acacia shrubland in the foreground is tall and appears to be regrowth after past clearing, while the top of the hill in the background supports Melaleuca shrubland. Pasture lies to the left. 25

List of Appendices

Appendix 1. Explanation of fauna values. 35
Appendix 2. Explanation of threatening processes. 38
Appendix 3. Categories used in the assessment of conservation status. 41
Appendix 4. Ecological and threatening processes identified under legislation and in the literature. 42
Appendix 5. Fauna recorded or expected to occur in the Balline survey area (Tables 1 to 5). 44
Appendix 6. Vertebrate species returned in database searches but unlikely to be found in the project area. 51

1 Introduction

1.1 Introduction

As part of Environmental Impact Assessment for development of the Balline Garnet Project, Bamford Consulting Ecologists (BCE) was commissioned by Pemaco Services to conduct a Level 1 fauna assessment, consistent with EPA Guidance, (desktop review and site inspection) within the Balline area – termed the "project area". A level 1 fauna assessment is required to identify the fauna values of a site so that impacts upon these from any proposed development can be assessed and, where possible, minimised.

1.2 General Approach to Fauna Impact Assessment

The purpose of impact assessment is to provide government agencies with the information they need to decide upon the significance of impacts of a proposed development. BCE uses an impact assessment process with the following components:

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

Descriptions and background information on these values and processes can be found in Appendices 1 to 4. Based on this impact assessment process, the objectives of investigations are to: identify fauna values; review impacting processes with respect to these values and the proposed development; and provide recommendations to mitigate these impacts.

1.3 Description of Survey Area

The Balline survey area is comprised of tenement M70/1280, L70/134 and associated infrastructure footprints, and is located approximately 35km south of Kalbarri and 460km north of Perth. It lies in a region extensively cleared for agriculture, but with large tracts of uncleared land to the north, east and south (Figures 1 and 2). Some of these areas of uncleared vegetation are within conservation areas (Kalbarri National Park to the north and Utcha Well Nature Reserve to the south, see Figure 1). The site contains remnant patches of *Acacia rostellifera* thicket and *Melaleuca cardiophylla* heath (Ecoscape 2009), and these patches are part of a network that may provide connectivity for fauna between the larger areas of native vegetation to the north, east and south (Figure 2).

The total area of the site is about 1176ha, of which about 426ha supports remnant native vegetation in four blocks: an area in the north, two patches in the centre and a large area in the south (Figure 2). Part of this southern block has been previously disturbed but is now regenerating although has high levels of weed invasion. The remainder is cleared agricultural land.

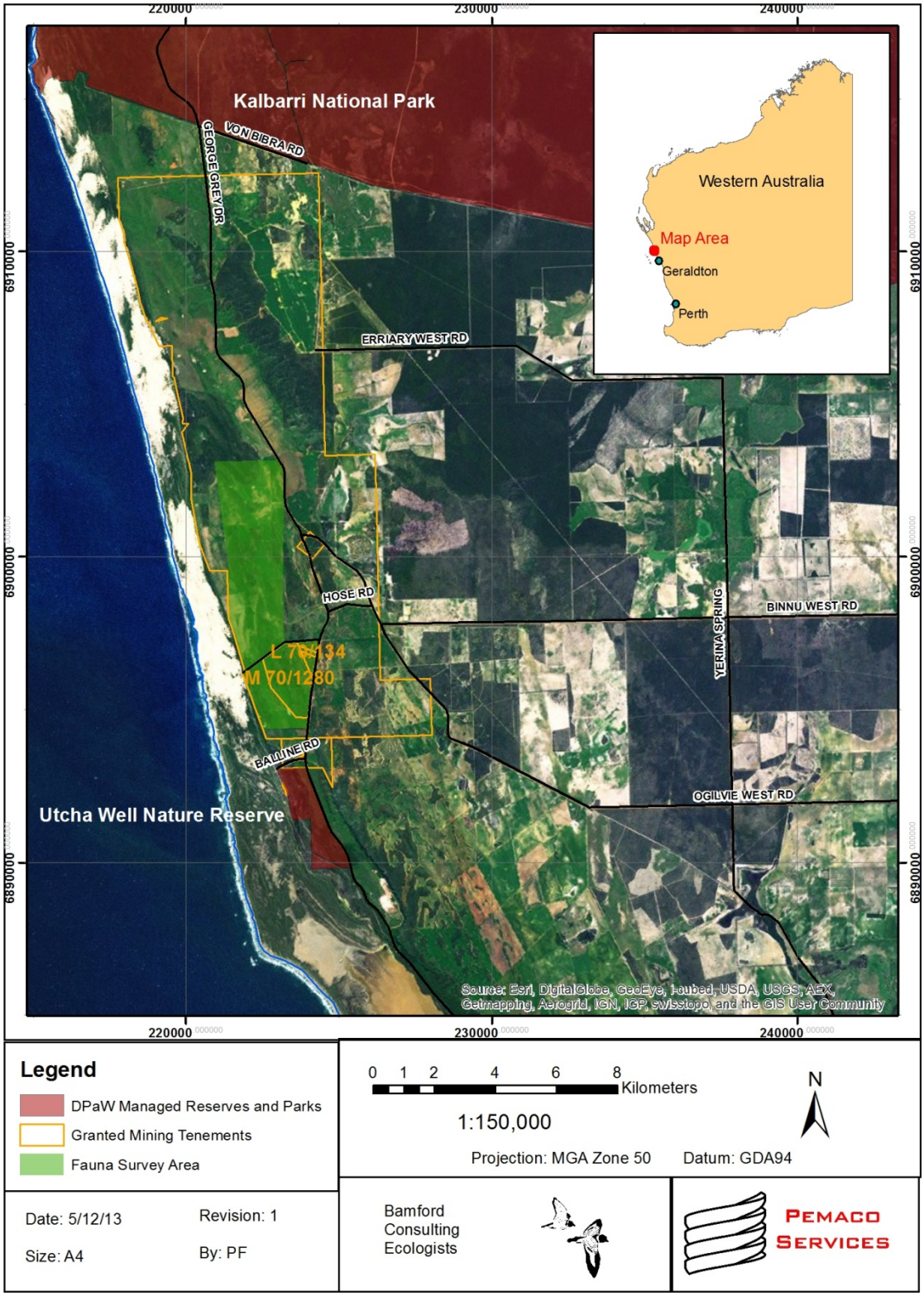

Figure 1. Location of project area.

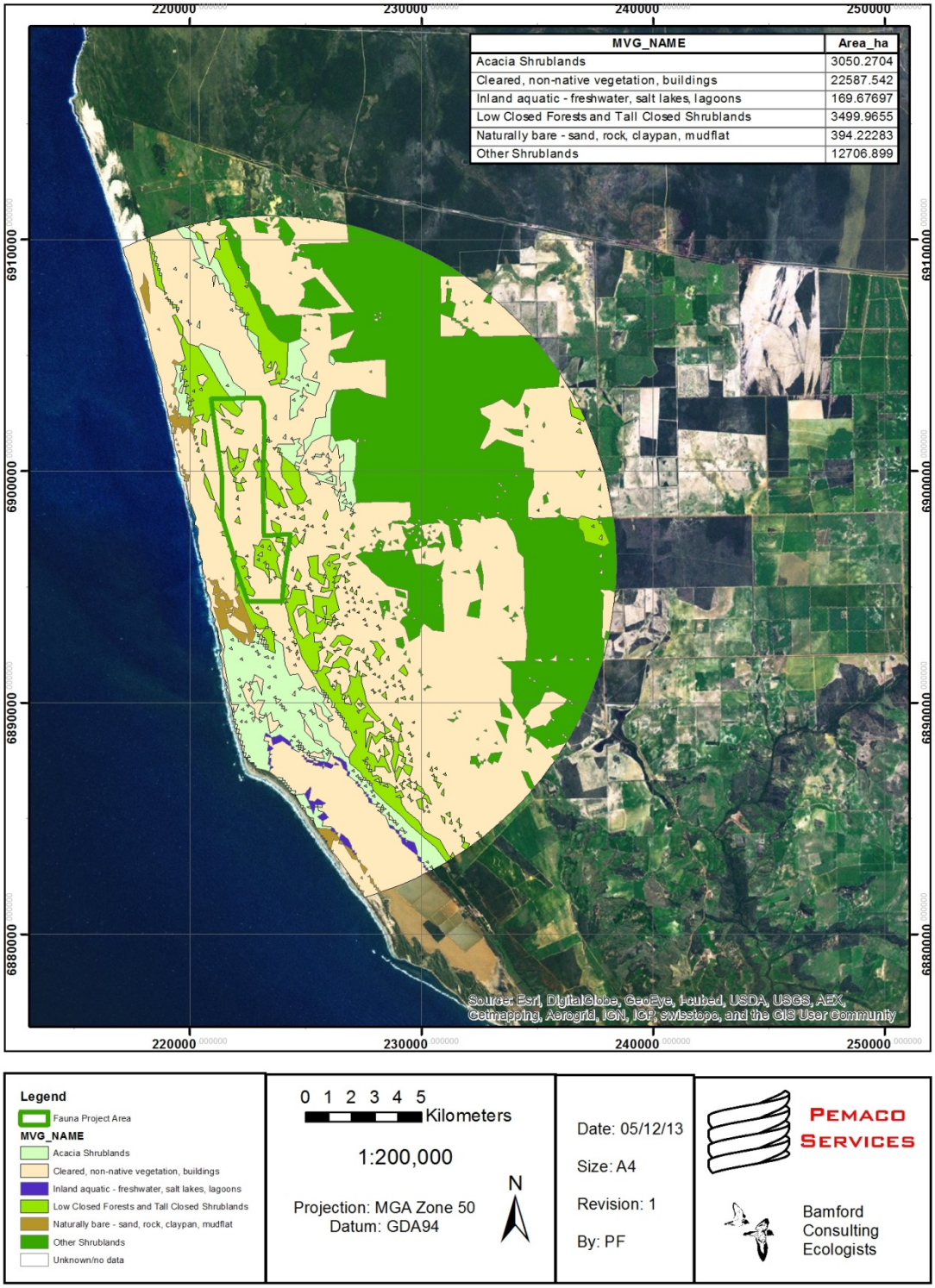

Figure 2. The extent of remnant native vegetation within a 15km radius of the project area.

2 Background

2.1 Regional Description

The Interim Biogeographic Regionalisation of Australia (IBRA) (Environment Australia, 2000) has identified 26 bioregions in Western Australia (Figure 2). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell, 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA, 2004).

The Balline survey area lies in the Geraldton Sandplains Bioregion and the Geraldton Hills Subregion (DSEWPaC 2013b), although it is probably atypical of these areas with distinctive near-coastal soils and vegetation.

Figure 3. IBRA Subregions in Western Australia.

Note the project area lies in GS2 (Geraldton Hills) IBRA subregion.

The Geraldton Hills subregion is characterised by "sand heaths with emergent Banksia and Actinostrobus, York Gum woodlands on alluvial plains, proteaceous heath and Acacia shrubs on limestones. The climate is Warm semi-arid to Mediterranean with 400-500mm of rainfall annually, and the subregional area is 2,242,033 ha."(Desmond and Chant 2001)

The dominant land use in this subregion is dry-land agriculture and smaller areas of conservation, grazing native pastures, UCL and Crown Reserves. Desmond and Chant (2001) describe the Geraldton Hills Subregion as having areas of relatively high ecosystem or species diversity.

2.2 Vegetation Units

Beard (1972, 1976) mapped the Geraldton Hills region including the Balline survey area. The vegetation community in the area is mostly Shrubland; *Acacia rostellifera* thicket.

3 Methods

3.1 Overview

The methods used in these investigations are based upon the general approach to fauna investigations for impact assessment as outlined in Section 1.2 and EPA Guidance Statement 56, and with reference to Appendices 1 to 4. Thus, the impact assessment process involves the identification of fauna values, review of impacting processes and preparation of mitigation recommendations.

In addition, the approach to fauna impact assessment was carried out with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (EPA) on fauna surveys and environmental protection, and Commonwealth biodiversity legislation (EPA 2002; EPA 2004). The EPA proposes two levels of investigation that differ in the approach to field investigations, Level 1 being a review of data and a site reconnaissance to place data into the perspective of the site, and Level 2 being a literature review and intensive field investigations (e.g. trapping and other intensive sampling). The level of assessment recommended by the EPA is determined by the size and location of the proposed disturbance, the sensitivity of the surrounding environment in which the disturbance is planned, and the availability of pre-existing data.

As the proposed Balline Garnet Project is in bankable feasibility stage, Pemaco Services requested a Level 1 fauna assessment of the area. A Level 1 fauna assessment consists of a desktop study and basic ground-truthing through a reconnaissance survey.

The following approach and methods is divided into three groupings that relate to the stages and the objectives of impact assessment:

- Desktop assessment. The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the project area based on unpublished and published data using a precautionary approach.
- Field investigations. The purpose of the field investigations is to gather information on this assemblage: confirm the presence of as many species as possible (with an emphasis on species of conservation significance), place the list generated by the desktop review into the context of the environment of the project area, collect information on the distribution and abundance of this assemblage, and develop an understanding of the project area's ecological processes that maintain the fauna. Note that field investigations cannot confirm the presence of an entire assemblage, or confirm the absence of a species. This requires far more work than is possible in the EIA process. For example, in an intensive trapping study, How and Dell (1990) recorded in any one year only about 70% of the vertebrate species found over three years. In a study spanning over two decades, Bamford (2010b) has found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a set of sites only defines the assemblage of those sites at the time of sampling.
- Impact assessment. Determine how the fauna assemblage may be affected by the proposed development based on the interaction of the project with a suite of ecological and threatening processes.

3.2 Desktop Assessment

3.2.1 Sources of information

Information on the fauna assemblage of the project area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the DEC Naturemap (incorporating the Western Australian Museum's FaunaBase and the DEC Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA), the EPBC Protected Matters Search Tool and the BCE database (Table 1). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Frogs: Tyler *et. al.* (2000);
- Reptiles: Storr *et al.* (1983); Storr *et al*. (1990); Storr *et al*. (1999); Storr *et al.* (2002) and Wilson & Swan (2008);
- Birds: Blakers *et al*. (1984); Johnstone and Storr (1998, 2004) and Barrett et al. (2003); and
- Mammals: Menkhorst & Knight (2001); Strahan (2004); Churchill (2008); and Van Dyck and Strahan (2008).

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

Database	Type of records held on database	Area searched
NatureMap (DPaW 2013)	Records in the WAM and DPaW databases. Includes historical data and records on Threatened and Priority species in WA.	28° 01' 10"S, 114° 10' 53"E – plus 40 km buffer
BirdLife Australia Atlas Database	Records of bird observations in Australia, 1998-2013.	Species list for one degree cell containing: 28° 01' 10"S, 114° 10' 53"E
EPBC Protected Matters	Records on matters of national environmental significance protected under the EPBC Act.	28° 01' 10"S, 114° 10' 53"E – plus 40 km buffer

3.2.2 Previous Fauna Surveys

A Level 1 fauna and flora investigation of the survey area was conducted by Ecoscape (2009); this was based upon a literature review and ground-truthing. A Subterranean Fauna Survey of the site was conducted by Goater and Knott (2009), using digital imaging and net sampling.

3.2.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004a), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) *Checklist of the Vertebrates of Western Australia 2008*. The authorities used for each vertebrate group were: amphibians (Doughty and Maryan 2010a), reptiles (Doughty and Maryan 2010b), birds (Christidis and Boles 2008), and mammals (How *et al*. 2009). English names of species, where available, are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

3.2.4 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey area, meant that it was highly unlikely that these species would be present. Some are also known to be regionally extinct. In general, however, species returned by the desktop review process are considered to be potentially present in the survey area whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This is because fauna are highly mobile, often seasonal and frequently cryptic. This is particularly important for significant species that are often rare and hard to find. Species returned from databases but excluded from species lists are presented in Appendix 6.

Interpretation of species lists generated through the desktop review included assigning an expected status within the survey area to species of conservation significance. This is particularly important for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive. The status categories used are:

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

3.3 Field survey

3.3.1 Overview

The field survey included several components:

- targeted searching for conservation significant fauna;
- opportunistic fauna observations; and
- habitat assessment.

3.3.2 Dates and Personnel

The Balline survey area was assessed on the 14th September 2013 by Dr Michael Bamford (B.Sc. Hons. Ph.D.) and Ms Amanda Bamford (B.Sc. Hons.). This fauna assessment document was prepared by Ms Claudia McHarrie (B.Sc. Hons.) and Dr Mike Bamford.

3.3.3 Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) throughout the survey area were assessed during the desktop review and as part of the field investigations. Within the Balline survey area, each major VSA was visited to develop an understanding of major fauna habitat types present and to assess the likelihood of conservation significant species being present in the area.

3.3.4 Targeted searching for conservation significant species

Significant species recorded during the desktop assessment include several that can be found by searching for evidence of their activities (e.g. scats, tracks, diggings, burrows) or listening for their call. Searching for evidence of significant fauna was therefore undertaken by walking through habitat considered suitable for such species, as well as searching for suitable nesting hollows for black-cockatoos.

3.3.5 Opportunistic observations

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds or reptiles seen while travelling through the site.

3.4 Survey limitations

The EPA Guidance Statement 56 (EPA 2004a) outlines a number of limitations that may arise during surveying. These survey limitations are discussed in the context of the BCE fauna survey at the project area in Table 2.

Table 2. Survey limitations as outlined by EPA (2004).

EPA Limitation	BCE Comment
Level of survey.	Level 1 (desktop study and reconnaissance survey). Survey intensity was deemed adequate due to the level of survey and the number of fauna surveys previously conducted in the region.
Competency/experience of the consultant(s) carrying out the survey.	The authors have had extensive experience in conducting desktop reviews and site inspections.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	As a level 1 survey, the scope was not to comprehensively sample fauna; the inspection was adequate to define fauna habitats and there was abundant desktop data on the fauna assemblage in the region.
Proportion of fauna identified, recorded and/or collected.	No specimens collected, all fauna observed identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include previous Ecoscape fauna survey of the site; databases (BA, DEC, WAM, EPBC)
The proportion of the task achieved and further work which might be needed.	Site inspection completed.
Timing/weather/season/cycle.	Site inspection conducted during September 2013. Conditions were mild, with 6.6mm rainfall recorded on the day of the survey
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	Significant clearing for agriculture, livestock grazing and weed invasion See description in Section 5.1.1
Intensity. (In retrospect, was the intensity adequate?)	Survey intensity was low (desktop study and site inspection) however was adequate to satisfy EPA guidelines.
Completeness (e.g. was relevant area fully surveyed).	Desktop study covered survey area and adjacent habitats. Site inspection covered all areas of the project.
Resources (e.g. degree of expertise available in animal identification to taxon level).	All species identified to taxon level.
Remoteness and/or access problems.	No access problems.
Availability of contextual (e.g. biogeographic) information on the region.	Extensive regional information was available and was consulted.

3.5 Presentation of results for Impact Assessment

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

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

The impact assessment process therefore involves reviewing the fauna values identified through the desktop assessment and field investigations with respect to the project and impacting processes. The severity of impacts on the fauna assemblage and conservation significant fauna can then be quantified on the basis of predicted population change.

The presentation of this assessment follows the general approach to impact assessment as given in Section 1.2, but modified to suit the characteristics of the site. Key components to the general approach to impact assessment are addressed as follows:

Fauna values

This section presents the results of the desktop and field investigations in terms of key fauna values (described in detail in Appendix 1):

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

Impact assessment

This section reviews impacting processes (as described in detail in Appendix 2) with respect to the project and examines the potential effect of these impacts upon biodiversity of the alignment. It thus expands upon Section 1.3 and discusses the contribution of the project to impacting processes, and the consequences of this with respect to biodiversity. A major component of impact assessment is consideration of threats to species of conservation significance as these are a major and sensitive element of biodiversity. Therefore, the impact assessment includes the following:

- Review of impacting processes; will the proposal result in:

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

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

3.5.1 Criteria for impact assessment

Impact assessment criteria are based on the severity of impacts on the fauna assemblage and conservation significant fauna, and were quantified on the basis of predicted population change (Table 3). Population change can be the result of direct habitat loss and/or impacts upon ecological processes.

The significance of population change is contextual. The EPA (2004) suggests that the availability of fauna habitats within a radius of 15km can be used as a basis to predict low, moderate or high impacts. In this case, a high impact is where the impacted environment and its component fauna is rare (<5% of the landscape within a 15km radius or within the Bioregion), whereas a low impact is where the environment is widespread (10% of the local landscape). Under the Ramsar Convention, a wetland that regularly supports 1% of a population of a waterbird species is considered to be significant. These provide some guidance for impact assessment criteria. In the following criteria (Table 3), the significance of impacts is based upon percentage population decline within a 15 km radius (effectively local impact) and upon the effect of the decline upon the conservation status of a recognised taxon (recognisably discrete genetic population, sub-species or species). Note that percentage declines can usually only be estimated on the basis of distribution of a species derived from the extent of available habitat.

Table 3. Assessment criteria of impacts upon fauna.

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

4 Results

4.1 Vertebrate Fauna

4.1.1 Overview of fauna assemblage

The desktop study identified 187 vertebrate fauna species as potentially occurring in the Balline survey area (see Table 4 and Appendix 6): 10 frogs, 64 reptiles, 87 birds, and 14 native and 8 introduced mammals. Note that this assemblage comes from databases and includes species that may occur occasionally on the site, but for which it is not important (such as birds that rarely fly overhead). The vertebrate assemblage includes at least 30 species of conservation significance ((Table 5), with a further 46 significant species returned from databases but which are not considered likely to occur in the project area (included in Appendix 6). In addition, one terrestrial invertebrate species of high conservation significance was returned from databases, while three invertebrate species that may be of local conservation significance were recorded. These are also listed in Table 5, and significant species are discussed further in Section 4.1.2.

While the assemblage is large, the site is extensively cleared and therefore many of the species expected to be present probably only occur infrequently and may not be reliant on the site. As a result, key features of the fauna assemblage expected in the project area are:

- Uniqueness: The assemblage is likely to be typical of the region, but may have some unusual elements because of the near-coastal vegetation and soils. The site inspection confirmed the presence of a number of bird species reliant upon remnant native vegetation (and thus absent from surrounding farmland).
- Completeness: The assemblage is likely to be incomplete because much of the site is cleared. The mobility of fauna means that many species could be recorded in the project area over time, but many of the records would be of vagrant individuals moving between nearby patches of native vegetation.
- Richness: The assemblage is likely to be depauperate because of the scarcity of intact native vegetation.

As a fauna value, the most important feature of the site's assemblage is that it is reliant upon remnant native vegetation in an otherwise agricultural landscape.

Table 4. Composition of vertebrate fauna assemblage expected to occur within the survey area
(Values in parenthesis are numbers of introduced species included in the total. CS – Conservation Significant).

Taxon	Number of species expected	Number of species recorded	Significant fauna Expected (recorded)		
			CS1	CS2	CS3
Frogs	10	0	0	0	1 (0)
Reptiles	64	4	2 (0)	1 (0)	0
Birds	87	20	7 (0)	4 (0)	6 (0)
Native Mammals	14	2	0	0	0
Introduced Mammals	8	4			
CS Invertebrates	4	3	1 (0)	0	3 (3)
Total	**187**	**33**	**10**	**5**	**10**

Table 5. Conservation status of significant fauna species expected to occur in project area (based on desktop review and field investigation).

Common Name	Latin Name	Conservation Status			Expected status in project area
		CS1	CS2	CS3	
AMPHIBIANS					
Southern Sandhill Frog	*Arenophryne xiphorhyncha*			X	Resident?
REPTILES					
Carpet Python	*Morelia spilota*	S4			Resident
	Cyclodomorphus branchialis	S1			Resident
Stripe-sided Robust Slider	*Lerista axillaris*		P2		Resident
BIRDS					
Fork-tailed Swift	*Apus pacificus*	Mig, S3			Occasional visitor
Malleefowl	*Leipoa ocellata*	S1			Vagrant
Peregrine Falcon	*Falco peregrinus*	S4			Occasional visitor
Rainbow Bee-eater	*Merops ornatus*	Mig, S3			Regular visitor
Major Mitchell's Cockatoo	*Cacatua leadbeateri*	S4			Vagrant
White-browed Babbler (wheatbelt form)	*Pomatostomus superciliosus*		P4		Recorded in project area
Australian Bustard	*Ardeotis australis*		P4		Occasional visitor
Bush Stone-curlew	*Burhinus grallarius*				Vagrant
Crested Bellbird (wheatbelt form)	*Oreoica gutturalis*				Occasional visitor
Splendid Fairy-wren	*Malurus splendens*			X	Recorded in project area
Variegated Fairy-wren	*Malurus lamberti*			X	Recorded in project area
White-winged Fairy-wren	*Malurus leucopterus*			X	Recorded in project area
Blue-breasted Fairy-wren	*Malurus pulcherrimus*			X	Regular visitor
Inland Thornbill	*Acanthiza apicalis*			X	Recorded in project area
White-browed Scrubwren	*Sericornis frontalis*			X	Recorded in project area
INVERTEBRATES					
Native Bee	*Neopasiphae simplicior*	Cr, S1			Resident?
Isopod (slater)	*Buddelundia "81"*			X	Recorded in project area
Subterranean crustacea	Ostracod and calanoid copepod			X	Recorded in project area

See Appendix 1 for descriptions of conservation significance levels. Species recorded are indicated and the predicted status of each species in the project is also given (as per Section 2.4.1).

EPBC Act listed species: V = Vulnerable, En = Endangered, Cr = Critically Endangered, Mig = Migratory.

WC Act listed species: S1 = Schedule 1, S3 = Schedule3, S4 = Schedule 4, DEC Priority Species: P1 = Priority 1, P2 = Priority 2, P3 = Priority 3, P4 = Priority 4, P5 = Priority 5.

4.1.2 Species of conservation significance

Details on species of conservation significance returned from the database and expected (including those recorded) to occur in the project area (even as vagrants) are presented in Table 5. This list includes one amphibian species, three reptile species, 15 bird species and four invertebrate species. Further information on species that might be present, including observations from the site inspection, is presented below. Note that species extinct in the region and that may have been present historically on the basis of broad patterns of distribution have not been included (but are listed in Appendix 6).

Southern Sandhill Frog (*Arenophyrne xiphorhyncha*)
This species has a restricted distribution, occurring along the coast from Kalbarri National Park north to Shark Bay. It may occur in the sandy hills and ridges present within the survey area, which lies immediately to the south of Kalbarri National Park, but the project area may lie just south of the species' range.

Carpet Python (*Morelia spilota*)
This species is listed as CS1 and, if present in the survey area, is at the extreme north of its known range. It has been reported in the vicinity by local farmers and may be a resident of native vegetation in the project area.

Cyclodomorphus branchialis
This species may be present in the remnant vegetation of the project area. It has previously been recorded during a survey near Galena, approximately 70km east of the survey area (M. Bamford unpubl. data).

Stripe-sided Robust Slider *(Lerista axillaris)*
This species may be present in the project area, confined to patches of remnant vegetation.

Peregrine Falcon (*Falco peregrinus*)
This species is found in a variety of habitats, including rocky ledges, cliffs, watercourses, open woodland and acacia shrublands. The distribution of the Peregrine Falcon is often tied to the abundance of prey as this species predates heavily on other birds. The Peregrine Falcon lays its eggs in recesses of cliff faces, tree hollows or in large abandoned nests of other birds (Birds Australia 2012). Blakers *et al.* (1984) consider that Australia is one of the strongholds of the species, since it has declined in many other parts of the world. Though it is unlikely that Peregrine Falcons breed in the project area due to lack of nesting habitat, it is possible that a pair lives in the region and forages over the project area occasionally.

Australian Bustard (*Ardeotis australis*)
The Australian Bustard is nomadic and may range over very large areas, largely dependent on rainfall and hence food availability. It may be an occasional visitor to the project area.

Fork-tailed Swift (*Apus pacificus*) and Rainbow Bee-eater (*Merops ornatus*)
The Fork-tailed Swift is largely aerial but may over-fly the project area occasionally. The Rainbow Bee-eater is an abundant, ground-nesting species that catches insects on the wing over a range of environments. It is a summer, breeding visitor to the South-West of WA and is likely to be present annually in the project area.

Malleefowl (*Leipoa ocellata*)

No Malleefowl mounds were found during the field survey but the species is known to be present in the general region. The remnant vegetation within the site may be too small to support the species, but may allow for vagrant birds to move through the project area.

White-browed Babbler (western wheatbelt sub-species)

This species is listed as CS2 due to extensive clearing of habitat. It was recorded in the project area during the field survey, with one party found in the large area of remnant native vegetation in the south.

Major Mitchell's Cockatoo

Known from the general region but probably only present as a vagrant as there is no eucalypt woodland, its preferred habitat.

Bush Stone-curlew

This species is listed as CS2 due to extensive clearing of habitat and probably predation by Foxes. It was not recorded on the site during the field survey but may be a vagrant. There is probably too little continuous habitat to support this species.

Crested Bellbird (Wheatbelt sub-species)

This species is listed as CS2 due to habitat loss as a result of clearing for agriculture. It was not recorded on the site during the field survey and is very conspicuous due to its distinctive call. Therefore it is probably not resident but may be an occasional visitor.

CS3 Birds

The Splendid Fairy-wren, Variegated Fairy-wren, White-winged Fairy-wren, White-browed Scrubwren and Inland Thornbill were recorded during the site visit, and are listed as CS3 because they are likely to be restricted to native vegetation; thus populations may be locally significant where they occur.

Significant invertebrates

There is one terrestrial invertebrate of high conservation significance (CS1) that may be present in the project area, the native bee *Neopasiphae simplicior*. *Neopasiphae simplicior* is a short-tongued bee which utilises *Lobelia tenuior*, *Goodenia filiformis* and *Angianthus preissianus*. This species was not recorded in the project area during the survey but may be a resident. An isopod (slater) collected during the site inspection is the first known example of an undescribed species and has been described as *Buddelundia '81'* by Phoenix Environmental (2013), who concluded that it was likely to be a short range endemic (SRE and thus CS3). It was recorded only in areas of native vegetation where limestone was present on the surface (VSA 3, see Figure 3). Two species of subterranean crustacea were found in the superficial groundwater aquifer of the site, a species of ostracod and a calanoid copepod (Goater and Knott 2009). The distribution of these is unknown but they have to be assumed to be short range endemics because they occur in a restricted environment. They are thus of CS3.

4.1.3 Introduced / Feral Species

The desktop study identified six introduced fauna species as potentially occurring in the Balline survey area. Of these two were recorded on site and many of the other species are expected to be occasional visitors to the survey area. In addition, two species of domestic livestock were observed during the site inspection. While domestic and not included in databases, they have ecological impacts and were present in remnant native vegetation.

Table 6. Introduced fauna species expected to occur in project area (based on desktop review and field investigation).

Common Name	Latin Name	Expected status in project area
MAMMALS		
Red Fox	*Vulpes vulpes*	Recorded in project area
House Mouse	*Mus musculus*	Resident
Black Rat	*Rattus rattus*	Occasional visitor
Goat	*Capra hircus*	Occasional visitor
Cat	*Felis catus*	Resident
European Rabbit	*Oryctolagus cuniculus*	Recorded in project area
Domestic Sheep	*Ovis aries*	Recorded in project area
Domestic Cattle	*Bos taurus*	Recorded in project area

4.2 Summary of species of conservation significance

Significant species expected to be present at least occasionally within the project area include three reptiles, up to 15 birds, possibly two terrestrial invertebrates and two species of invertebrate stygofauna. Of greatest conservation interest are the Southern Sandhill Frog, Carpet Python, the skinks *Cyclodomorphus branchialis* and *Lerista axillaris,* and the CS3 birds. These species are restricted to native vegetation and therefore, are likely to be reliant on the remnant patches of vegetation remaining within the survey area. A possible SRE invertebrate, the slater *Buddelundia '81'*, may be restricted to areas where limestone is present on the surface. The two species of stygofauna were present in the superficial aquifer.

4.3 Vegetation and Substrate Associations (VSAs)

Three VSAs were identified during field investigations. These were:

- 1. Pasture. This is very extensive (see Figure 4) across the project area. It includes one small area that might be inundated for short periods in winter.
- 2. *Acacia rostellifera* Shrubland to Tall Shrubland on yellow-brown sands.
- 3. *Melaleuca cardiophylla* Shrubland to tall shrubland on shallow grey sands over limestone, with extensive limestone outcropping. This vegetation associated with limestone close to the surface occurs largely in the west, but also on the hilltop in the southern block.

The VSAs occurring within the survey area are described below. Their representation within the survey area and conservation significance for fauna is also listed.

1) Pasture.
   a. Representation. Widespread and well-represented in cleared land in the region.
   b. Conservation Significance for Fauna. Generally of low value as habitat.

2) Acacia Shrubland to Tall Shrubland on yellow-brown sands (Figures 5, 6 and 7).
   a. Representation. Restricted to remnants in the study area, with patches in the south, centre and north. Degraded by grazing where livestock not excluded. Restricted to near-coastal locations in region and extensively cleared.
   b. Conservation Significance for Fauna. Important for most of the native fauna assemblage still present in the study area, providing habitat and connectivity across the landscape.

3) Melaleuca Acacia Shrubland to Tall Shrubland on grey sand over limestone (Figures 8 and 9).
   a. Representation. Restricted to remnants in the study area, with patches in the west and on a low hill in the south. Degraded by grazing where livestock not excluded. Restricted to near-coastal locations in region and extensively cleared.
   b. Conservation Significance for Fauna. Important for most of the native fauna assemblage still present in the study area, providing habitat and connectivity across the landscape. The probable SRE isopod *Buddelundia '81'* may be restricted to this VSA.

Detailed mapping of vegetation types and therefore VSAs outside the project area is not available, but the loss due to clearing of both natural VSAs within the region of the project area is probably similar to the general level of clearing. Within 15km of the project area, 47% of native vegetation remains (Figure 1). Remnant vegetation within the project area represents 2.0% of native vegetation within a 15km radius. The area of native vegetation to be cleared within the project area (132ha) represents 33% of native vegetation within the project area, but only 0.3% of native vegetation within a 15km radius.

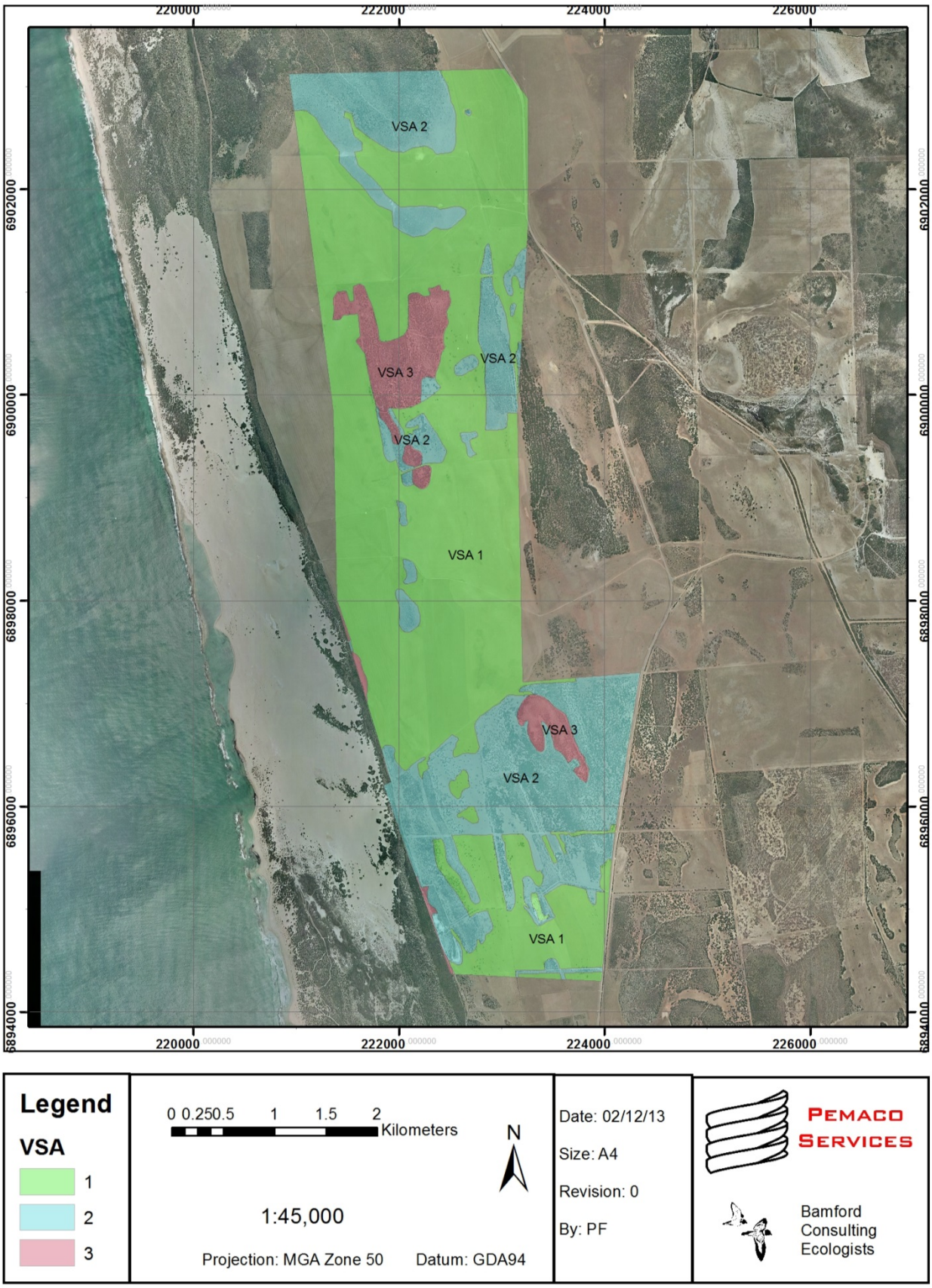

Figure 4. The distribution of Vegetation and Substrate Associations in the project area.

Figure 5. Acacia shrubland in remnant in north of project area.

Figure 6. Acacia shrubland badly degraded by livestock.

Figure 7. Acacia tall shrubland in sheltered valley in southern remnant.

Figure 8. Melaleuca shrubland with exposed limestone in western remnant.

Figure 9. View across large remnant in south from the west. Acacia shrubland in the foreground is tall and appears to be regrowth after past clearing, while the top of the hill in the background supports Melaleuca shrubland. Pasture lies to the left.

4.4 Patterns of biodiversity

Patterns of biodiversity can be interpreted from initial field observations and the characteristics of the VSAs described above, although intensive field investigations are required to provide detailed information. In a project area as extensively cleared as the Balline Garnett site, the key pattern of biodiversity is the importance of any remnant vegetation. There will be differences in biodiversity related to size, location, condition and type of remnant vegetation. For example, small and degraded remnants in the centre and north of the project area may have fewer species than the large remnant in the south, but they may have an important linkage function.

4.5 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix 4 for descriptions and other ecological processes). These include:

Local hydrology. The ground water of the site occurs within a superficial aquifer that is likely to be unconfined (Goater and Knott 2009) and therefore may be sensitive to changes associated with mining. A groundwater-dependent subterranean fauna assemblage is present.

Fire. The shrublands may be prone to fire in dry weather and while appropriate fire regimes can benefit biodiversity, inappropriate regimes can lead to a loss of biodiversity. This is a particular concern in a fragmented landscape when all of a fragment may be burnt at once.

Feral species and interactions with over-abundant native species. The fauna assemblage of the project areas has already been impacted by feral species (loss of a major component of the mammal fauna), and both feral and domestic herbivores are leading to degradation of native vegetation. Human activity has the potential to alter the abundance of feral species.

Habitat degradation due to weed invasion. The project area currently has high levels of weed invasion, exacerbated by livestock grazing.

Connectivity. Remnant vegetation in the project area may have a role in landscape connectivity for fauna, primarily between Kalbarri National Park in the north and Utcha Well Nature Reserve in the south, but also in an east-west direction, as uncleared native vegetation lies to the east (see Figures 1 and 2). Note that the remnant vegetation is fragmented but such fragments can be used as “stepping stones” for movement, particularly by birds. To some extent there is a corridor of native vegetation between the project area and the coastal sand-dunes, but this is narrow and may not support the same suite of species as remnant vegetation in the project area.

4.6 Summary of fauna values

Fauna values within the study area can be summarised as follows:

Fauna assemblage. Depauperate due to extensive clearing. Remnant vegetation on shallow soils over limestone is distinctive, regionally uncommon and thus may have a locally unusual (albeit species-poor) fauna assemblage.

Species of conservation significance. A range of significant species may be present but in small numbers. Species of note are the Southern Sandhill Frog, Carpet Python, the skinks *Cyclodomorphus branchialis* and *Lerista axillaris*, a suite of CS3 (locally significant) birds and several invertebrates. All are likely to be associated with remnant native vegetation, with the isopod *Buddelundia '81'* possibly restricted to VSA 3.

Vegetation and Substrate Associations. Three VSAs were identified across the project area, of which only two are natural. Both the natural VSAs are extensively cleared in the region.

Patterns of biodiversity. Biodiversity is likely to be spread across the natural VSAs, VSA2 and VSA3. These VSAs are likely to be important for most of the native fauna assemblage present in the study area.

Key ecological processes. Main processes currently affecting the fauna assemblage in the project area include extensive clearing and grazing by domestic livestock degrading the remaining remnants of native vegetation.

5 Impact assessment

5.1 Overview of Impacts

As outlined in section 1.1, Pemaco Services is investigating the Balline Garnet Project survey area about 35 km south of Kalbarri, Western Australia. A level 1 fauna assessment identified the fauna values of this survey area. The following sections examine possible impacts upon these fauna values based upon the impacting or threatening processes outlined in Appendix 2. Impacts are summarised in Table 7. Impact criteria are outlined in Table 3. Recommendations relating to impacts are made in Section 6.

5.1.1 Loss of habitat leading to population decline

Disturbance of farmland would have little if any impact upon biodiversity, but direct loss in areas of remnant vegetation could lead to population declines. The southern remnant of native vegetation is the largest in the project area and part of this is targeted for mining, with existing approval to clear 90ha. Some of the vegetation targeted for clearing is regenerating following earlier disturbance, but it still provides habitat for fauna.

5.1.2 Loss of habitat leading to population fragmentation

Remnant vegetation in the project area may have a connectivity function for fauna. Therefore, impacts upon remnant vegetation could facilitate population fragmentation. The southern remnant of native vegetation is the largest in the project area and part of this is targeted for mining, and this may increase population fragmentation.

5.1.3 Degradation of habitat due to weed invasion

Weed invasion of the project area is currently high and is unlikely to be exacerbated by the proposed development if reasonable hygiene measures are employed.

5.1.4 Ongoing mortality

Direct mortality of common species during clearing is unavoidable but can be minimised (see recommendations below). Ongoing mortality would only be a concern if placement of roads and vehicle movements were such that they posed a risk to species such as the Carpet Python. This would occur if roads were placed through areas of remnant vegetation.

5.1.5 Species interactions

Feral species are a major conservation concern; two introduced species were detected and others are highly likely to be present. Foxes and feral cats are likely to be attracted by recent disturbance, possibly leading to increased local impacts on native fauna on the margins of disturbed areas. Inappropriate waste management may also attract foxes and feral cats, as well as native predators and scavengers, which may exacerbate localised impacts on other native fauna.

5.1.6 Hydroecology

Impacts upon groundwater are expected to be minimal. Mining activities will only reach below the water table in a small portion of the total area to be mined. As such, there is no reason to expect that there will be adverse impacts upon any subterranean fauna that may be present, and no effect on deep-rooted plants that may depend upon groundwater. Surface water appears only to be transient in the project area.

5.1.7 Altered fire regimes

While the biota of the region is probably adapted to a particular fire regime, a succession of fires, especially in a fragmented landscape, could lead to local extinction. Activities in the project area are a potential source of fire although this can be managed.

5.1.8 Disturbance

Impacts of dust, light, disturbance and noise upon fauna are expected to be likely as processing operations will run 24 hours a day. This may impact fauna if there is an increase in artificial lighting in the project area.

5.1.9 Summary of impacts

Impacts upon key fauna values are summarised in Table 7 and are considered to be Minor or less. This is due to the site being extensively cleared and to the impact footprint being small. However, there is some concern with localised loss of habitat due to mining in the southern remnant of native vegetation which can be expected to lead to localised population declines and could affect fauna movements through the area. Offsite impacts from fire and feral fauna on adjacent areas of bushland may also be of some concern. Recommendations made in this table are expanded in Section 6.

Table 7. Summary of potential impacts upon key fauna values that are expected to occur in the survey area.

Criteria for significance of impacts are outlined in Section 3.5.1.

Fauna Value	Nature and Significance of Impact		Action required
	Potential Impacts	Significance	
Fauna assemblage	Loss of fauna in areas of remnant vegetation (mostly in southern block)	Minor as impacts very localized in a regional context	Minimise impact footprint on remnant vegetation and rehabilitate where possible.
VSAs	Loss of remnant vegetation (VSAs 2 and 3) mainly in southern block.	Minor as these are moderately widespread in the region	Minimise footprint, avoid remnant vegetation where possible
Significant fauna	Risk mainly to locally significant (CS3) birds with population decline due to habitat loss anticipated in the southern block of remnant vegetation	Minor as impacts very localized	Minimise footprint in remnant vegetation where possible.
Patterns of biodiversity	Proposed clearing lies mainly in natural VSAs (VSAs 2 and 3) that are locally important for biodiversity.	Minor as impacts very localized	Minimise footprint in remnant vegetation where possible.
Ecological processes	Some possible impacts on fire regimes and feral predators; impacts upon subterranean hydrology appear unlikely. Development may increase fragmentation of fauna populations.	Minor but fragmentation could be a concern.	Management to prevent off-site impacts. Rehabilitate to restore connectivity where possible. Potential exists to improve connectivity through planting of corridors in pasture areas.

6 Recommendations

Section 5 (Impact Assessment) identified several potential adverse impacts that may occur from the disturbance to the survey area. While impacts are expected to be mostly Negligible to Minor, any reduction in impacts is desirable. Management strategies are recommended below to reduce the potential impacts of this development on fauna species.

Loss of habitat

- Minimise the disturbance footprint;
- Clearly delineate areas to be cleared;
- Where possible, rehabilitate post-disturbance to replace at least some lost habitat, and to enhance linkage.

Habitat fragmentation

- Minimise the disturbance footprint;
- Rehabilitation post-disturbance to enhance linkage.
- Plant native vegetation in unused parts of the survey area to provide additional linkage. This could include planting corridors through pasture areas.

Species interactions

- Discourage the presence of feral species, particularly the feral Cat and Fox, by the use of appropriate waste management procedures.

Hydrological changes

- Monitor groundwater levels to ensure these do not alter during mining.

Habitat degradation due to weed invasion

- Develop a weed management/hygiene plan. For example, vehicles visiting the site should be clear of weeds and should not have come from weed-infested agricultural land nearby.
- Fence remnants to exclude stock.

Changes in fire regime

- Develop a fire management plan. Of particular importance is prevention of unplanned fires in adjacent bushland.

Dust, noise, light and disturbance

- Minimise the production of dust, noise and light spill; especially where these may affect adjacent bushland.

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8 Appendices

Appendix 1. Explanation of fauna values.

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

Assemblage characteristics

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

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

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

Vegetation/substrate associations (VSAs)

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

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a

large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

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

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Wildlife Conservation Act 1950* (Wildlife Conservation Act). In addition, the Western Australian Department of Environment and Conservation (DEC) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in Appendix 3.

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

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

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

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

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

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

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

Introduced species

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

Ecological processes upon which the fauna depend

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

Appendix 2. Explanation of threatening processes.

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

Loss of habitat affecting population survival

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

Loss of habitat leading to population fragmentation

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

Degradation of habitat due to weed invasion leading to population decline

Weed invasion can occur as a result of development and if this alters habitat quality, can lead to effects similar to habitat loss.

Increased mortality

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

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

Species interactions, including predation and competition

Changes in species interactions often occur with development. Introduced species, including the feral Cat, Red Fox and Rabbit may have adverse impacts upon native species and development can alter their abundance. In particular, some mammal species are very sensitive to introduced

predators and the decline of many mammals in Australia has been linked to predation by the Red Fox, and to a lesser extent the feral Cat (Burbidge and McKenzie 1989). Introduced grazing species, such as the Rabbit, Goat, Camel and domestic livestock, can also degrade habitats and deplete vegetation that may be a food source for other species.

Changes in the abundance of some native species at the expense of others, due to the provision of fresh watering points, can also be a concern. Harrington (2002) found the presence of artificial fresh waterpoints in the semi-arid mallee rangelands to influence the abundance and distribution of certain bird species. Common, water-dependent birds were found to out-compete some less common, water-independent species. Over-abundant native herbivores, such as kangaroos, can also adversely affect less abundant native species through competition and displacement.

Hydroecology

Interruptions of hydroecological processes can have major effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Fauna may be impacted by potential changes to groundwater level and chemistry and altered flow regime. These changes may alter vegetation across large areas and may lead to habitat degradation or loss. Impacts upon fauna can be widespread and major.

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

Fire

The role of fire in the Australian environment and its importance to vertebrate fauna has been widely acknowledged (Gill *et al.* 1981; Fox 1982; Letnic *et al.* 2004; Bamford and Roberts 2003). It is also one of the factors that has contributed to the decline and local extinction of some mammal and bird species (Burbidge and McKenzie 1998). Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Changes in fire regime, whether to more frequent or less frequent fires, may be significant to some fauna. Impacts of severe fire may be devastating to species already occurring at low densities or to species requiring long unburnt habitats to survive. In terms of conservation management, it is not fire *per se* but the fire regime that is important, with evidence that infrequent, extensive and intense fires adversely affect biodiversity, whereas frequent fires that cover small areas and are variable in both season and intensity can enhance biodiversity. Fire management may be considered the responsibility of managers of large tracts of land.

Dust, light, noise and vibration

Impacts of dust, light, noise and vibration upon fauna are difficult to predict. Some studies have demonstrated the impact of artificial night lighting on fauna, with lighting affecting fauna behaviour more than noise (Rich and Longcore 2006). Effects can include impacts on predator-prey interactions,

changes to mating and nesting behaviour, and increased competition and predation within and between invertebrates, frogs, birds and mammals.

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

Appendix 3. Categories used in the assessment of conservation status.

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

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

Schedules used in the WA *Wildlife Conservation Act 1950*

Schedule 1	Rare and Likely to become Extinct.
Schedule 2	Extinct.
Schedule 3	Migratory species listed under international treaties.
Schedule 4	Other Specially Protected Fauna

WA Department of Environment and Conservation Priority species (species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern).

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

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

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

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

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

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 19 key threatening processes listed by the federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC 2011):

- Competition and land degradation by feral/unmanaged Goats (*Capra hircus*);
- Competition and land degradation by feral Rabbits (*Oryctolagus cuniculus*);
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*);
- Incidental catch (bycatch) of Sea Turtles during coastal otter-trawling operations within Australian waters north of 28 degrees South;
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations;
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis;
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris;
- Invasion of northern Australia by Gamba Grass and other introduced grasses;
- Land clearance;
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants;
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean;
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases;
- Predation by exotic rats on Australian offshore islands of less than 1000 km2 (100 000 ha);

- Predation by feral Cats (*Felis catus*);
- Predation by the European Red Fox (*Vulpes vulpes*);
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs (*Sus scrofa*);
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species;
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*); and
- The reduction in the biodiversity of Australian native fauna and flora due to the imported Red Fire Ant, *Solenopsis invicta*.

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

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

In addition to the above processes, DSEWPaC has produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

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

Appendix 5. Fauna recorded or expected to occur in the Balline survey area (Tables 1 to 5).

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the local area. Results do not include returned marine species. These are:

- BA = Birds Australia Database: searched September 2013; (Lit in this column = species likely to be present based upon interpretation of general literature).
- E = EPBC Protected Matters Search Tool: searched September 2013;
- N = NatureMap Database: searched September 2013;
- Balline = Found in the project area during the site inspection.

TABLE 1. Significant Invertebrates expected to occur and recorded in the Balline survey area.

Common Name	Species Name	Status	E	N	Balline
Native Bee	*Neopasiphae simplicior*	CS1		X	
Ostracod crustacean	NA	CS3			**X**
Copepod crustacean	*Calanoidae*	CS3			**X**
Isopod (slater)	*Buddelundia '81'*	CS3			**X**
Total Species	**1**	**CS = 4**			

TABLE 2. Frogs expected to occur and recorded in the Balline survey area.

Common Name	Species Name	Status	E	N	Balline
Myobatrachidae					
Southern Sandhill Frog	*Arenophryne xiphorhyncha*	CS3		X	
Squelching Froglet	*Crinia insignifera*			X	
Moaning Frog	*Heleioporus eyrei*			X	
Western Spotted Frog	*Heleioporus albopunctatus*			X	
Sand Frog	*Heleioporus psammophilus*			X	
Western Banjo Frog	*Limnodynastes dorsalis*			X	
Turtle Frog	*Myobatrachus gouldii*			X	
Kunapalari Frog	*Neobatrachus kunapalari*			X	
Humming Frog	*Neobatrachus pelobatoides*			X	
	Neobatracus wilsmoreii				
Total Species	**10**	**CS=1**			

TABLE 3. Reptiles expected to occur and recorded in the Balline survey area.

Common Name	Species Name	Status	E	N	Balline
Agamidae					
Long-nosed Water Dragon	*Amphibolurus longirostris*			X	
Southern Heath Dragon	*Ctenophorus adelaidensis*			X	
Shark Bay Heath Dragon	*Ctenophorus butlerorum*			X	
Spotted Military Dragon	*Ctenophorus maculatus*			X	X
Central Netted Dragon	*Ctenophorus nuchalis*			X	
Western Netted Dragon	*Ctenophorus reticulatus*			X	
	Ctenophorus scutulatus			X	
Thorny Devil	*Moloch horridus*			X	
Dwarf Bearded Dragon	*Pogona minor*			X	
Diplodactylidae					
	Diplodactylus ornatus			X	
	Diplodactylus pulcher			X	
Carphodactylidae					
	Nephrurus levis			X	
Gekkonidae					
Clawless Gecko	*Crenadactylus ocellatus*			X	
	Gehyra variegata			X	X
Bynoe's Gecko	*Heteronotia binoei*			X	
	Lucasium alboguttatum			X	
	Strophurus spinigerus			X	
Pygopodidae					
	Aprasia repens			X	
	Aprasia smithi			X	
	Delma australis			X	
	Delma grayii			X	
	Lialis burtonis			X	
Keeled Legless Lizard	*Pletholax gracilis*			X	
Common Scaly Foot	*Pygopus lepidopodus*			X	
Scincidae					
	Cryptoblepharus buchananii			X	
	Ctenotus australis			X	
	Ctenotus fallens			X	
Leopard Ctenotus	*Ctenotus pantherinus*			X	
	Ctenotus schomburgkii			X	
	Cyclodomorphus branchialis	CS1	MB recorded Galena		
	Cyclodomorphus celatus			X	
King's Skink	*Egernia kingii*			X	
Broad-banded Sand Swimmer	*Eremiascincus richardsonii*			X	
Stripe-sided Robust Slider, skink	*Lerista axillaris*	CS2, P2		X	
	Lerista connivens			X	
	Lerista elegans			X	
	Lerista lineopunctulata			X	

	Lerista macropisthopus			X	
	Lerista micra			X	
	Lerista planiventralis			X	
	Lerista praepedita			X	
	Menetia greyii			X	
	Menetia surda			X	
	Morethia butleri			X	
	Morethia lineoocellata			X	
Western Bluetongue	*Tiliqua occipitalis*			X	
	Tiliqua rugosa			X	X
Varanidae					
	Varanus caudolineatus		MB recorded Eurardy		
Bungarra or Sand Monitor	*Varanus gouldii*			X	
Racehorse Monitor	*Varanus tristis*			X	
Typhlopidae					
	Ramphotyphlops australis			X	
	Ramphotyphlops leptosoma			X	
Boidae					
Carpet Python	*Morelia spilota*	CS1	Reported by landowner		
Stimson's Python	*Antaresia stimsoni*			X	
Elapidae					
	Brachyurophis semifasciatus			X	
Yellow-faced Whipsnake	*Demansia psammophis*			X	
Bardick	*Echiopsis curta*			X	
Black-naped Snake	*Neelaps bimaculatus*			X	
	Parasuta gouldii			X	
Mulga Snake	*Pseudechis australis*			X	
Western Brown Snake	*Pseudonaja mengdeni*			X	X
Ringed Brown Snake	*Pseudonaja modesta*			X	
Jan's Banded Snake	*Simoselaps bertholdi*			X	
West Coast Banded Snake	*Simoselaps littoralis*			X	
Total Species	**64**	**CS = 3**			**4**

TABLE 4. Birds expected to occur and recorded in the Balline survey area.

Common Name	Species Name	Status	BA	E	N	Balline
Casuariidae						
Emu	*Dromaius novaehollandiae*		X		X	X
Megapodiidae						
Malleefowl	*Leipoa ocellata*	CS1			X	
Phasianidae						
Stubble Quail	*Coturnix pectoralis*				X	
Columbidae						
Domestic Pigeon	*Columba livia*				X	
Diamond Dove	*Geopelia cuneata*				X	
Peaceful Dove	*Geopelia striata*				X	
Crested Pigeon	*Ocyphaps lophotes*				X	X
Common Bronzewing	*Phaps chalcoptera*				X	
Laughing Turtle-Dove	*Streptopelia senegalensis*	Introduced			X	X
Podargidae						
Tawny Frogmouth	*Podargus strigoides*				X	
Apodidae						
Fork-tailed Swift	*Apus pacificus*	CS1			X	
Accipitridae						
Collared Sparrowhawk	*Accipiter cirrocephalus*				X	
Brown Goshawk	*Accipiter fasciatus*				X	
Wedge-tailed Eagle	*Aquila audax*				X	
Little Eagle	*Aquila morphnoides*				X	
Spotted Harrier	*Circus assimilis*				X	
Whistling Kite	*Haliastur sphenurus*				X	
Black-breasted Buzzard	*Hamirostra melanosternon*				X	
Black-shouldered Kite	*Elanus axillaris*		X			
Falconidae						
Brown Falcon	*Falco berigora*				X	
Nankeen Kestrel	*Falco cenchroides*		X		X	
Australian Hobby	*Falco longipennis*				X	
Peregrine Falcon	*Falco peregrinus*	CS1			X	
Otididae						
Australian Bustard	*Ardeotis australis*	CS2, P4			X	
Burhinidae						
Bush Stone-curlew	*Burhinus grallarius*	CS2			X	
Charadriidae						
Banded Lapwing	*Vanellus tricolor*				X	
Psittacidae						
Major Mitchell's Cockatoo	*Cacatua leadbeateri*	CS1			X	
Cockatiel	*Nymphicus hollandicus*				X	

Cuculidae						
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		X		X	
Pallid Cuckoo	*Cacomantis pallidus*		X		X	
Horsfield's Bronze Cuckoo	*Chalcites basalis*		X			
Shining Bronze Cuckoo	*Chalcites lucidus*		X			
Strigidae						
Boobook Owl	*Ninox novaeseelandiae*				X	
Halcyonidae						
Red-backed Kingfisher	*Todiramphus*		Lit			
Sacred Kingfisher	*Todiramphus sanctus*				X	
Meropidae						
Rainbow Bee-eater	*Merops ornatus*	CS1	X		X	
Maluridae						
Variegated Fairy-wren	*Malurus lamberti*	CS3	X		X	X
White-winged Fairy-wren	*Malurus leucopterus*	CS3	X		X	X
Blue-breasted Fairy-wren	*Malurus pulcherrimus*	CS3			X	
Splendid Fairy-wren	*Malurus splendens*	CS3	X		X	X
Acanthizidae						
Inland Thornbill	*Acanthiza apicalis*	CS3			X	X
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		X			X
Rufous Fieldwren	*Calamanthus campestris*				X	
Redthroat	*Pyrrholaemus brunneus*				X	
Pardalotidae						
Southern Whiteface	*Aphelocephala leucopsis*				X	
Striated Pardalote	*Pardalotus striatus*				X	
White-browed Scrubwren	*Sericornis frontalis*	CS3	X		X	X
Meliphagidae						
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*				X	X
Red Wattlebird	*Anthochaera carunculata*				X	
White-fronted Chat	*Epthianura albifrons*				X	
Orange Chat	*Epthianura aurifrons*				X	
Crimson Chat	*Epthianura tricolor*				X	
Singing Honeyeater	*Lichenostomus virescens*		X			X
Brown Honeyeater	*Lichmera indistincta*				X	
Yellow-throated Miner	*Manorina flavigula*				X	
White-cheeked Honeyeater	*Phylidonyris niger*		X			
White-plumed Honeyeater	*Ptilotula penicillatus*				X	
White-fronted Honeyeater	*Purnella albifrons*				X	
Pomatostomidae						
White-browed Babbler (wheatbelt)	*Pomatostomus superciliosus superciliosus*	CS2			X	X
Psophodidae						
Chiming Wedgebill	*Psophodes occidentalis*				X	
Campephagidae						

White-winged Triller	*Lalage sueurii*		Lit			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				X	
Pachycephalidae						
Grey Shrike-thrush	*Colluricincla harmonica*				X	X
Golden Whistler	*Pachycephala pectoralis*		X		X	
Rufous Whistler	*Pachycephala rufiventris*				X	X
Crested Bellbird (wheatbelt)	*Oreoica gutturalis gutturalis*	CS2			X	
Artamidae						
Black-faced Woodswallow	*Artamus cinereus*				X	
Masked Woodswallow	*Artamus personatus*		X			
Grey Currawong	*Strepera versicolor*		X			
Pied Butcherbird	*Cracticus nigrogularis*		X			
Australian Magpie	*Cracticus tibicen*				X	X
Grey Butcherbird	*Cracticus torquatus*				X	X
Rhipiduridae						
Grey Fantail	*Rhipidura fuliginosa*				X	
Willie Wagtail	*Rhipidura leucophrys*				X	X
Corvidae						
Little Crow	*Corvus bennetti*				X	
Australian Raven	*Corvus coronoides*		X			X
Monarchidae						
Magpie-lark	*Grallina cyanoleuca*				X	
Petroicidae						
Southern Scrub-robin	*Drymodes brunneopygia*				X	
Western Yellow Robin	*Eopsaltria australis*				X	
Jacky Winter	*Microeca fascinans*				X	
Hooded Robin	*Petroica cucullata*				X	
Red-capped Robin	*Petroica goodenovii*				X	
Megaluridae						
Rufous Songlark	*Cincloramphus mathewsi*				X	
Timaliidae						
Silvereye	*Zosterops lateralis*		X		X	X
Estrildidae						
Zebra Finch	*Taeniopygia guttata*				X	
Nectariniidae						
Mistletoebird	*Dicaeum hirundinaceum*				X	X
Motacillidae						
Australasian Pipit	*Anthus novaeseelandiae*		X			
Total Species	**87**	**CS = 17**				**20**

TABLE 5. Mammals expected to occur and recorded in the Balline survey area.

Common Name	Species Name	Status	E	N	Balline
Tachyglossidae					
Echtdna	*Tachyglossus aculeatus*				X
Canidae					
Dingo/wild dog	*Canis lupus*			X	
Red Fox	*Vulpes vulpes*	Introduced			X
Dasyuridae					
Fat-tailed Dunnart	*Sminthopsis crassicaudata*			X	
Little long-tailed Dunnart	*Sminthopsis dolichura*			X	
White-tailed Dunnart	*Sminthopsis granulipes*			X	
Hairy-footed Dunnart	*Sminthopsis hirtipes*			X	
Peramelidae					
Macropodidae					
Western Grey Kangaroo	*Macropus fuliginosus*			X	X
Euro	*Macropus robustus*			X	
Muridae					
House Mouse	*Mus musculus*	Introduced		X	
Ash-grey Mouse	*Pseudomys albocinereus*			X	
Black Rat	*Rattus rattus*	Introduced		X	
Vespertilionidae					
Lesser Long-eared Bat	*Nyctophilus geoffroyi*			X	
Finlayson's Cave Bat	*Vespadelus finlaysoni*			X	
Pteropodidae					
Little Red Flying-fox	*Pteropus scapulatus*			X	
Molossidae					
White-striped Freetail-bat	*Tadarida australis*			X	
Tarsipedidae					
Honey Possum	*Tarsipes rostratus*			X	
Bovidae					
Sheep (domestic)	*Ovis aries*	Introduced			X
Cattle (domestic)	*Bos Taurus*	introduced			X
Goat	*Capra hircus*	Introduced			
Felidae					
Cat	*Felis catus*	Introduced			
Leporidae					
European Rabbit	*Oryctolagus cuniculus*	Introduced			X
Total Species	**22**	**CS = 0 Int = 8**			**6**

Appendix 6. Vertebrate species returned in database searches but unlikely to be found in the project area.

Database searches often return species that, despite being found nearby, are unlikely to be present in the survey area due to lack of suitable habitat (e.g. aquatic species) or ecological barriers preventing them from reaching the area (e.g. island species). There are also some errors, out-of-date Latin names, zoo specimens and subtleties of distribution that are not recognised in databases. Note some species listed below (notably birds) could occur as vagrants but the project area would be of no importance to them.

Common Name	Latin Name	Status	BA	E	N
Invertebrates					
Shield-backed Trapdoor Spider	*Idiosoma nigrum*	CS1			X
Graceful Sunmoth	*Synemon gratiosa*	CS2, P4			X
Amphibians					
Slender Tree Frog	*Litoria adelaidensis*				X
Motorbike Frog	*Litoria moorei*				X
Bleating Froglet	*Crinia pseudinsignifera*				X
Crawling Toadlet	*Pseudophryne guentheri*				X
Reptiles					
Sea-snake	*Disteira major*				X
Sea-snake	*Hydrophis elegans*				X
Oblong Tortoise	*Chelodina colliei (oblonga)*				X
	Lerista kendricki				X
Birds					
Western Wattlebird	*Anthochaera lunulata*				X
Slender-billed Thornbill	*Acanthiza iredalei*	CS1		X	
Chestnut-rumped Thornbill	*Acanthiza uropygialis*				X
Western Gerygone	*Gerygone fusca*		X		X
Weebill	*Smicrornis brevirostris*				X
Swamp Harrier	*Circus approximans*				X
Common Sandpiper	*Actitis hypoleucos*	CS1			X
Ruddy Turnstone	*Arenaria interpres*	CS1	X		
Sharp-tailed Sandpiper	*Calidris acuminata*	CS1			X
Sanderling	*Calidris alba*	CS1			X
Curlew Sandpiper	*Calidris ferruginea*	CS1			X
Red-necked Stint	*Calidris ruficollis*	CS1			X
Long-toed Stint	*Calidris subminuta*	CS1			X
Great Knot	*Calidris tenuirostris*	CS1			X
Bar-tailed Godwit	*Limosa lapponica*	CS1			X
Black-tailed Godwit	*Limosa limosa*	CS1			X
Little Curlew	*Numenius minutus*	CS1			X
Whimbrel	*Numenius phaeopus*	CS1			X
Red-necked Phalarope	*Phalaropus lobatus*	CS1			X
Grey-tailed Tattler	*Tringa brevipes*	CS1			X
Wood Sandpiper	*Tringa glareola*	CS1			X
Common Greenshank	*Tringa nebularia*	CS1			X
Marsh Sandpiper	*Tringa stagnatilis*	CS1			X
Grey Teal	*Anas gracilis*				X

Australasian Shoveler	*Anas rhynchotis*				X
Pacific Black Duck	*Anas superciliosa*				X
Hardhead	*Aythya australis*				X
Musk Duck	*Biziura lobata*				X
Australian Wood Duck	*Chenonetta jubata*				X
Black Swan	*Cygnus atratus*				X
Pink-eared Duck	*Malacorhynchus membranaceus*				X
Australian Shelduck	*Tadorna tadornoides*				X
Fairy Tern	*Sternula nereis*	CS1	X		
Eastern Great Egret	*Ardea modesta*	CS1			X
White-necked Heron	*Ardea pacifica*	CS1			X
Australasian Bittern	*Botaurus poiciloptilus*	CS1		X	
Eastern Reef Egret	*Egretta sacra*				X
Nankeen Night Heron	*Nycticorax caledonicus*				X
Little Woodswallow	*Artamus minor*				X
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	CS1		X	X
Greater Sand Plover	*Charadrius leschenaultii*	CS1			X
Lesser Sand Plover	*Charadrius mongolus*	CS1			X
Red-capped Plover	*Charadrius ruficapillus*				X
Grey Plover	*Pluvialis squatarola*	CS1			X
Banded Stilt	*Cladorhynchus leucocephalus*				X
Black-winged Stilt	*Himantopus himantopus*				X
Red-necked Avocet	*Recurvirostra novaehollandiae*				X
Lesser Noddy	*Anous tenuirostris*	CS1		X	X
Silver Gull	*Chroicocephalus novaehollandiae*				X
Pacific Gull	*Larus pacificus*				X
White-bellied Sea Eagle	*Haliaeetus leucogaster*	CS1		X	X
Sooty Oystercatcher	*Haematopus fulinginosus*		X		X
Pied Oystercatcher	*Haematopus longirostris*				X
Common Peafowl	*Pavo cristatus*	Introduced			X
Southern Royal Albatross	*Diomedea epomophora*	CS1		X	
Amsterdam Albatross	*Diomedea exulans amsterdamensis*	CS1		X	
Tristan Albatross	*Diomedea exulans exulans*	CS1		X	
Wandering Albatross	*Diomedea exulans sensu lato*	CS1		X	
Indian Yellow-nosed Albatross	*Thalassarche carteri*	CS1		X	X
Shy Albatross	*Thalassarche cauta cauta*	CS1		X	X
White-capped Albatross	*Thalassarche cauta steadi*	CS1		X	X
Black-browed Albatross	*Thalassarche melanophris*	CS1		X	X
Campbell Albatross	*Thalassarche melanophris impavida*	CS1		X	X
Eurasian Coot	*Fulica atra*				X
Buff-banded Rail	*Gallirallus philippensis*				X
Australian Spotted Crake	*Porzana fluminea*		X		X
Spotless Crake	*Porzana tabuensis*		X		X
Southern Giant-Petrel	*Macronectes giganteus*	CS1		X	
Northern Giant-Petrel	*Macronectes halli*				X

Slender-billed Prion	*Pachyptila belcheri*				X
Soft-plumaged Petrel	*Pterodroma mollis*	CS1		X	
Little Grassbird	*Megalurus gramineus*		X		X
Australian Pelican	*Pelecanus conspicillatus*				X
Great Cormorant	*Phalacrocorax carbo*				X
Little Black Cormorant	*Phalacrocorax sulcirostris*				X
Pied Cormorant	*Phalacrocorax varius*		X		X
Ruff	*Philomachus pugnax*	CS1			X
Yellow-billed Spoonbill	*Platalea flavipes*				X
Australian White Ibis	*Threskiornis molucca*				X
Straw-necked Ibis	*Threskiornis spinicollis*				X
Great Crested Grebe	*Podiceps cristatus*				X
Hoary-headed Grebe	*Poliocephalus poliocephalus*				X
Australasian Grebe	*Tachybaptus novaehollandiae*				X
Gull-billed Tern	*Sterna nilotica macrotarsa*				X
Crested Tern	*Thalasseus bergii*		X		
Mammals					
Woylie	*Bettongia penicillata ogilbyi*	CS1; locally extinct		X	
Chuditch	*Dasyurus geoffroii*	CS1; locally extinct			X
Quenda	*Isoodon obesulus*	CS2, locally extinct			X
Tammar Wallaby	*Macropus eugenii*	CS1; locally extinct			X
Spinifex Hopping-mouse	*Notomys alexis*				X
Common Brushtail Possum	*Trichosurus vulpecula*	Locally extinct			X
Feral Pig	*Sus scrofa*	Introduced		X	
Total Number of Species	**102**	**CS = 46**			