

# Appendix C

Appendix C: Proposed Keyneton Wind Farm; Avifauna and Raptor Nest Assessment (EBS Ecology)



# **Proposed Keyneton Wind Farm: Avifauna and Raptor Nest Assessment**

# Proposed Keyneton Wind Farm Avifauna and Raptor Nest Assessment

24 APRIL 2012

Version 2.0

Prepared by EBS Ecology for Pacific Hydro Pty. Ltd.

Document Control					
Revision No.	Date issued	Authors	Reviewed by	Date Reviewed	Revision type
1.0	03/03/10	A. Derry	C. Nield	5/03/10	Draft
1.1	09/03/11	A. Derry	A. Everitt	9/3/11	Revised draft
1.2	24/03/11	A. Derry	A. Everitt	24/3/11	Revised draft
1.3	07/09/11	A. Derry	A. Everitt	07/09/11	Revised draft
1.4	15/01/12	A. Derry	A. Everitt	15/02/12	Revised draft
1.5	21/03/12	A. Derry	A. Everitt	21/03/12	Revised draft
1.6	13/04/12	A. Derry	T. How	13/04/12	Revised draft
2.0	24/04/12	A. Derry	T. How	24/04/12	Final

Distribution of Copies			
Revision No.	Date issued	Media	Issued to
1.0	9/03/10	Electronic	Jillian Adams, Pacific Hydro
1.1	9/3/11	Electronic	Kim Derriman, Pacific Hydro
1.2	24/3/11	Electronic	Kim Derriman, Pacific Hydro
1.3	07/09/11	Electronic	Kim Derriman, Pacific Hydro
1.4	15/02/12	Electronic	Kim Derriman, Pacific Hydro
1.5	21/03/12	Electronic	Kim Derriman, Pacific Hydro
1.6	13/04/12	Electronic	Kim Derriman, Pacific Hydro
2.0	24/04/12	Electronic	Kim Derriman, Pacific Hydro



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CITATION: EBS (2012) *Proposed Keyneton Wind Farm Avifauna and Raptor Nest Assessment* EBS Ecology, Adelaide.

Front cover photo: Wedge-tailed Eagle nest, proposed Keyneton Wind Farm.

## ACKNOWLEDGMENTS

EBS Ecology would like to thank the following people for their assistance and advice:

- Ian Falkenberg (DENR) for expert advice regarding Peregrine Falcon activity and breeding sites in relation to the project site
- Graham Carpenter (DENR) for expert advice on recommended nest buffers for the Wedge-tailed Eagle
- Land holders for allowing us property access.

## Executive Summary

EBS Ecology conducted a series of bird surveys at the proposed Keyneton Wind Farm situated in north eastern Mount Lofty Ranges (South Australia). The surveys can be summarised as the following:

- an avifauna assessment, completed in September/October 2008 – referred to as spring 2008
- a winter bird utilisation survey, completed June 2009 – referred to as winter 2009
- a spring bird utilisation survey and Wedge-tailed Eagle breeding success evaluation, completed September 2009 – referred to as spring 2009
- a Wedge-tailed Eagle nest check to determine breeding success, nest investigation for any Peregrine Falcons that may breed on site and recording of raptor flight behaviours over the ridgeline, completed in December 2010 – referred to as summer 2010.

The bird utilisation survey in spring 2008 was a Level 1 bird survey as per *AUSWIND Best Practice Guidelines* 2006. The bird utilisation surveys in winter and spring 2009 were Level 2 bird surveys as per *AUSWIND Best Practice Guidelines* 2006. The surveys completed during spring 2009 and summer 2010 aimed to assess the level of bird activity at a number of established bird survey sites. The surveys were also aimed at identifying any significant species and assess the breeding status of Wedge-tailed Eagle (*Aquila audax*) nest sites that had been initially located in winter 2009. The potential impact of the wind farm development on resident and migratory birds was assessed.

No *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) listed bird species were recorded. The EPBC Protected Matters Online Search Tool did however list three EPBC listed species as likely to occur in the project area, although they were not recorded during any of the survey periods. These were the Rainbow Bee-eater (*Merops ornatus*), Great Egret (*Phalacrocorax carbo*) and the Cattle Egret (*Ardea ibis*).

Four state rare species listed under the *National Parks and Wildlife Act 1972* (NPW) were recorded from surveys conducted within the proposed Keyneton Wind Farm. The Peregrine Falcon (*Falco peregrinus*) was recorded over three survey periods, winter and spring 2009 and a breeding site confirmed in summer 2010; the Elegant Parrot (*Neophema elegans*) was recorded on site during winter and spring 2009 surveys and the White-winged Chough (*Corcorax melanorhamphos*) was observed in spring 2008. A single observation of the Jacky Winter (*Microeca fascinans fascinans*) was recorded opportunistically during the winter 2009 survey. All four species were identified from the Biological Database of South Australia (BDBSA) as potentially utilising the area.

During a two day survey in September/October 2008, a total of 744 bird observations from 43 bird species were detected on site. Twenty-five bird survey sites were conducted over eight different habitat types. No birds of national conservation status were detected but the White-winged Chough, listed as State rare under the NPW Act 1972, was recorded.

During the winter 2009 survey a total of 1,362 bird movements of 27 different species were observed during point count surveys at 13 fixed survey sites. No birds of national conservation status were detected but the Peregrine Falcon and Elegant Parrot, both listed as State rare under the NPW Act 1972, were recorded.

During the 2009 surveys, a total of 1,712 bird movements of 34 different species were observed during point count surveys at 13 fixed survey sites. A further 99 records of six species were recorded opportunistically when travelling across the project site. Bird utilisation data revealed a large disparity in the usage of the site by birds between surveys; Site K11 at the southern end of the site recorded a utilisation rate six-times that of Site K3 at the northern end in spring 2009. The data previously collected in winter 2009 revealed the reverse of this trend, where birds predominantly utilised the northern end of the proposed wind farm.

Twelve potential Wedge-tailed Eagle nests were investigated for active breeding signs. Nine were determined as belonging to the Wedge-tailed Eagle, two were determined to be of raven origin and one belonged to a kite species. One nest, partially utilised by a pair of Peregrine Falcons, was adjacent to a rocky ledge that was identified as a Peregrine Falcon breeding site during the 2010 survey. Two of the nine nests were considered active during the 2010 breeding season. The nine eagle nests were considered likely to belong to at least two breeding pairs on site, with one pair of Wedge-tailed Eagles recorded as occupying the middle section of the proposed wind farm during the summer 2010 survey (Nest 9 was deemed active). Nests 7 and 11 were determined as being likely to be used by eagles in the future, based on the condition of the nest and the location of the nest within the Keyneton landscape. Wedge-tailed Eagles were observed across all four survey periods which suggest they have been regularly utilising the project area over a period of time. No nests were identified south of Pine Hut Road.

Results from raptor surveys indicate that habitat utilisation by Wedge-tailed Eagles and Peregrine Falcons is substantial; a minimum buffer zone of 500 m around both active and inactive Wedge-tailed Eagle nesting sites has been recommended. EBS Ecology also recommends a buffer area of 1000 m around the Peregrine Falcon nesting site identified within the north eastern corner of the proposed wind farm. Buffers are primarily aimed at reducing the disturbance the birds experience during breeding and when juveniles are near fledging.

A number of measures have been adopted as embedded design mitigations by Pacific Hydro Pty Ltd. The proposed number of turbines has been reduced since EBS was engaged (from 60 to 42) and the turbine layout refined. The proposed site area has also been amended to avoid areas to the north and west of the site that contain better quality native vegetation. These changes have been influenced by EBS Ecology's flora and avifauna (including raptors and bats) surveys and associated recommendations directed at reducing potential impacts. With particular regard to raptors such as the State rare Peregrine Falcon and priority species such as the Wedge-tailed Eagle, "buffers" have been adopted around nests

(as recommended by EBS Ecology). Buffers are an effective mitigation measure adopted worldwide to lessen the potential impact on such species. Furthermore the general avoidance of areas of significant native vegetation will also minimise potential impacts to birds. The current design has two distinct clusters of turbines with a spacing of 5 km between them. Spacing between turbines in the current layout is generally in the order of 4-500 m, which contributes toward allowing for safe bird passage between turbines. In addition to the mitigation measures outlined above monitoring of raptor breeding activity during construction and operation of the wind farm is recommended as well as an ongoing bird-strike monitoring program.

The bird species identified as performing flights considered as “at-risk” movements (e.g. above 40 m), in winter 2009 and spring 2009, are discussed in relation to risk assessment. This risk assessment determines the potential impact of the proposed Keyneton Wind Farm on these bird species (as per the requirement of the Level 2 AusWind Guidelines). The overall level of risk for all species was determined as low. The likelihood of collision causing mortality was determined as **likely** for one species, the Australian Magpie. The likelihood of collision causing mortality was determined as **unlikely** for four raptor species: Wedge-tailed Eagle, Brown Falcon, Nankeen Kestrel and Peregrine Falcon. The likelihood of collision causing mortality was determined as **rare** for 14 species, where the event may occur in exceptional circumstances. The consequence of mortality at a species/population level was determined as **minor** for the Peregrine Falcon and Elegant Parrot. The consequence of mortality may impact on the local population of these two species, with no impact on the species. Consequence was determined as **insignificant** for 17 species; individuals may be affected, but viability of a local population for these species is not impacted upon.

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## GLOSSARY AND ABBREVIATION OF TERMS

BDBSA	Biological Databases of South Australia (managed by DENR)
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals
CP	Conservation Park
DEH	Department of Environment and Heritage (now known as DENR)
DENR	Department of Environment and Natural Resources
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EBS	Environmental and Biodiversity Services
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
JAMBA	Japan Australia Migratory Bird Agreement
NP	National Park
NPW Act	<i>National Parks and Wildlife Act 1972</i>
Priority species	a species expected to be at relatively greater risk than other species
Project area	the broader geographical location within which the project site is situated
Project site	the area that was surveyed within the proposed wind farm boundary (as provided by Pacific Hydro)
SA	South Australia
ssp.	subspecies
sp.	species (singular)
spp.	species (plural)

# 1 INTRODUCTION

Four bird surveys have been undertaken at the proposed Keyneton Wind Farm by EBS Ecology on behalf of Pacific Hydro Pty Ltd. These included:

- an avifauna assessment, completed in September/October 2008 – referred to as spring 2008
- a winter bird utilisation survey, completed June 2009 – referred to as winter 2009
- a spring bird utilisation survey and Wedge-tailed Eagle breeding success evaluation, completed September 2009 – referred to as spring 2009
- a Wedge-tailed Eagle nest check to determine breeding success, nest investigation for any Peregrine Falcons that may breed on site and recording of raptor flight behaviours over the ridgeline, completed in December 2010 – referred to as summer 2010.

Individual draft reports were completed for the first two surveys (EBS 2008 and EBS 2009) and a combination draft report was prepared by EBS Ecology for the spring 2009 and summer 2010 surveys (EBS 2011). This report presents a compilation of all survey findings with the discussion and suggested mitigation measures drawing on the results of all surveys completed to date at the project site.

The methods employed for the spring 2008 survey were consistent with a Level 1 survey as described in the *AUSWind Best Practice Guidelines* (2006). The winter 2009 and spring 2009 surveys were conducted using the guidelines for a Level 2 survey (EBS 2009) and primarily aimed to:

- identify and describe bird abundance on site
- determine species diversity and bird utilisation at repeated sites across the project site.

The *AUSWind Best Practice Guidelines* (2006) provides a strategy for undertaking an assessment of avian issues at a proposed wind farm. The lowest level studies are preliminary surveys to identify species on a site, with studies increasing in their complexity and specificity up through the levels. For example, if investigations at a lower level identify a species that is a priority and insufficient data are available to conduct a risk assessment, the next level of investigation should be undertaken. Three levels of investigation are provided, and the purpose of each level is to obtain data that will enable assessment of the potential impact of a proposed wind farm on the relevant species of birds. The levels of survey completed at the proposed Keyneton Wind Farm are explained in further detail in the methods section (Section 2).

Measures of bird utilisation involve recording how birds use an area, in terms of the number and type of movements or flights performed. This provides a measure of the level of bird activity, which can be compared between survey locations and wind farm sites. Identifying the extent of bird activity at a proposed wind farm site is important in assessing the likelihood of bird collision and mortality resulting from construction of wind turbines. Utilisation studies also provide a means of identifying areas where bird activity is highest. Recording the height and direction of bird flights also provides a means of identifying the species that are most possibly at-risk of interaction with turbines. This Level 2 survey aims

to identify the potential effects of the wind farm on the local bird community, identify any threatened species within the project site and identify how priority species such as the Wedge-tailed Eagle utilise the site.

Raptor focussed surveys in spring 2009 and summer 2010 aimed to:

- report on the breeding success of Wedge-tailed Eagles at nesting locations identified during winter 2009
- determine the presence/absence of Peregrine Falcons on site and possible nesting sites
- assess the flight behaviour of raptors surveyed on site.

## 1.1 Regional and Site information

The proposed wind farm occupies a narrow ridge along a north to south gradient and is approximately 15km in length (Figure 1). Elevation of the project site ranges from 170 m at the base of the hill to 450 m along the ridge (Figure 2). The project site is currently used primarily for sheep grazing and cropping. The majority of the site has been extensively cleared and grazed however several areas of good quality remnant vegetation are present to the north west of the site. These areas have also been surveyed by EBS Ecology; results are summarised in the *Proposed Keyneton Wind Farm Flora and Fauna Assessment* (EBS 2010). Much of this area has been avoided by the reduction in the site boundary / area that Pacific Hydro undertook following the 2008 survey.

The aim of the avifauna assessment was to:

- Establish the level of bird activity across the proposed wind farm development using a standard point count (PC) method for collecting bird utilisation data
- Identify bird species listed as threatened or migratory under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or those listed as threatened under the *South Australian National Parks and Wildlife Act 1972* (NPW Act)
- Record the location and extent of habitat for birds of conservation significance (listed under the *EPBC* and *NPW Act*)
- Assess the breeding success of Wedge-tailed Eagles at nesting locations across the project site
- Record flight behaviour and movements of Wedge-tailed Eagles observed near the nest or whilst travelling across the site
- Record nest locations of Peregrine Falcons observed on or near the site
- Record flight behaviour and movements of Peregrine Falcons observed on site
- Identify mitigation measures that can be embedded within the project's design and implementation that will help to avoid or minimise potential impacts. Particular focus is given to any species listed as threatened under the EPBC or NPW Act
- Recommend any monitoring requirements during wind farm operations.



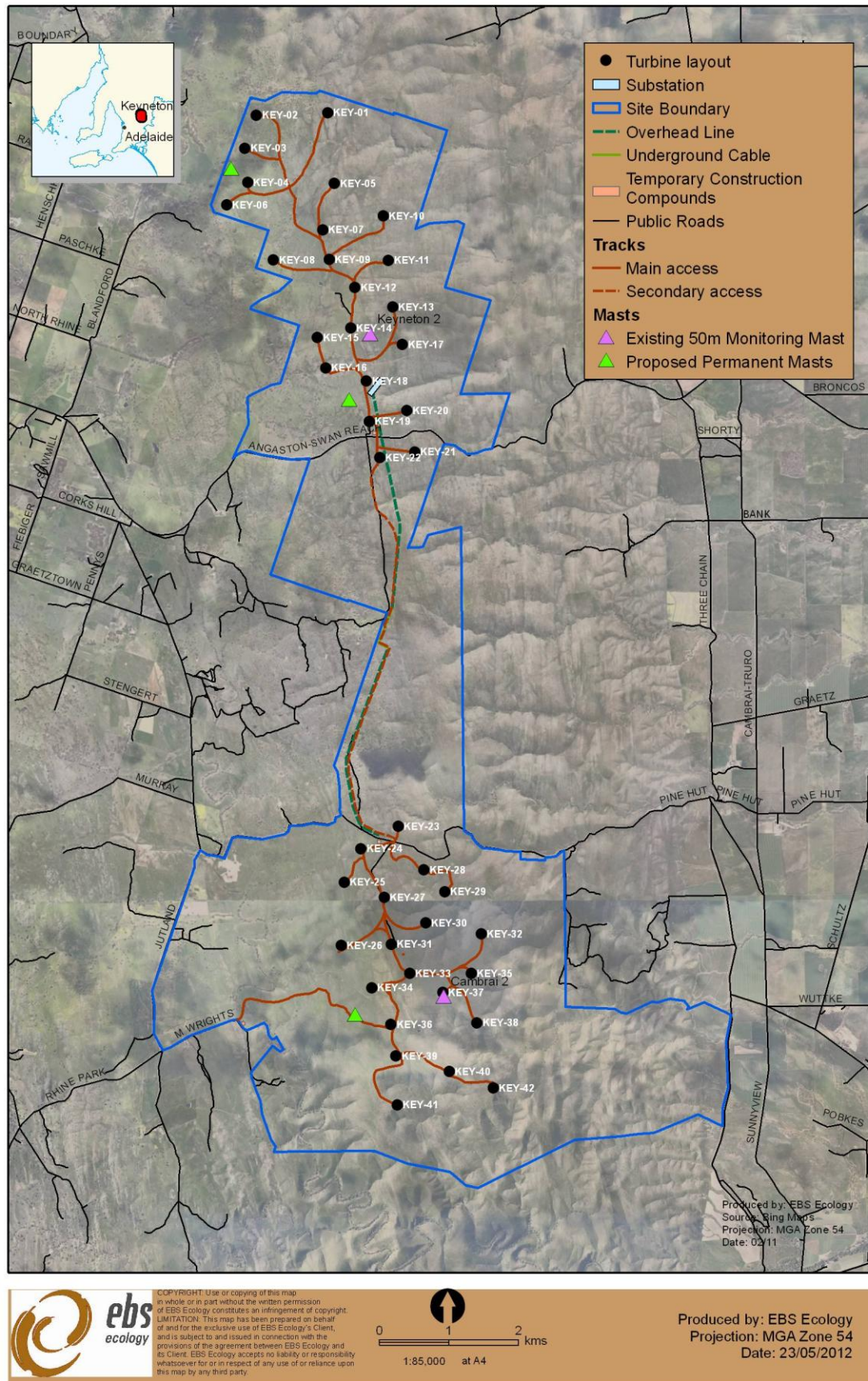


Figure 1. Map showing the location and current boundary of the proposed Keyneton Wind Farm in the Mt. Lofty Ranges Region of South Australia.



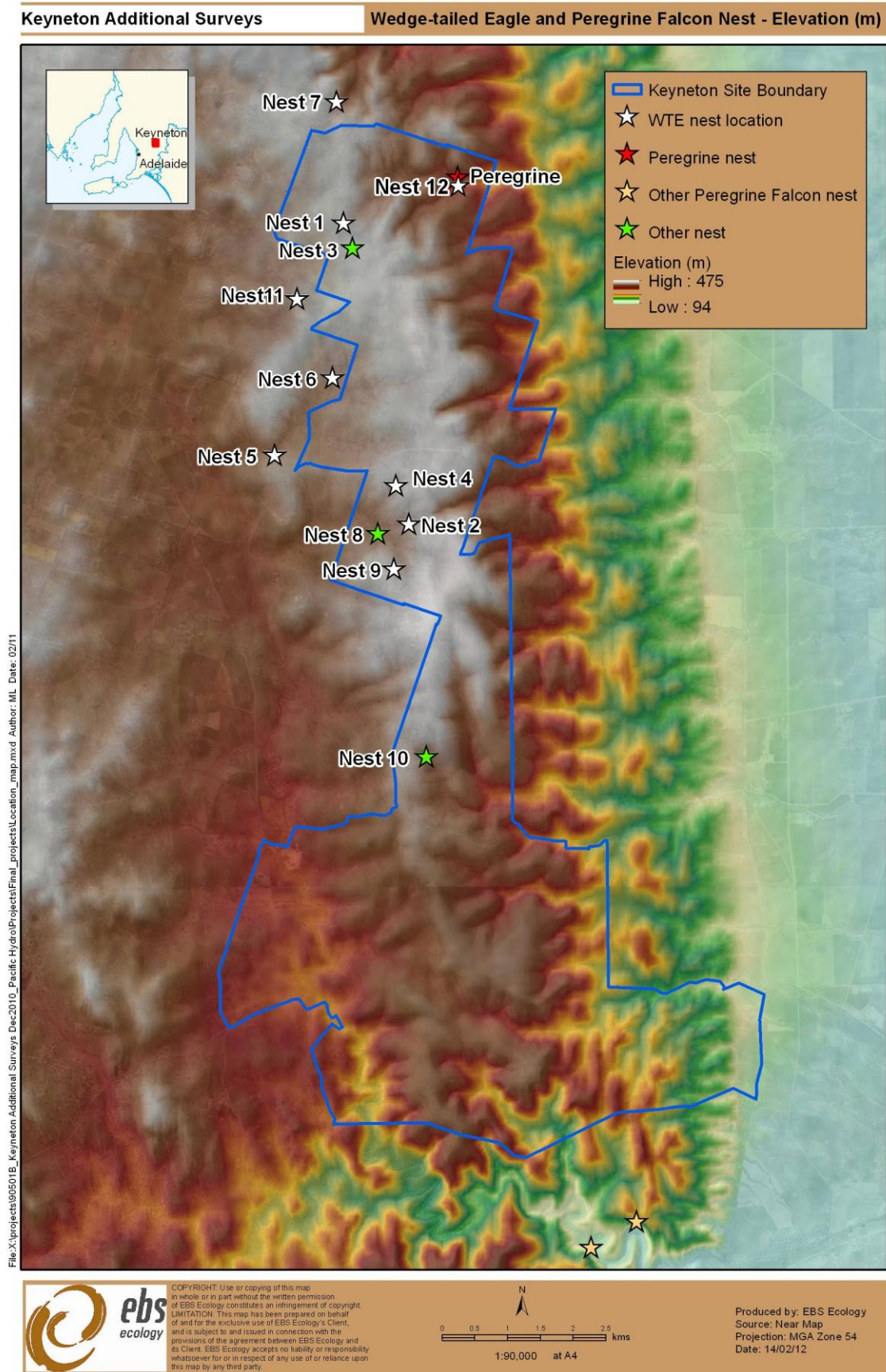


Figure 2. Elevation levels across the proposed Keyneton Wind Farm in relation to Wedge-tailed Eagle and Peregrine Falcon nesting sites.



## 2 METHODS

In accordance with the *AUSWind* guidelines an initial desk top assessment was carried out, to assess the species likely to be present at site, followed by field survey work. As described in Section 2.3 the *AUSWind* protocols for bird utilisation surveys were used, followed by more roaming surveys.

The methods employed for the spring 2008 survey were consistent with a level one survey as described in the *AUSWind Best Practice Guidelines* (2006). The level one investigation was a minimum requirement for assessing potential bird impacts at the proposed Keyneton Wind Farm. The spring 2008 survey determined priority species on or near the site, general avian species present and identified avian habitat (EBS 2008). As a result of the level one survey, it was not clear whether all species using the site were adequately identified, or that all priority species and their use of the site were sufficiently understood. A key recommendation from the level one survey was to undertake level two bird utilisation surveys on site. This was to ensure that site visits were timed to coincide with a range of seasons which would provide a better representation of both the resident and transient bird species, so that the entire bird community was identified.

Level two investigations were conducted to obtain further data on the presence of bird species on site in order to undertake a risk assessment. Field surveys were completed in 2009 (winter and spring) and summer 2010, and included bird utilisation studies, to determine the use of the site by species that may not have been detected during level one investigations. By undertaking surveys across different periods, seasonal comparisons were able to be made. The bird utilisation studies were able to quantify which species were present across different seasons, the numbers of birds present and how they utilised the site. The summer 2010 survey was targeted at further quantifying how Wedge-tailed Eagles (*Aquila audax*) utilised the proposed Keyneton Wind Farm site. Data collected from utilisation surveys included comparisons of flight height for at-risk species, which was used to help assess the potential collision risk of avian species.

It was determined that sufficient data was obtained during the level one and two investigations to conduct a risk assessment, and that issues pertaining to species (particularly priority species) had been adequately addressed, so a level three investigation was not considered necessary.

### 2.1 Database searches

Two main sources were consulted to determine birds of conservation significance that were likely to occur within the proposed Keyneton Wind Farm. The *Environment Protection and Biodiversity Conservation* (EPBC) Protected Matters online database was used to identify birds of national environmental significance or matters protected by the *EPBC Act 1999*. The Biological Database of South Australia (BDBSA) is a database of flora and fauna records maintained by the Department of

Environment and Natural Resources (DENR). This was used to determine species of national and state significance that have been recorded within the vicinity of the project site.

The *EPBC Act 1999* provides legislative protection for *matters of national environmental significance*. Species of national conservation significance are listed under the Commonwealth *EPBC Act 1999* as threatened, migratory or marine. Threatened species are further categorised as Extinct in the wild, Critically Endangered, Endangered, or Vulnerable. Some migratory and marine species are also protected under international agreements to which Australia is a signatory (JAMBA, CAMBA and the Bonn Convention), are also listed and protected under the *EPBC Act 1999*.

Species of state conservation significance or rating are listed under the *National Parks and Wildlife (NPW) Act 1972* Schedule 7, 8 and 9 (revised February 2008) as Endangered, Vulnerable or Rare. The role of the NPW Act is to detail species of state conservation significance. The NPW Act does not currently have approval requirements if a proposal is likely to impact on a state threatened species. It should be noted that references to State rated species within this report, is reference to that species' rating under the NPW Act.

Species are identified as being of regional conservation significance based on the *Regional Plan for Threatened Species and Ecological Communities of Adelaide and the Mount Lofty Ranges, South Australia 2009-2014*. Regional ratings do not carry any specific approval requirements.

## **2.2 Assessment of the likelihood of threatened species occurring**

A likelihood of occurrence rating (i.e. likelihood of that species occurring on or near site) was assigned to each threatened species identified in the Protected Matters Search and BDBSA database searches. This likelihood of occurrence rating, 'Highly Likely', 'Likely', 'Possible' and 'Unlikely' takes the following criteria into consideration:

- proximity of the records (distance to the project area)
- landscape location of the records, vegetation remnancy and vegetation type of the record location (taking into consideration the landscape, remnancy and vegetation type of the project area, with higher likelihood assigned to species that were found in similar locations/condition/vegetation associations)
- knowledge of the species' habitat preferences, causes of its decline, and local population trends.

## **2.3 Field Survey**

### **2.3.1 Survey site locations**

Bird surveys were conducted in spring 2008 across eight different habitat types at a total of 25 survey sites (Figure 3), and opportunistically across the project site and surrounding region. These different habitat types were representative of variations in the landscape and not based on the botanical

communities at the site. The project site was surveyed for birds at several times of the day including early morning, the middle of the day and late afternoon.

A winter 2009 survey was conducted following the findings and recommendations of an AusWind Level One bird survey completed for the same site within the previous year (EBS 2008). During this survey a total of thirteen survey points were established across the proposed wind farm site. These locations were established in order to focus more directly on the areas where turbines were proposed. The sites were positioned in areas that were readily accessible and the observer was positioned with a clear view of the surrounding area. A range of habitat types were surveyed within the project site. Survey site locations are shown in Figure 4 and a description of the bird survey sites and the habitat types from the winter 2009 survey is provided in Table 1. The vegetation descriptions are consistent with the 12 associations defined by EBS Ecology within the flora and fauna assessment (EBS 2010). Surveys were carried out during daylight hours, between sunrise and sunset. All sites were surveyed each day but at different times of day to avoid any biases in the collection of data. Counts were rotated so that each of the optimal times of the day was covered, inclusive of early/mid morning and early/late afternoon periods.

A total of thirteen bird survey sites, established in winter 2009, were revisited during the spring 2009 survey. Methodology used during the spring 2009 survey was consistent with the previous survey, in assessing the breeding activity of Wedge-tailed Eagles and determining bird utilisation across the site. Ten potential *Aquila audax* (Wedge-tailed Eagle) nests were first observed during the winter 2009 survey, however no nesting behavior was recorded due to the timing of the survey and the fact that the Wedge-tailed Eagles breeding cycle fell outside of the winter 2009 survey. The spring 2009 survey was performed at a time when eagle chicks would be expected to be present and therefore provide a means of assessing nest activity.

The summer 2010 survey focussed on determining the breeding success of ten potential Wedge-tailed Eagles at the nest locations originally determined during the winter 2009 survey. One additional Wedge-tailed Eagle nest location was recorded during the spring 2009 survey. A twelfth nesting location was also recorded during the summer 2010 survey. Possible breeding locations for the Peregrine Falcon were also searched during the summer 2010 survey, including rocky ledges and rocky outcrops within gullies on the eastern edge of the project site.



Table 1. The 13 bird survey site locations, descriptions and general habitat information at the proposed Keyneton Wind Farm.

Site	Easting	Northing	Description	Habitat	Vegetation Description
K1	333096	6178035	Hilltop with 360 degree view of scattered trees, and bare paddocks	Scattered Blue Gum over cropping land	Scattered <i>Eucalyptus leucoxylon</i> (South Australian Blue Gum) over Exotic Grassland/Cropping Land
K2	333108	6178725	Hilltop with 360 degree view of scattered trees, and bare paddocks	Scattered Blue Gum over cropping land	Scattered <i>Eucalyptus leucoxylon</i> (South Australian Blue Gum) over Exotic Grassland/Cropping Land
K3	333575	6177206	Bare hill tops with 360 degree view of surrounding hilltops, paddocks and steep gullies	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants
K4	333668	6176528	Bare hilltop, with 360 degree view of paddocks and scattered trees to west, and farm dam to south west	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants
K5	334098	6175948	Bare hilltop, with 360 degree view of paddocks, and a few solitary tress	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants
K6	334374	6165324	Bare hill tops with 360 degree view of surrounding hilltops and steep gullies	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants
K7	334009	6173753	Bare hilltop, with 360 degree view of open paddocks and scattered eucalypts	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants
K8	334820	6172419	Under power lines on top of bare hill, with 360 degree view of bare paddocks and woodland on hills to west	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants
K9	335089	6171045	Bare hill tops with 360 degree view of surrounding hilltops and steep gullies	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants
K10	334187	6168529	In paddock with tree-lined road to south, and scattered trees to west, bare hills to east	Open Woodland over Exotic Grassland	<i>Eucalyptus leucoxylon</i> (South Australian Blue Gum) +/- <i>Eucalyptus odorata</i> (Peppermint Box) Open Woodland over Exotic Grassland.
K11	334657	6166770	Bare hilltop, with 360 degree view of open paddocks and scattered trees	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants
K12	335789	6166629	Bare hilltop, with 360 degree view of open paddocks and steep gullies	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants
K13	334701	6175276	Bare hilltop, with 360 degree view of open paddocks and steep gullies, and a few scattered trees	Exotic Grassland	Exotic Grassland/Herb Land, <i>Avena barbata</i> (Wild Oats), <i>Echium plantagineum</i> (Salvation Jane) dominants



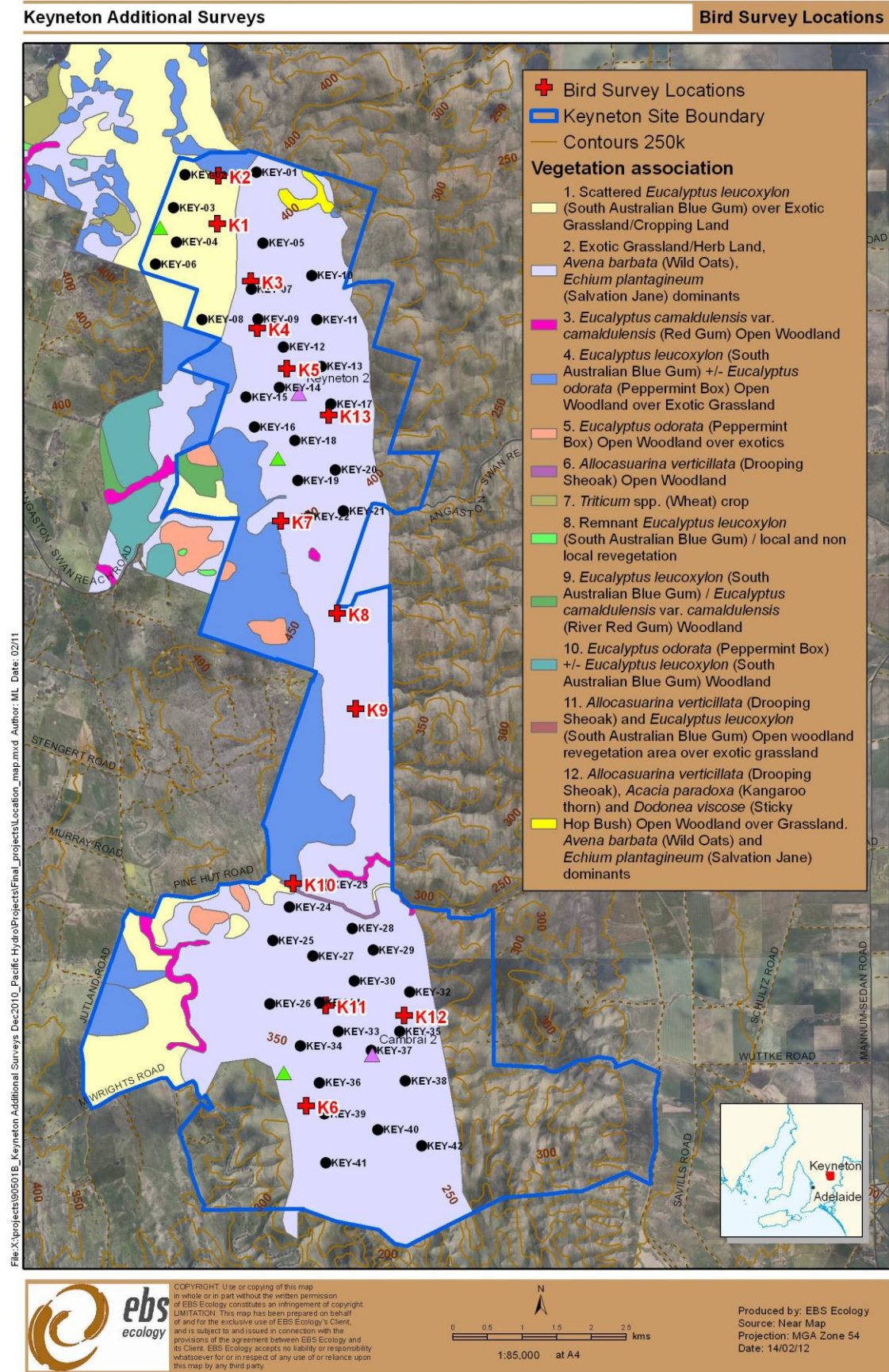


Figure 4. Bird survey site locations across the proposed Keyneton Wind Farm (established during the winter 2009 survey).

### 2.3.2 Survey Effort

Four surveys, across three seasons, have been conducted at the proposed Keyneton Wind Farm. Survey methodology included fixed point count surveying, opportunistic observations and targeted surveying for the State rare *Falco peregrinus* (Peregrine Falcon) and priority species, *Aquila audax* (Wedge-tailed Eagle). The overall survey effort used to investigate bird utilisation on site at the proposed Keyneton Wind Farm was 138 hours over 14 days (Table 2).

**Table 2. Survey effort completed on site at the proposed Keyneton Wind Farm.**

Survey	Survey Dates	Survey Types	Survey Effort	Comments
Spring 2008	22 September and 20 October 2008	<ul style="list-style-type: none"> <li>Fixed Point Count</li> <li>Opportunistic Observations</li> </ul>	2 days (16 hours)	Wider site area, 25 survey sites – See figure 3
Winter 2009	22 – 26 June 2009	<ul style="list-style-type: none"> <li>Fixed Point Count</li> <li>Opportunistic Observations</li> <li>WTE Nest Survey</li> </ul>	5 days (52 hours)	Site area reduced since spring 2008, 13 point count survey locations – See figure 4
Spring 2009	7 – 10 October 2009	<ul style="list-style-type: none"> <li>Fixed Point Count</li> <li>Opportunistic Observations</li> <li>WTE Nest Survey</li> </ul>	3 days (30 hours)	13 point count survey locations – as above
Summer 2010	13 – 16 December 2010	<ul style="list-style-type: none"> <li>WTE Nest Survey</li> <li>PF Nest Survey</li> <li>Opportunistic Observations</li> </ul>	4 days (40 hours)	Nest checks and breeding activity assessed at 12 identified nest locations, targeted survey for Peregrine Falcon and opportunistic observations

### 2.3.3 Fixed Point Count Method

A fixed point count was conducted at each of the 25 bird survey sites during the spring 2008 survey. After a change in turbine design, the site area was reduced and fixed point counts were conducted at each of the 13 bird survey sites during the winter and spring 2009 surveys. Upon reaching a survey site, the observer stood quietly for five minutes to allow birds to settle. During these five minutes, the observer recorded the time, site details and weather conditions, including:

- wind strength (using the Beaufort Scale)
- wind direction (using compass bearings)
- rain (nil, drizzle/light rain, heavy rain)
- cloud cover (<10%, 11-30%, 31-70%, 71-100%)
- temperature (°C).

After the five minute acclimatisation period, a 20 minute point count was conducted. During this period the observer scanned the entire area (360°) at a slow steady rate. All species of birds sighted during point count surveys were recorded. The details recorded for each observation were:

- species

- number of movements
- number of individuals
- height above ground (m)
- distance from observer (m)
- behaviour:
  - flying in a single direction – FLM
  - flying (hovering or circling) over or around a single point – FLH
  - foraging (feeding) on ground - FOG
  - perching/resting/walking on ground – ROG
  - perching/resting/climbing on trees or shrubs – ROT
  - direction of flight where possible (it is difficult to follow the flight path of a bird when they are at a considerable distance from the observer).

If a bird remained within the observation zone during a 20 minute survey and did not change its behaviour (e.g. remained perched in a tree for the observation period), it was only recorded once. Changes in flight behaviour were recorded as additional records, regardless of whether the bird remained within, or moved out and then back into the observation zone. For example, if a bird flew, landed and then flew again, each of the flights within the observation zone constituted a movement.

The observation zone was broad within the project site where the observer was able to detect birds with the naked eye. Binoculars or spotting scopes were used to assist in identifying birds to species level. Bird calls were only used to alert the observer to the presence of a bird and to assist in identifying its location and identity. The distance to a bird and its height above ground was estimated from fixed points in the landscape, whose distance and height was measured with a range finder. At the completion of the each survey, the observer moved on to the next point count survey location.

#### **2.3.4 Opportunistic Records**

In addition to point count surveys, all birds observed whilst travelling between sites, and during the five minute acclimatisation period at a survey point, were recorded as opportunistic records.

#### **2.3.5 Targeted Wedge-tailed Eagle nest searches**

Searches were conducted on foot through all woodland habitat across the site to locate Wedge-tailed Eagle (WTE) nests and determine the breeding success (if any) of birds present. The location, dimension, sign of activity of the WTE nests and nearby WTE sightings and behaviours were recorded during the winter 2009 survey. Photographs of each of the nesting sites were taken during the winter 2009 survey and again during both the spring 2009 and summer 2010 surveys. During the spring 2009



and summer 2010 surveys, the occupancy of a nest site was assessed as well as its status. The presence of a chick, fledgling or adult Wedge-tailed Eagle, in or near the nest, was determined. Any eagles flying from the area upon arrival were also recorded. Other parameters were also used as an indication of nest occupancy such as fresh whitewash (bird excrement), prey remains on the ground beneath or within the nest and the presence of green leaves in the nest bowl (when views were available).

### **2.3.6 Targeted Peregrine Falcon nest searches**

A targeted survey for Peregrine Falcons investigated potential nest locations and assessed the breeding status of this species. Suitable habitat for the Peregrine Falcon characteristically includes rocky crevices and ledges however the species has also been known to occupy abandoned nests of other species. Whilst checking the breeding status of Wedge-tailed Eagles during the summer 2010 survey, eagle nest locations were also surveyed for the presence of Peregrine Falcons. Rocky crevices and ledges situated in gullies on site were also searched as potential nest locations.

## **2.4 Bird Utilisation Rates**

Based on the sightings of birds during fixed point count surveys (winter and spring 2009), a number of calculations were made to provide an indication of bird utilisation of the site. These included:

- the number of movements (flights) made by each species;
- the minimum and maximum height flown by each species;
- their behaviour as they flew across the site, over the ridge, on the slope or over the valley
- an overall determination of whether each species is at risk of collision with a potential turbine.

Opportunistic observations of flying Wedge-tailed Eagles and Peregrine Falcons were recorded during the summer 2010 survey, to gain a better understanding of how both raptors utilised the ridgelines within the site. A range of details were recorded:

- number of individuals
- direction of flight
- distance from observer
- number of movements
- height above ground (m)
- behaviour (soaring, flying over, circling)
- flying location (over slope, ridge and/or valley).

## **2.5 Risk assessment**

A risk assessment matrix has been used to qualitatively define the risk of the proposed Keyneton Wind Farm on birds that performed at-risk movements within the project site as well as those species defined as likely to occur within the project site (based on the BDBSA search). The assessment is an adaptation

of the qualitative measures of likelihood and consequence used in the Australian Defence Risk Management Framework (DRMF) (Gaidow and Boey 2005).

The DRMF provided generic guidance on the introduction and ongoing implementation of a risk management process; it may be applied to different activities or operations of any corporate, community or public sector organisation (Gaidow and Boey 2005). This risk assessment matrix considered the risk consequences (impact or magnitude of effect) and likelihood (measured by frequency or probability) of risk occurrence to combine them into the level of risk.

The risk assessment methodology used within the DRMF was adapted to a science based situation to include likelihood and consequence of an event on a species or local population. EBS Ecology used the risk assessment matrix to qualitatively define the risk of a proposed wind monitoring mast on birds within the mid-north of South Australia. The risk matrix was accepted (when previously used by EBS Ecology) by the Environment, Resources and Development (ERD) Court. State threatened species, raptors and migratory species were targeted in the assessment. This was based on bird species that had been identified as potentially occurring on site (through database searches) and those species that had been previously recorded on site.

Likelihood was defined as how likely is mortality from collision to occur, and consequence was defined by significance of associated impact on species viability (Table 3). A category of A to E was used to define likelihood, ranging from chronic (the event is expected to occur in most circumstances) to rarely (where the event may occur only in exceptional circumstances). A category of one to five was used to define consequence, where one equated to nil/insignificant (individuals may be affected, but viability of local population was not impacted) and five equated to catastrophic disaster (potential to lead to collapse of a species) (Table 3). Table 4 outlines the qualitative risk analysis matrix, which summarises four levels of impact: low, medium, high and extreme.

**Table 3. Qualitative measures of likelihood and consequence (adopted from AS/NZS 4360:1999).**

Likelihood (How likely is mortality from collision to occur)	Consequence (Significance of associated impact on species viability)
Rating Definition	Rating Definition
<b>A Chronic:</b> The event is expected to occur in most circumstances	<b>5 Catastrophic Disaster:</b> potential to lead to collapse of species
<b>B Frequent:</b> The event probably will occur in most circumstances (e.g. weekly to monthly).	<b>4 Major:</b> Critical event, very likely to have significant impact on species
<b>C Likely:</b> The event should occur at some time i.e. once in a while	<b>3 Moderate:</b> likely to have impact on population, potential to impact on long term viability under some scenarios
<b>D Unlikely:</b> The event could occur at some time	<b>2 Minor:</b> may have impact on local population, no impact on species
<b>E Rarely:</b> The event may occur only in exceptional circumstances	<b>1 Insignificant:</b> individuals may be affected, but viability of local population not impacted



**Table 4. Qualitative Risk Analysis Matrix – Level of Risk (adopted from AS/NZS 4360:1999 and HB 143:1999).**

Likelihood	Consequences				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
A (chronic)	High	High	Extreme	Extreme	Extreme
B (frequent)	Medium	High	High	Extreme	Extreme
C (likely)	Low	Medium	High	Extreme	Extreme
D (unlikely)	Low	Low	Medium	High	Extreme
E (rarely)	Low	Low	Medium	High	High

If the level of risk was determined as high to extreme, then resulting impact on an individual species and local population would be unacceptable. If the level of risk was categorised as medium, then all efforts should be made to mitigate against potential impact on the species. If the level of risk was low, then impact would be restricted to an individual level and impact on a species would be unlikely to affect the viability of a local population.

## 2.6 Survey limitation

A range of bird survey locations were positioned within different habitat types across the project site. Naturally some of these bird sites were situated along ridgelines to observe birds utilising this part of the landscape. A bias toward the number of observations recorded along the ridgeline may have been a result of this site placement.

There is limitation in determining the resulting impact of acceptability and significance with regard to the risk assessment matrix. The matrix provides a guide to risk consequences and likelihood of risk occurrence based on the bird species that were identified as performing flights considered as “at-risk movements (20 species in total).

## 3 RESULTS

### 3.1 Database Search

Eleven bird species were identified from the EPBC search as potentially occurring within the project site, including nine migratory bird species of national significance (Table 22). The likelihood of each of these species occurring on site is based on the availability of suitable habitat and its potential occurrence within the immediate vicinity of the wind farm. Although none were observed during the field surveys, three migratory species were recognised as possibly utilising the project site due to availability of suitable habitat. They include *Merops ornatus* (Rainbow Bee-eater), *Ardea alba* (Great Egret) and *Ardea ibis* (Cattle Egret) (listed as rare under the NPW Act). Profiles of the three species detailing their likelihood of occurring on site and an assessment of the potential impacts of the proposed wind farm are detailed in Section 3.9.1.

Twenty-three (23) species of state conservation significance were identified as possibly occurring within the Keyneton project site from the BDBSA database search (Table 22). Three State rare birds (listed under the NPW Act) have been recorded during EBS surveys on site: *Falco peregrinus* (Peregrine Falcon), *Neophema elegans* (Elegant Parrot) and *Corcorax melanorhamphos* (White-winged Chough). Ten of the 23 species were considered likely to utilise the project site. Species profiles are provided in section 3.9.2. All bird species identified from the BDBSA search as potentially occurring within the project area are listed in Appendix 6.

**Table 5. Conservation rated bird species and their likelihood of occurrence in the proposed Keyneton Wind Farm project site based on the EPBC Protected Matters Online Search Tool.**

Species name	Common name	Records in the area	Aus status	SA status	Likelihood of utilising project site	Likelihood of utilising the project site
<i>Pachycephala rufogularis</i>	Red-lored Whistler	No	VU		Unlikely	Species occurs within low mallee shrublands, heathlands and woodlands that have an open canopy and a moderately dense but patchy understorey. Habitat on site is unlikely to support this species.
<i>Rostratula australis</i>	Australian Painted Snipe	No	VU	R	Unlikely	This species inhabits inland wetlands, either freshwater or brackish. Preferred habitat is not present on site.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	No	MI, MA	E	Unlikely	Species occurs near large rivers, fresh and saline lakes, reservoirs, estuaries and coastal seas. Preferred habitat is not present on site.
<i>Hirundapus caudacutus</i>	White-throated Needletail	No	MI, MA		Unlikely	Species is mostly aerial during its stay in Australia. It is unlikely to occur on site.
<i>Leipoa ocellata</i>	Malleefowl	No	MI		Unlikely	This species occupies shrublands and low woodlands dominated by mallee vegetation. Habitat type includes <i>Eucalypt</i> or native pine <i>Callitris</i> woodlands, <i>Acacia</i> shrublands, <i>Melaleuca uncinata</i> vegetation or coastal heathlands. Preferred habitat is not present on site.
<i>Merops ornatus</i>	Rainbow Bee-eater	No	MI, MA		Possible	This species prefers open forests, woodlands, shrublands, and within cleared or semi-cleared habitats (including farmland). Often, but not always, located in close proximity to permanent water, widespread along creek lines in red gum communities. May utilise the site as preferred habitat present.
<i>Ardea alba</i>	Great Egret, White Egret	No	MI, MA		Possible	Species prefers floodwaters, rivers, wetlands, mudflats. Limited extent of preferred habitat may be present on site.
<i>Ardea ibis</i>	Cattle Egret	No	MI, MA	R	Possible	This species occupies grasslands, woodlands and wetlands with a preference for moist areas with tall grass, shallow open wetlands and wetland margins. May utilise the site as preferred habitat present.
<i>Gallinago hardwickii</i>	Latham's Snipe, Japanese Snipe	No	MI	MI	Unlikely	This summer migrant is unlikely to occur on site given a preference for soft wet ground, shallow water with tussocks and irrigated areas. This preferred habitat is not present on site.
<i>Rostratula benghalensis s. lat.</i>	Painted Snipe	No	MI		Unlikely	This species is unlikely to occur on site with a preference for shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. This preferred habitat is not present on site.
<i>Apus pacificus</i>	Fork-tailed Swift	No	MI, MA		Unlikely	This Asian species is mostly aerial during its stay in Australia which makes it difficult to detect. It is unlikely to occur on site.

Table 6. Threatened species identified from the Biological Database of South Australia (BDBSA) search.

Species name	Common name	Aus status	SA status	Likelihood of utilising project area	Likelihood of utilising the project area
<i>Ardea intermedia</i>	Intermediate Egret		R	Possible	Nests in colonies with other herons, usually on platforms of sticks in trees or shrubs. Prefer shallow coastal or fresh water, including flooded fields. They may possibly occur within project site if paddocks/fields are flooded.
<i>Biziura lobata</i>	Musk Duck		R	Possible	This species is found in deep freshwater lagoons, with dense reed beds. They are normally observed singly or in pairs, but may form medium to large groups in the winter. May be present on water at farm dams with the project site.
<i>Cinclosoma castanotum castanotum</i>	Chestnut Quail-thrush		R	Possible	This species occurs within a wide range of arid and semi-arid habitats, mainly in the low shrubs and undergrowth of mallee scrub, but also in <i>Acacia</i> scrubs, dry sclerophyll woodland, heath and native pine. These birds forage mostly on the ground which makes detection difficult. Limited preferred habitat may be present on site.
<i>Corcorax melanorhamphos</i>	White-winged Chough		R	Known	This species prefers areas of vegetated woodland. Preferred habitat for this species is present on site.
<i>Falco peregrinus</i>	Peregrine Falcon		R	Known	This species requires abundant prey and secure nest sites. It prefers coastal and inland cliffs or open woodlands near water. Peregrine Falcons commonly occur at windy sites along ranges. Preferred habitat for this species is present on site.
<i>Falcunculus frontatus</i>	Crested Shrike-tit		V	Possible	This species favours grassy woodland, heathy woodland and riparian areas. It occurs high up in trees within mallee, and stands of cypress pines and Banksias. It is unclear at what height they fly through the canopy when travelling between patches of woodland. Preferred habitat is present on site.
<i>Lophoictinia isura</i>	Square-tailed Kite		E	Unlikely	This species is found in a variety of timbered habitats including dry woodlands and open forests. It shows a particular preference for timbered watercourses and is generally absent from treeless inland areas. This preferred habitat is not present on site.
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (South East ssp)		R	Likely	This species prefers lightly timbered habitats, especially eucalypt woodlands, mallee and <i>Acacia</i> shrublands. Preferred habitat for this species is present on site.
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater		V	Unlikely	This species is found in the upper levels of open eucalypt forests and woodlands dominated by box and ironbark eucalypts. It is often found along waterways, especially in arid and semi-arid areas. Distribution of this species on site would be limited based on its last recording within the project area

Species name	Common name	Aus status	SA status	Likelihood of utilising project area	Likelihood of utilising the project area
					(Figure 23) in 1982. Unlikely to be found as preferred box and ironbark habitat is not present on site.
<i>Microeca fascians fascians</i>	Jacky Winter (South East ssp)		R	Known	This species prefers open grassy woodland and mallee, with an open shrub layer. May utilise the site as preferred habitat present.
<i>Myiagra inquieta</i>	Restless Flycatcher		R	Possible	This species occurs in open forests, woodlands, farmland and inland scrub. May utilise the site as preferred habitat present.
<i>Neophema elegans</i>	Elegant Parrot		R	Known	This species prefers heathland and open country, open woodland, cropland and semiarid scrub. They feed on the seeds of native and introduced grasses. May utilise the site as preferred habitat present.
<i>Northiella haematogaster</i>	Blue Bonnet		R	Likely	This species prefers lightly timbered grassland and habitat of mulga, mallee and Sheoak, and can be found along watercourses and in scattered paddock trees. May utilise the site as preferred habitat present.
<i>Oxyura australis</i>	Blue-billed Duck		R	Unlikely	The Blue-billed Duck is endemic to Australia, being found in the temperate wetlands of the south-east and south-west parts of the continent. The Blue-billed Duck is almost wholly aquatic, and is seldom seen on land.
<i>Pachycephala inornata</i>	Gilbert's Whistler		R	Unlikely	It occurs in ranges, plains and foothills in arid and semi-arid timbered habitats. It forages on or near the ground in shrub thickets and in tops of small trees. Unlikely to be found as preferred arid or semi-arid habitat is not present on site.
<i>Petroica boodang boodang</i>	Scarlet Robin (south-east ssp)		R	Likely	This species is commonly found in eucalypt woodland and forest. During its breeding season, they prefer forest and woodland with dense understory and ground cover. May utilise the site as preferred habitat present.
<i>Petroica phoenicea</i>	Flame Robin		V	Likely	This species prefers more open habitats with grassy and shrubby understoreys. May utilise the site as preferred habitat present.
<i>Plectorhyncha lanceolata</i>	Striped Honeyeater		R	Possibly	This species inhabits a wide range of habitats including drier open forests, woodlands, mallee, mulga, heathlands along rivers and mangroves. Preferred habitat for this species may be present on site.
<i>Podiceps cristatus</i>	Great Crested Grebe		R	Unlikely	It is a waterbird of open lagoons, lakes and wetlands; a specialist aquatic species that never emerges onto land. They prefer to nest in areas where dense reeds and sedges occur over water. This preferred habitat is not present on site.

Species name	Common name	Aus status	SA status	Likelihood of utilising project area	Likelihood of utilising the project area
<i>Stagonopleura guttata</i>	Diamond Firetail		V	Likely	This species lives in a wide range of eucalypt dominated vegetation that includes grassy understory, woodland, forest and mallee. May utilise the site as preferred habitat present.
<i>Strepera versicolor melanoptera</i>	Grey Currawong (ssp for SE)		U - regional	Likely	This species lives in a wide range of eucalypt dominated vegetation that includes grassy understory, woodland, forest and mallee. Preferred habitat for this species is likely to be present on site.
<i>Turnix varius</i>	Painted Button-quail		R	Possible	Habitat for this species ranges from temperate and eastern tropical forests to woodlands. They appear to prefer closed canopies with some understory and deep leaf litter on the ground. It may occur within the wider project area although no records have been found.
<i>Zoothra lunulata</i>	Bassian Thrush		R	Unlikely	A secretive inhabitant of shrubland, forests and rainforests, typically in locations with a dense overhead canopy and a thick-leaf litter. Suitable habitat commonly occurs in heavily vegetated gullies in shrublands and forests, or in dune swales. Preferred habitat of areas of remnant vegetation >100ha is not present on site.

**KEY****Regions:**

AUS = Australia

SA = South Australia

**Conservation Status Codes:**

**X** = Extinct/Presumed extinct: not located despite thorough searching of all known and likely habitats; known to have been eliminated by the loss of localised population(s); or not recorded for more than 50 years from an area where substantial habitat modification has occurred.

**E** = Endangered: Rare and in danger of becoming extinct in the wild.

**T** = Threatened: likely to be either Endangered or Vulnerable but insufficient data for a more precise assessment.

**V** = Vulnerable: Rare and at risk from potential threats or long term threats which could cause the species to become endangered in the future.

**K** = Uncertain: likely to be either Threatened or Rare but insufficient data for a more precise assessment.

**R** = Rare: has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant threats, but warrants monitoring and protective measures to prevent reduction of population sizes.

**U** = uncommon: less common species of interest but not Rare enough to warrant special protective measure



### 3.2 General Bird Community

No EPBC listed species were observed within the project sites. Four (4) state threatened species and six regionally threatened species (Mount Lofty Ranges) were detected across the entire survey period (Table 22). Regional ratings are outlined in the *Regional Recovery Plan for Threatened Species and Ecological Communities of Adelaide and the Mount Lofty Ranges, South Australia 2009 – 2014*.

**Table 7. Bird species observed during all survey periods within the proposed Keyneton Wind Farm project site.**

Species Name	Common Name	Exotic	Conservation rating		
			AUS	SA	Regional
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill				AMLR U;
<i>Acanthiza pusilla</i>	Brown Thornbill				
<i>Accipiter fasciatus</i>	Brown Goshawk				
<i>Alauda arvensis</i>	Eurasian Skylark*				
<i>Anas gracilis</i>	Grey Teal				
<i>Anas platyrhynchos</i>	Mallard				
<i>Anthochaera carunculata</i>	Red Wattlebird				
<i>Anthochaera chrysoptera chrysoptera</i>	Little Wattlebird				
<i>Anthus novaeseelandiae</i>	Richard's Pipit				
<i>Aphelocephala leucopsis leucopsis</i>	Southern Whiteface				AMLR V;
<i>Aquila audax</i>	Wedge-tailed Eagle				
<i>Cacatua roseicapilla</i>	Galah				
<i>Cacatua sanguine</i>	Little Corella				
<i>Chenonetta jubata</i>	Australian Wood Duck				
<i>Cincloramphus cruralis</i>	Brown Songlark				
<i>Climacteris picumnus</i>	Brown Treecreeper				AMLR V;
<i>Colluricincla harmonica</i>	Grey Shrike-thrush				
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				
<i>Corcorax melanorhamphos</i>	White-winged Chough			R	
<i>Corvus coronoides</i>	Australian Raven				
<i>Corvus mellori</i>	Little Raven				
<i>Cracticus torquatus</i>	Grey Butcherbird				
<i>Dacelo novaeguineae</i>	Laughing Kookaburra				
<i>Dromaius novaehollandiae</i>	Emu				
<i>Egretta novaehollandiae</i>	White-faced Heron				
<i>Elanus axillaris</i>	Black-shouldered Kite				
<i>Falco berigora</i>	Brown Falcon				
<i>Falco cenchroides</i>	Nankeen Kestrel				
<i>Falco peregrinus</i>	Peregrine Falcon			R	AMLR R;
<i>Glossopsitta concinna</i>	Musk Lorikeet				AMLR U;
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet				
<i>Grallina cyanoleuca</i>	Magpie-lark				

## Proposed Keyneton Wind Farm: Avifauna and raptor nest assessment

Species Name	Common Name	Exotic	Conservation rating		
			AUS	SA	Regional
<i>Gymnorhina tibicen</i>	Australian Magpie				
<i>Haliastur sphenurus</i>	Whistling Kite				
<i>Hirundo neoxena</i>	Welcome Swallow				
<i>Lalage sueurii</i>	White-winged Triller				
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater				
<i>Lichenostomus virescens</i>	Singing Honeyeater				
<i>Malurus cyaneus</i>	Superb Fairy-wren				
<i>Malurus lamberti</i>	Variegated Fairy-wren				
<i>Manorina flavigula</i>	Yellow-throated Miner				
<i>Manorina melanocephala</i>	Noisy Miner				
<i>Microeca fascinans fascinans</i>	Jacky Winter			R	
<i>Neophema elegans</i>	Elegant Parrot			R	
<i>Ocyphaps lophotes</i>	Crested Pigeon				
<i>Pachycephala rufiventris</i>	Rufous Whistler				
<i>Pardalotus striatus</i>	Striated Pardalote				
<i>Petrochelidon nigricans</i>	Tree Martin				AMLR U;
<i>Petroica goodenovii</i>	Red-capped Robin				
<i>Platycercus elegans</i>	Crimson Rosella				
<i>Platycercus elegans adalaidae</i>	Adelaide Rosella				
<i>Psephotus haematonotus</i>	Red-rumped Parrot				AMLR U;
<i>Rhipidura leucophrys</i>	Willie Wagtail				
<i>Sturnus vulgaris</i>	Common Starling				
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe				
<i>Turdus merula</i>	Eurasian Blackbird				
<i>Vanellus miles</i>	Masked Lapwing				
<i>Vanellus tricolor</i>	Banded Lapwing				

### Conservation Region Codes

AUS = Australia

SA = South Australia

AMLR = Adelaide Mt Lofty Ranges

### CONSERVATION STATUS CODES

X = Extinct/Presumed extinct: not located despite thorough searching of all known and likely habitats; known to have been eliminated by the loss of localised population(s); or not recorded for more than 50 years from an area where substantial habitat modification has occurred.

E = Endangered: rare and in danger of becoming extinct in the wild.

T = Threatened: likely to be either Endangered or Vulnerable but insufficient data for a more precise assessment.

V = Vulnerable: Rare and at risk from potential threats or long term threats which could cause the species to become endangered in the future.

K = Uncertain: likely to be either Threatened or Rare but insufficient data for a more precise assessment.

R = Rare: has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant threats, but warrants monitoring and protective measures to prevent reduction of population sizes.

U = Uncommon: less common species of interest but not rare enough to warrant special protective measures.

Blank = Not of particular significance/Common.

### 3.3 Spring 2008 survey

A total of 744 bird observations from 43 different species were recorded during the two day survey of the Keyneton Wind Farm Site (Table 22). The most commonly recorded species was *Cacatua roseicapilla* (Galah), accounting for 19% of all observations (Table 22). Other commonly recorded species were *Sturnus vulgaris* (Common Starling) and *Gymnorhina tibicen* (Australian Magpie), with 92 and 90 observations recorded respectively. *Platycercus elegans adalaidae* (Adelaide Rosella) and *Petrochelidon nigricans* (Tree Martin) were also recorded in abundance; 10% of all birds recorded were Adelaide Rosella (74 observations) and 9% were Tree Martins (69 observations) (Table 22). Together, these five common species accounted for 62% of all bird observations.

Of all species recorded, 53% (23/43) consisted of one to five observations (Table 22). These less common species accounted for only 6% of all observations recorded during the two day survey. Table 22 shows all birds recorded during the survey for the proposed Keyneton Wind Farm site, listed from most to least common. It also shows the proportion of all observations sighted belonging to each species.

Table 8. All bird records made during the two day survey (from most observed to least).

Scientific name	Common name	Number of observations	% of all observations
<i>Cacatua roseicapilla</i>	Galah	138	18.5
<i>Sturnus vulgaris</i>	Common Starling	92	12.4
<i>Gymnorhina tibicen</i>	Australian Magpie	90	12.1
<i>Platycercus elegans adalaidae</i>	Adelaide Rosella	74	9.9
<i>Petrochelidon nigricans</i>	Tree Martin	69	9.3
<i>Manorina melanocephala</i>	Noisy Miner	42	5.6
<i>Glossopsitta concinna</i>	Musk Lorikeet	24	3.2
<i>Pardalotus striatus</i>	Striated Pardalote	21	2.8
<i>Cacatua sanguine</i>	Little Corella	18	2.4
<i>Chenonetta jubata</i>	Australian Wood Duck	15	2.0
<i>Corcorax melanorhamphos</i>	White-winged Chough	13	1.7
<i>Corvus coronoides</i>	Australian Raven	12	1.6
<i>Climacteris picumnus</i>	Brown Treecreeper	10	1.3
<i>Anas gracilis</i>	Grey Teal	10	1.3
<i>Anthochaera carunculata</i>	Red Wattlebird	9	1.2
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	7	0.9
<i>Falco cenchroides</i>	Nankeen Kestrel	6	0.8
<i>Psephotus haematonotus</i>	Red-rumped Parrot	6	0.8
<i>Rhipidura leucophrys</i>	Willie Wagtail	6	0.8
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	5	0.7
<i>Vanellus miles</i>	Masked Lapwing	4	0.5
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet	4	0.5
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	3	0.4
<i>Anthus novaeseelandiae</i>	Richard's Pipit	3	0.4

Scientific name	Common name	Number of observations	% of all observations
<i>Lichenostomus virescens</i>	Singing Honeyeater	3	0.4
<i>Aquila audax</i>	Wedge-tailed Eagle	3	0.4
<i>Haliastur spheurnus</i>	Whistling Kite	3	0.4
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	2	0.3
<i>Cincloramphus cruralis</i>	Brown Songlark	2	0.3
<i>Turdus merula</i>	Eurasian Blackbird	2	0.3
<i>Anthochaera chrysoptera chrysoptera</i>	Little Wattlebird	2	0.3
<i>Grallina cyanoleuca</i>	Magpie-lark	2	0.3
<i>Malurus lamberti</i>	Variegated Fairy-wren	2	0.3
<i>Hirundo neoxena</i>	Welcome Swallow	2	0.3
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	1	0.1
<i>Elanus axillaris</i>	Black-shouldered Kite	1	0.1
<i>Falco berigora</i>	Brown Falcon	1	0.1
<i>Accipiter fasciatus</i>	Brown Goshawk	1	0.1
<i>Petroica goodenovii</i>	Red-capped Robin	1	0.1
<i>Pachycephala rufiventris</i>	Rufous Whistler	1	0.1
<i>Egretta novaehollandiae</i>	White-faced Heron	1	0.1
<i>Lalage sueurii</i>	White-winged Triller	1	0.1
	<b>Grand Total</b>	<b>744</b>	

No birds of national conservation status were detected during the spring 2008 survey. One bird of state conservation status was detected during the spring 2008 survey, the White-winged Chough. It is listed as State rare under the *NPW Act 1972* and 13 observations (2% of all observations) were recorded on site. The regionally vulnerable *Climacteris picumnus* (Brown Treecreeper), and regionally uncommon *Glossopsitta concinna* (Musk Lorikeet) and *Psephotus haematonotus* (Red-rumped Parrot) were also recorded.

### 3.3.1 Abundance, Diversity and Habitat Utilisation

The most commonly surveyed habitat type was of scattered eucalypt in paddocks. These paddocks most commonly contained pasture grasses for livestock grazing, but in some areas cereal crops were being grown. Large old growth eucalypts, mainly of the species *Eucalyptus odorata* (Peppermint Box), and *E. leucoxylon* (South Australian Blue Gum) were the dominant type of tree. Bird surveys were undertaken in habitat which was inter dispersed between pasture grasses on bare hilltops, pasture grasses and crops in the valleys, and eucalypt woodlands. These eucalypt woodlands were most common in the north western sector of the project site at the bird survey locations of B1-B3, as well as at survey site number 17 and 20 (Figure 3). All these locations have subsequently been deleted from the proposed layout and site boundary. This created a clear west to east gradient in bird habitat across the northern sector of the site which influenced the abundance and distribution of birds in the area.

The largest diversity of birds were recorded at bird survey point one (B1), where 15 species were identified (Figure 3, Table 22). The habitat at site B1 was eucalypt woodland with no understorey, and there was no ground cover due to grazing by livestock. Of the top ten sites for species diversity, six occurred in this habitat type. This suggested that open woodland supported the largest diversity of bird species within the project site, during the 2008 survey. The highest number of individuals recorded during this survey also occurred within this habitat type, as well where eucalypts were scattered among pasture grasses (Table 22).

The survey locations are denoted by a single number representing the bird surveys done in conjunction with vegetation assessment survey (22 September 2008). Survey locations labelled with a B followed by a number indicate bird surveys that were conducted on the secondary visit to the site (20<sup>th</sup> October 2008).

**Table 9. Habitat type at bird survey sites compared with bird diversity (spring 2008).**

Site	Species Diversity	Habitat Type
B1	15	Eucalypt woodland
B7	13	Scattered eucalypts in paddocks
Survey site number 1	9	Pasture grasses and crops in valleys
B12	9	Native plantations
B2	9	Eucalypt woodland
B4	9	Eucalypt woodland
B5	8	Eucalypt woodland
B8	8	Scattered eucalypts in paddocks
Survey site number 4	7	Eucalypt woodland
Survey site number 8	7	Eucalypt woodland
B11	7	Scattered eucalypts in paddocks

**Table 10. Habitat type at bird survey sites compared with bird abundance (spring 2008).**

Site	Species Abundance	Habitat Type
B7	138	Scattered eucalypts in paddocks
B1	118	Eucalypt woodland
B4	74	Eucalypt woodland
B2	48	Eucalypt woodland
Survey site number 1	36	Pasture grasses and crops in valleys
Survey site number 8	36	Eucalypt woodland
B12	32	Native plantations
B5	27	Eucalypt woodland
B8	23	Scattered eucalypts in paddocks
B6	22	Dam

Hill tops differed in the southern sector of the site from the eastern part of the northern sector (Figure 3), as they had a complete absence of trees. The absence of eucalypts and other trees resulted in fewer

parrots and honeyeaters using this habitat type. This area was also largely devoid of any ground cover (shrubs or heath), being dominated by heavily grazed pasture grasses. As such, there was little suitable habitat for small passerines. This habitat of pasture grasses recorded the lowest abundance and diversity of bird species (Table 22 and 9), as only one to four species were observed during the 5-20 minute surveys conducted. These were the Wedge-tailed Eagle, Australian Magpie, *Falco cenchroides* (Nankeen Kestrel), *Anthus novaeseelandiae* (Richard's Pipit) and *Corvus coronoides* (Australian Raven).

### 3.4 Winter 2009 survey

A total of 1,362 bird observations of 27 species were recorded during 52 point count surveys across the site (Appendix 2). The most commonly recorded species was the Australian Magpie, accounting for 47% of all observations (Table 22). Other commonly recorded species were the Common Starling, Galah and *Corvus mellori* (Little Raven), each with over 100 observations. Together these four most common species accounted for nearly 80% of all bird observations (Table 22). In contrast, 15 species were recorded less than 10 times during point count surveys across the project site (Appendix 1). This suggested that they were relatively less common during the winter survey period, or it could have been that they inhabit the site in relatively low densities.

Table 11. Most common species recorded during the winter 2009 survey.

Scientific name	Common name	Number of observations	% of all observations
<i>Gymnorhina tibicen</i>	Australian Magpie	643	47
<i>Sturnus vulgaris</i>	Common Starling	163	12
<i>Cacatua roseicapilla</i>	Galah	138	10
<i>Corvus mellori</i>	Little Raven	128	9
<i>Hirundo neoxena</i>	Welcome Swallow	77	6
<i>Platyercus elegans flaveolus</i>	Adelaide Rosella	44	3
<i>Cacatua sanguinea</i>	Little Corella	35	3
<i>Anthus novaeseelandiae</i>	Richard's Pipit	27	2
<i>Chenonetta jubata</i>	Australian Wood Duck	22	2

There were no birds of national conservation significance recorded during the winter 2009 survey. Three species of state conservation status were recorded during the winter 2009 survey: the rare Peregrine Falcon and Elegant Parrot were recorded at bird sites whilst a single *Microeca fascians fascians* (Jacky Winter) was recorded opportunistically on site during the winter survey (Appendix 1). A total of 27 Elegant Parrot observations were recorded, one of which was of a single bird flying low over the ridge between scattered trees at the very northern end of the wind farm at Site K1 (Figure 4). The remainder of sightings were recorded opportunistically, with small flocks of two-four birds observed to the west of proposed turbines in scattered Eucalypts. On one occasion a flock of 18 birds were sighted flying low over the ridge top in the southern sector of the wind farm (near survey Site K10) (Figure 4). Elegant Parrots are most often encountered in flocks of 20-100 or more, except in the breeding season when



they tend to be found either in pairs or small parties. Due to a high number of hollows in trees within the project site, it is possible that they may breed on site.

A total of four Peregrine Falcons observations were recorded during the winter survey at Sites K1, K8 and K10 (Figure 4), indicating this species was resident to the project site. It was difficult to interpret during winter 2009 survey, whether all records of this species were of a single individual, four different individuals, or a number in between. All three bird survey sites were spaced across the project site; site K1 in the north, site K8 toward the middle and site K10 toward the southern extent (Figure 4).  
Abundance, Diversity and Habitat Utilisation

The number of bird observations recorded during 60 minutes of survey (4 x 15 min surveys) at each bird survey site varied markedly, ranging from 12 to 240 (Table 12). Species diversity was also largely varied, ranging from a total of 4 to 16 species recorded per site (Table 12).

**Table 12. Comparison of bird activity and species diversity for winter 2009.**

Survey site number	Habitat	Total number of observations	% of birds per site	Species diversity (number of species recorded)	% of all species recorded during Point Count
K1	Scattered Blue Gum over cropping land	116	9	14	52
K2	Scattered Blue Gum over cropping land	165	12	16	59
K3	Exotic Grassland	200	15	8	30
K4	Exotic Grassland	161	12	9	33
K5	Exotic Grassland	120	9	8	30
K6	Exotic Grassland	75	6	6	22
K7	Exotic Grassland	240	18	5	19
K8	Exotic Grassland	55	4	5	19
K9	Exotic Grassland	36	3	7	26
K10	Open Woodland over Exotic Grassland	50	4	10	37
K11	Exotic Grassland	73	5	5	19
K12	Exotic Grassland	12	1	4	15
K13	Exotic Grassland	59	4	5	19
<b>Total</b>		<b>1362</b>	<b>100</b>	<b>27</b>	<b>100</b>

#### 3.4.1 Inter-site Comparisons of Bird Abundance

During winter, the highest number of observations was recorded at Site K7, with a total of 240 records (Table 22). Site K7 is situated on a hilltop with pasture grasses and scattered trees in the near vicinity (Figure 4). The second highest bird abundance, of 200 records, was recorded at Site K3, which was also located on pasture grasses with scattered trees nearby (Table 22). Bird abundance was comparably low

at the remaining two sites located within this habitat type, with 50 to 70 observations. In comparison, a moderate abundance of birds was recorded at sites located in woodland habitats, ranging from 116 to 165 observations (Table 22). Bird abundance was lowest at sites located in pasture grasses, however bird observation numbers varied widely, from 12 to 161 (Table 22). The lowest abundance of all sites was recorded at site K12, with only 12 bird observations recorded during 60 minutes of survey (Table 22 and 12).

### 3.4.2 Inter-site Comparisons of Species Diversity

Species diversity varied widely during the winter 2009 survey, ranging from four to 16 species between sites (Table 22). The highest diversity was recorded at Sites K1 and K2, which were located in scattered Blue Gum over cropping land habitat (Table 22). Over half of all species recorded during point counts were sighted at these survey sites (Table 22) and the Brown Treecreeper, *Manorina flavigula* (Yellow-throated Miner) and Elegant Parrot were only recorded at these sites (Appendix 2). Species diversity was moderate at sites located on pasture grasses with scattered trees nearby, ranging from five to ten species (Table 22). *Dacelo novaeguineae* (Laughing Kookaburra), *Anas platyrhynchos* (Mallard) and *Pardalotus striatus* (Striated Pardalote) were only recorded from sites within this habitat type (Appendix 2). Species diversity recorded at pasture grass sites ranged from four to nine species, three sites in this habitat type recorded species at the lower end of this range. Lowest diversity occurred at Site K12, with only four species, whilst K8 and K13 had five species (Table 22). *Falco berigora* (Brown Falcon) and *Dromaius novaehollandiae* (Emu) were only recorded from pasture sites (Appendix 1).

**Table 13. Bird abundance and diversity relative to habitat for winter 2009.**

Site	Habitat	Abundance	Species Diversity
K1	Scattered Blue Gum over cropping land	116	14
K2	Scattered Blue Gum over cropping land	165	16
K7	Exotic Grassland	240	5
K3	Exotic Grassland	200	8
K10	Open Woodland over Exotic Grassland	50	10
K11	Exotic Grassland	73	5
K6	Exotic Grassland	75	6
K9	Exotic Grassland	36	7
K4	Exotic Grassland	161	9
K5	Exotic Grassland	120	8
K8	Exotic Grassland	55	5
K12	Exotic Grassland	12	4
K13	Exotic Grassland	59	5

### 3.4.3 Inter-site Comparisons of Flight Heights and Species Performing At-risk Movements

The maximum turbine dimensions proposed for the Keyneton Wind Farm are 145.5 metres in height (e.g. - 50.5m blades on a 95m tower). At these dimensions, the lowest extent of a rotating blade tip would be

at 44.5m and the highest at 145.5m in height. For the purposes of this report, flights that are performed above 40m over the top of the ridge are considered at-risk movements, as this air-space corresponds with the rotor-swept area of turbines (Lane 2004). Refer to Section 4.4.2 for further details on the concept of at risk and rotor swept area.

Bird survey sites were located within different habitat types across the Keyneton project site. Bird observations were recorded across three main landscape features: ridge, slope and valley. A ridgeline is a line of high ground, usually with rapid changes in elevation on either side of the ridgeline, creating a steep descent into deep valleys. Figure 5 provides a snapshot of this feature within the project site. Contour patterns show defined ridgelines in the north-east corner of the project site.

A hill is an area of high ground. From a hilltop, the ground slopes down in all directions. A slope is an included portion of ground or the side of a slope of a hill. A valley is a stretched-out groove in the land, usually formed by streams or rivers. A ridge is a sloping line of high ground. If you cross a ridge at right angles, you will climb steeply to the crest and then descend steeply to the base. When you move along the path of the ridge, depending on the geographic location, there may be either an almost unnoticeable slope or a very obvious incline. Contour lines forming a ridge tend to be U-shaped or V-shaped.

Overall, the Australian Magpie performed the largest number of movements during the winter 2009 survey, with a total of 181 flights recorded (Table 13). Of these flights, 54% were performed over the ridge top, 29% over the slopes of hills, and the remaining 17% over the valley floor (Table 14). All of these flights were below the at-risk height. Bird survey locations were positioned across the project site to gain an adequate spread of different habitat types within the site and were not influenced by known turbine locations during the time of surveying. Naturally some of these bird sites were situated along ridgelines to observe birds utilising this part of the landscape, which is ultimately where turbines are likely to be positioned (refer to Section 2.6 Survey Limitations).

The Wedge-tailed Eagle has been identified as a species of concern, given that they were recorded flying at, or above, 40m on the ridge top. Three other bird species were recorded performing similar at-risk flights during the winter 2009 survey. These include the Common Starling, Little Raven and *Hirundo neoxena* (Welcome Swallow) (Table 14).



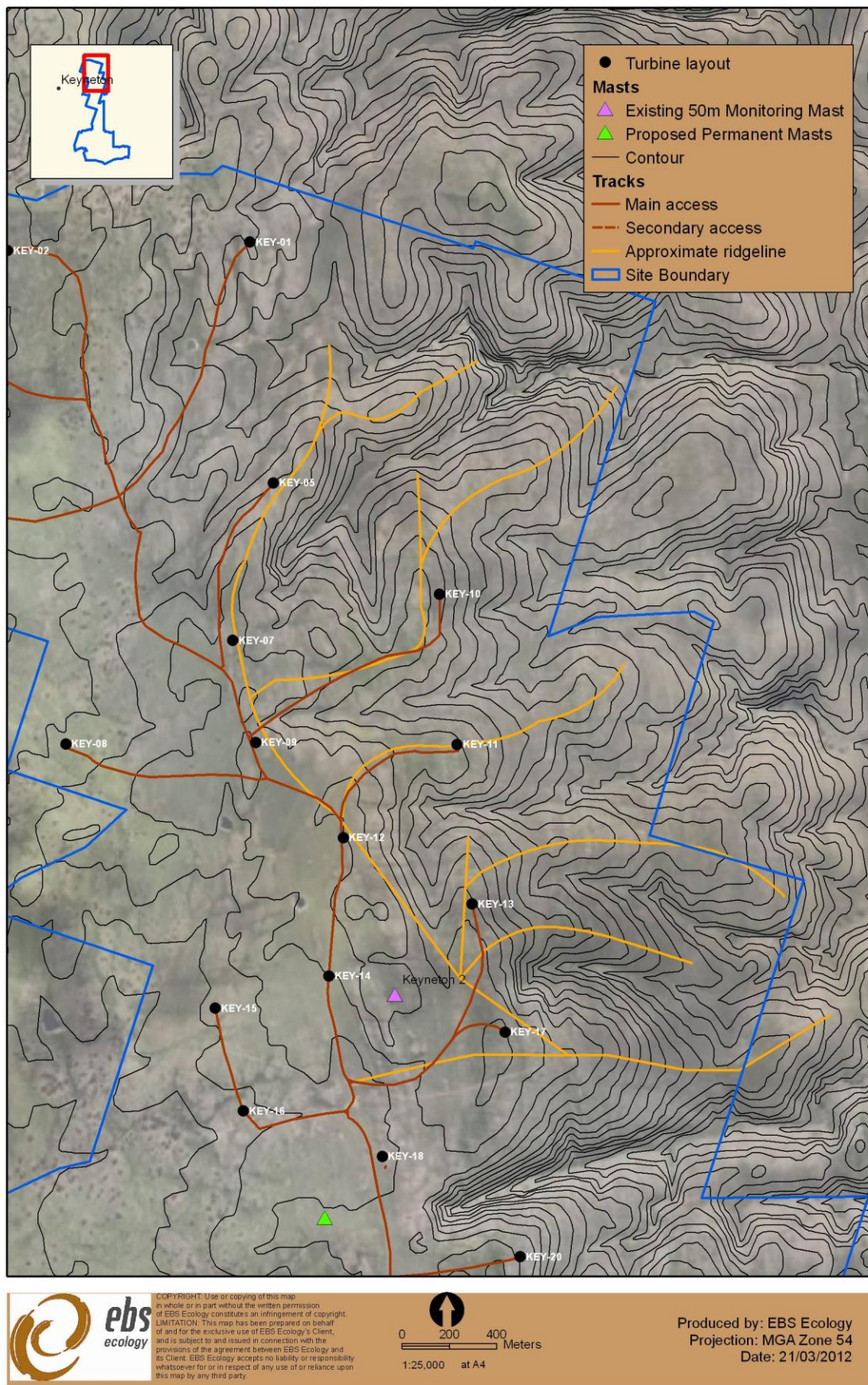


Figure 5. Approximate ridgeline in the north-east corner of the project site.



**Table 14. Minimum and maximum flight heights for all species recorded in flight during point count surveys (winter 2009), and proportion of flights performed over the ridge top. Results show birds performing at-risk flights (determined as flights above 40 m over the top of the ridge).**

Common name	Total Movements	Min Height	Max Height	% Over Ridge	% Over Slope	% Over Valley	At risk Flights recorded Y/N
Adelaide Rosella	24	5	8	33.3	56.7	10.0	N
Australian Magpie	181	7	30	54.1	28.7	17.2	N
Australian Wood Duck	16	17	25			100	N
Brown Falcon	3	10	12	75.0		25.0	N
Brown Treecreeper	3	5	5	75.0	25.0		N
Common Starling	88	13	45	95.5	2.2	2.3	Y
Elegant Parrot	1	12	12		100		N
Galah	120	9	20	54.2	17.5	28.3	N
Little Corella	8	8	10	100			N
Little Raven	95	9	50	83.2	7.4	9.4	Y
Nankeen Kestrel	2	9	15	100			N
Peregrine Falcon	3	28	40	100			N
Southern Whiteface	2	2	2		100		N
Tree Martin	15	14	40	33.3	66.7		N
Wedge-tailed Eagle	27	33	90	47.0	14.8	38.2	Y
Welcome Swallow	160	26	50	95.0	5.0		Y
White-plumed Honeyeater	11	4	5	54.5	36.4	9.1	N
Willie Wagtail	2	4	5	100			N
Yellow-rumped Thornbill	9	4	5	55.6	44.4		N
Yellow-throated Miner	1	5	5		100		N

#### DEFINITIONS

When a bird was observed as flying over more than one area (ridge, slope and/or valley), the initial observation was considered when determining at risk flight.

OR: a ridgeline is a line of high ground, usually with changes in elevation along its top and low ground on all sides. A ridge is a sloping line of high ground

OS: a slope is an inclined portion of ground or the side of a slope of a hill

OV: a valley is a stretched-out groove in the land, usually formed by streams or rivers.

% Over Ridge = percentage of the total number of movements for all observations recorded for all species during the point count survey. Survey points were taken along the ridge on the basis of obtaining data on bird movements in relation to potential turbine locations.

### 3.5 Spring 2009 survey

A total of 1712 observations of 34 bird species were recorded during 52 point count surveys across the proposed Keyneton Wind Farm site (Appendix 3). The most commonly recorded species was the Australian Magpie, accounting for 35% of all observations (Table 16). Other commonly recorded species were the Little Raven and Galah, each with over 300 observations. Together, these three common species accounted for just over 80% of all bird observations. Twenty-two species were recorded less than 10 times during point count surveys (Appendix 3). This is possibly due to being less common throughout the site during the spring 2009 survey period and/or inhabiting the site in relatively low

densities. The Brown Falcon was recorded in low numbers at two out of the thirteen point count sites (Appendix 3).

**Table 15. Most common species recorded during the spring 2009 survey.**

Scientific name	Common name	Number of observations	% of all observations
<i>Gymnorhina tibicen</i>	Australian Magpie	603	35.2
<i>Corvus mellori</i>	Little Raven	397	23.2
<i>Cacatua roseicapilla</i>	Galah	382	22.3
<i>Sturnus vulgaris</i>	Common Starling	55	3.2
<i>Petrochelidon nigricans</i>	Tree Martin	54	3.2
<i>Alauda arvensis</i>	Eurasian Skylark	45	2.6
<i>Vanellus tricolor</i>	Banded Lapwing	22	1.3
<i>Psephotus haematonotus</i>	Red-rumped Parrot	19	1.1
<i>Platycercus elegans adalaidae</i>	Adelaide Rosella	17	1.0

There were no birds of national conservation significance recorded during the spring 2009 survey. Two species of state conservation status were recorded during the spring 2009 survey; a Peregrine Falcon was sighted at Site K1 within the northern section of the proposed wind farm and two observations of the Elegant Parrot were recorded at Site K13, also situated in the northern section (Appendix 3).

### 3.5.1 Abundance, Diversity and Habitat Utilisation

The number of bird observations recorded during 80 minutes of survey (4 x 20 min surveys) at each site during the spring survey, varied markedly from 47 (K3) to 309 (K11) (Table 16). The total number of observations recorded at Site K11 was influenced by a high abundance of three common species: Australian Magpie, Little Raven and Galah (Appendix 3). Sites K3 and K11 both shared similar species diversity, ranging from nine (K11) to seven (K3) (Table 22) as well as the same habitat type of exotic grasslands. Species diversity varied considerably across all 13 sites, ranging from four (K8) to 17 (K2) species recorded per site (Table 16).

**Table 16. Comparison of bird activity and species diversity for spring 2009.**

Survey site number	Habitat	Total number of observations	% of birds per site	Species diversity (number of species recorded)	% of all species recorded during Point Count
K1	Scattered Blue Gum over cropping land	89	5.2	15	44.1
K2	Scattered Blue Gum over cropping land	67	3.9	17	50.0
K3	Exotic Grassland	47	2.7	7	20.6
K4	Exotic Grassland	113	6.6	8	23.5
K5	Exotic Grassland	169	9.9	5	14.7
K6	Exotic Grassland	252	14.7	6	17.6

Survey site number	Habitat	Total number of observations	% of birds per site	Species diversity (number of species recorded)	% of all species recorded during Point Count
K7	Exotic Grassland	172	10.0	9	26.5
K8	Exotic Grassland	161	9.4	4	11.8
K9	Exotic Grassland	67	3.9	6	17.6
K10	Open Woodland over Exotic Grassland	127	7.4	10	29.4
K11	Exotic Grassland	309	18.0	9	26.5
K12	Exotic Grassland	76	4.4	9	26.5
K13	Exotic Grassland	63	3.7	7	20.6

Table 16 illustrates the inter-site comparisons between bird abundance and diversity during the spring 2009 survey. Bird abundance is a reflection of many sightings of both common species (inclusive of conservation significance species), which are able to adapt to modified habitats such as open pasture. The better quality habitat, such as woodland areas or areas with over-story trees, supports a greater variety of species. A greater abundance does not necessarily mean greater species diversity.

### 3.5.2 Inter-site Comparisons of Bird Abundance

During spring 2009 the highest number of observations was recorded at Site K11, with a total of 309 records (Table 16), which equates to 18% of all birds recorded during the survey. Site K11 was situated in the southern section of the proposed wind farm on a bare hilltop within exotic grassland/herbland (Figure 4). Site K7 (172 records) was situated in a similar habitat, to the south of the Angaston - Sedan Road (within the northern section of the proposed wind farm), and scored the highest bird abundance in winter 2009 (EBS 2009). The second highest bird abundance (252 records) was recorded at Site K6, which was also located on a bare hilltop with surrounding pasture (Figure 4). Site K6 recorded 15% of all birds recorded during the spring 2009 survey (Table 22).

Bird abundance was lowest at Site K3 (47 records) during spring 2009, which incidentally had the second highest bird abundance (200 records) during the winter 2009 survey. Site K3 was also located in exotic grassland with scattered *Eucalyptus leucoxylon* (South Australian Blue Gum) trees nearby (Figure 4). Although Sites K3 (47 records), K7 (172 records) and K11 (309 records) shared the same habitat of exotic grassland (Table 16), bird abundance varied across all three sites. In comparison, a low to moderate abundance of birds was recorded at sites located in scatter Blue Gum over cropping land, ranging from 67 to 89 observations (Table 16). Bird abundance varied considerably within exotic grassland habitat, covering ten out of 13 sites and ranged from 63 to 252 birds observed (Table 16).

### 3.5.3 Inter-site Comparisons of Species Diversity

Species diversity varied in spring 2009, ranging from four to 17 species between sites (Table 22). The highest diversity was recorded at Sites K2 and K1 with 17 and 15 species recorded respectively. Both sites were located within scattered Blue Gum over cropping land habitat. This habitat type sustained a high diversity of woodland birds for both foraging and breeding during the spring 2009 survey. The lowest bird diversity was recorded within exotic grassland at Site K8, with only four species recorded. The Australian Wood Duck, *Egretta novaehollandiae* (White-faced Heron), Elegant Parrot and *Vanellus tricolor* (Banded Lapwing) were only recorded from pasture sites (Appendix 3).

**Table 17. Bird abundance and diversity relative to habitat for spring 2009.**

Survey site number	Habitat	Abundance	Species Diversity
K1	Scattered Blue Gum over cropping land	89	15
K2	Scattered Blue Gum over cropping land	67	17
K7	Exotic Grassland	172	9
K3	Exotic Grassland	47	7
K10	Exotic Grassland	127	10
K11	Exotic Grassland	309	9
K6	Exotic Grassland	252	6
K9	Exotic Grassland	67	6
K4	Exotic Grassland	113	8
K5	Open Woodland over Exotic Grassland	169	5
K8	Exotic Grassland	161	4
K12	Exotic Grassland	76	9
K13	Exotic Grassland	63	7

### 3.5.4 Inter-site Comparisons of Flight Heights and Species Performing At-risk Movements

As noted in Section 3.4.4 above, flights of over 40 m in height are considered for the purposes of this report to be at risk. The definition of a ridge top, slope and valley floor was also described in Section 3.4.4 above.

Based on observations on site and the typical flight patterns of some species listed in Table 18, it is apparent the majority of bird species listed recorded flights deemed not at risk (24 out of 33 species). The results in Table 18 are based on a small sample yet help to inform as to what species may be at risk from collision with turbine blades.

The Australian Magpie performed the highest number of movements during the spring 2009 survey. This was across 13 sites during 4x20 minute surveys, with a total of 148 flights recorded (Table 22). Of these flights, 78% were performed over the ridge top, 17% over the slopes of hills and the remaining 5% over the valley floor. This included a maximum flight height of 60 metres



The Wedge-tailed Eagle and Peregrine Falcon have been identified as two species of concern due to the flight heights observed over the ridge. When comparing all observations recorded for Wedge-tailed Eagles during the spring 2009 survey, 80% of its total number of movements were over the ridge and ranged between 2-300 metres in height. 100% of the Peregrine Falcons movements were recorded over the ridge between 20-50 metres height (Table 22). Six other bird species were recorded as flying at heights likely to be within a rotor swept area over the ridge. These species were the Little Raven, Brown Falcon, Nankeen Kestrel, Elegant Parrot, Tree Martin and Adelaide Rosella (Table 18).

The Tree Martin typically flies just above the tree canopy within woodland areas. Therefore whilst flights of up to 50m were recorded, this species is likely to be at negligible risk as the majority of its flights were recorded within woodland areas (which have been avoided by the revised layout) and below the at-risk height of 40 m.

**Table 18. Minimum and maximum flight heights for all species recorded in flight during point count surveys (spring 2009) and proportion of flights performed over the ridge top. Results show birds performing at-risk flights (determined as flights above 40 m over the top of the ridge).**

Common name	Total Movements	Min Height	Max Height	% Over Ridge	% Over Slope	% Over Valley	At risk Flights recorded Y/N
Yellow-rumped Thornbill	10	0	7	100			N
Eurasian Skylark	21	1	20	100			N
Red Wattlebird	3	3	20	100			N
Richard's Pipit	1	0	10	100			N
Southern Whiteface	3	1	15	66.6	33.4		N
Wedge-tailed Eagle	9	2	300	80	10	10	Y
Galah	123	0	30	88.6	6.6	4.8	N
Little Corella	7	0	20	100			N
Brown Songlark	2	1	8	100			N
Brown Treecreeper	8	2	10	100			N
Black-faced Cuckoo-shrike	6	5	20				N
Little Raven	128	0	60	83.6	9	7.4	Y
Laughing Kookaburra	2	8	10	100			N
White-faced Heron	1	20	20			100	N
Black-shouldered Kite	1	6	15	100			N
Brown Falcon	3	10	70	100			Y
Nanneken Kestrel	15	1	300	87.5	12.5		Y
Peregrine Falcon	2	20	50	100			Y
Australian Magpie	148	0	60	77.7	17	5.3	Y
Welcome Swallow	0	2	30	100			N
White-winged Triller	1	2	8	100			N
White-plumed Honeyeater	20	5	15	100			N
Elegant Parrot	1	100	100	100			Y
Crested Pigeon	1	3	3	100			N

Common name	Total Movements	Min Height	Max Height	% Over Ridge	% Over Slope	% Over Valley	At risk Flights recorded Y/N
Striated Pardalote	29	3	20	100			N
Tree Martin	39	1	50	94.4		5.6	Y
Adelaide Rosella	22	5	60	100			Y
Red-rumped Parrot	16	2	20	100			N
Willie Wagtail	3	6	8				N
Starling	23	1	15	94.7		5.3	N
Banded Lapwing	10	0	15	100			N

**DEFINITIONS**

When a bird was observed as flying over more than one area (ridge, slope and/or valley), the initial observation was considered when determining at risk flight.

OR: a ridgeline is a line of high ground, usually with changes in elevation along its top and low ground on all sides. A ridge is a sloping line of high ground

OS: a slope is an inclined portion of ground or the side of a slope of a hill

OV: a valley is a stretched-out groove in the land, usually formed by streams or rivers.

% Over Ridge = percentage of the total number of movements for all observations recorded for all species during the point count survey. Survey points were taken along the ridge on the basis of obtaining data on bird movements in relation to potential turbine locations.

### 3.6 Opportunistic Records

All birds observed whilst travelling between sites, and during the five minute acclimatisation period at a point count site, were recorded as opportunistic records. The opportunistic results from the spring 2008 were discussed together with results from the point count data (refer to Section 3.3 Spring 2008 survey). This was due to a shorter survey period of two days. Opportunistic records for the summer 2010 survey are summarised under Section 3.7.13.

#### 3.6.1 Winter 2009 survey

One species of state conservation status was recorded opportunistically during the winter 2009 survey, the Jacky Winter. An additional 368 observations of 24 bird species were recorded opportunistically during the winter 2009 survey (Appendix 1). These opportunistic records included observations of eight species that were not recorded during point count surveys (Appendix 1). This included three waterbirds, *Tachybaptus novaehollandiae* (Australasian Grebe), *Anas gracilis* (Grey Teal) and White-faced Heron which were recorded on farm dams to the west of the major ridge line. *Acanthiza pusilla* (Brown Thornbill), *Cracticus torquatus* (Grey Butcherbird) and the Red-rumped Parrot were recorded in areas of woodland habitat or in scattered paddock trees, at locations across the site. The Banded Lapwing was only recorded opportunistically, and was seen in an area of open pasture paddocks when driving between survey sites.

#### 3.6.2 Spring 2009 survey

A total of ninety-nine observations of six different bird species were recorded opportunistically during the 2009 spring survey (Appendix 4). The Little Raven recorded the highest number of opportunistic observations, the majority of which were recorded at Site K6 (Figure 4). The Nankeen Kestrel and

Peregrine Falcon recorded the lowest observations. The Nankeen Kestrel was observed at Site K11 (one record) and Peregrine Falcon was observed at Site K9 (two records) (Appendix 4). All species recorded opportunistically, were also observed during point count observations. The Peregrine Falcon was viewed low over the ridge line and perched on a large electricity tower (refer Section 3.8 for more information). Other bird species recorded during opportunistic surveys were the Galah, Australian Magpie and Tree Martin (Appendix 4), with the majority of birds surveyed between Sites K6 and Sites K12 (Figure 4). These survey sites were situated at the southern extent of the proposed wind farm, the majority of which were within exotic grassland habitat. The total number of observations was highest within pasture grass sites, although species diversity was considered low across all sites surveyed (Table 19).

**Table 19. Bird abundance and species diversity recorded during spring 2009 opportunistic surveys.**

Survey site number	Habitat	Total number of observations	% of birds	Species Diversity	% of all species
K1	Scattered Blue Gum over cropping land	0	0	0	0
K2	Scattered Blue Gum over cropping land	0	0	0	0
K3	Exotic Grassland	0	0	0	0
K4	Exotic Grassland	0	0	0	0
K5	Exotic Grassland	0	0	0	0
K6	Exotic Grassland	31	31.3	1	16.7
K7	Exotic Grassland	0	0	0	0
K8	Exotic Grassland	15	15.2	3	50.0
K9	Exotic Grassland	24	24.2	4	66.7
K10	Open Woodland over Exotic Grassland	17	17.2	2	33.3
K11	Exotic Grassland	1	1.0	1	16.7
K12	Exotic Grassland	11	11.1	2	33.3
K13	Exotic Grassland	0	0	0	0

### 3.7 Wedge-tailed Eagle nest locations

A total of twelve potential Wedge-tailed Eagle nests were located across the proposed Keyneton Wind Farm site (Table 20, Figure 6). Ten potential nests were identified during the winter 2009 survey, one additional nest was recorded during the spring 2009 survey and the twelfth nest was established during the nest check during the summer 2010 survey. The latter was originally thought to be inhabited by a pair of Peregrine Falcon however the Peregrine Falcon breeding location was later identified on an adjacent rocky ledge (approximately 100m from the eagle nest site). Three of the twelve nests were subsequently identified to belong to other species (i.e. kite and ravens). No eagle nests were identified within the project boundary, south of Pine Hut Road. The following section provides a brief description of each nest.

#### Winter 2009 survey

A total of ten potential Wedge-tailed Eagle nests were located the proposed Keyneton Wind Farm site. Most nests were located during a targeted search of all suitable nesting habitats (woodland and scattered South Australian Blue Gum). Some nests were sighted from the vehicle when driving around the project site. The ten nests could not be confirmed as active due to the timing of the survey which was outside of their breeding period. Nests 3, 8 and 10 appeared partially built and may not have been of Wedge-tailed Eagle origin. A pair of Wedge-tailed Eagles were observed 200m from Nest 1 and an individual eagle was observed perched less than 100m from Nest 7.

#### Spring 2009 survey

Three Wedge-tailed Eagle nests were recorded as active (Nest 5, 7 and 9) during the spring 2009 survey (see details below on individual nests). Two potential WTE nests (Nest 8 and 10), identified during the winter 2009 survey, were subsequently identified (upon further investigation) as being of Australian Raven origin. One nest (nest 3) was also determined as likely to belong to a Kite species.

#### Summer 2010 survey

Two nests were found to be active during the 2010 breeding season and Nest 9 showed signs of breeding activity although no fledged chick was apparent. A Peregrine Falcon nest was also identified to the east of Nest 1 and 3 within the north eastern corner of the Keyneton project site (Figure 23). Refer to Section 3.8 for further information on the Peregrine Falcon nest.

Table 20. Nest status during each of the survey periods.

Nest number	Spring 2009	Summer 2010	Breeding success
Nest 1	inactive	Inactive	No sign of a fledged chick
Nest 2	inactive	Inactive	No sign of a fledged chick
Nest 3	active (kite nest)	Active	No sign of a fledged chick
Nest 4	inactive	Inactive	No sign of a fledged chick
Nest 5	active	Inactive	No sign of a fledged chick

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Nest number	Spring 2009	Summer 2010	Breeding success
Nest 6	inactive	Inactive	No sign of a fledged chick
Nest 7	active	Inactive	No sign of a fledged chick
Nest 8	raven nest	Inactive	No sign of a fledged chick
Nest 9	active	Active	No sign of a fledged chick
Nest 10	raven nest	Inactive	No sign of a fledged chick
Nest 11	inactive	Inactive	No sign of a fledged chick
Nest 12	not identified	Active	Used by Peregrine Falcon pair
Peregrine Falcon	not identified	Active	Two chicks (I. Falkenberg pers. comm. 2011) were present in October 2010



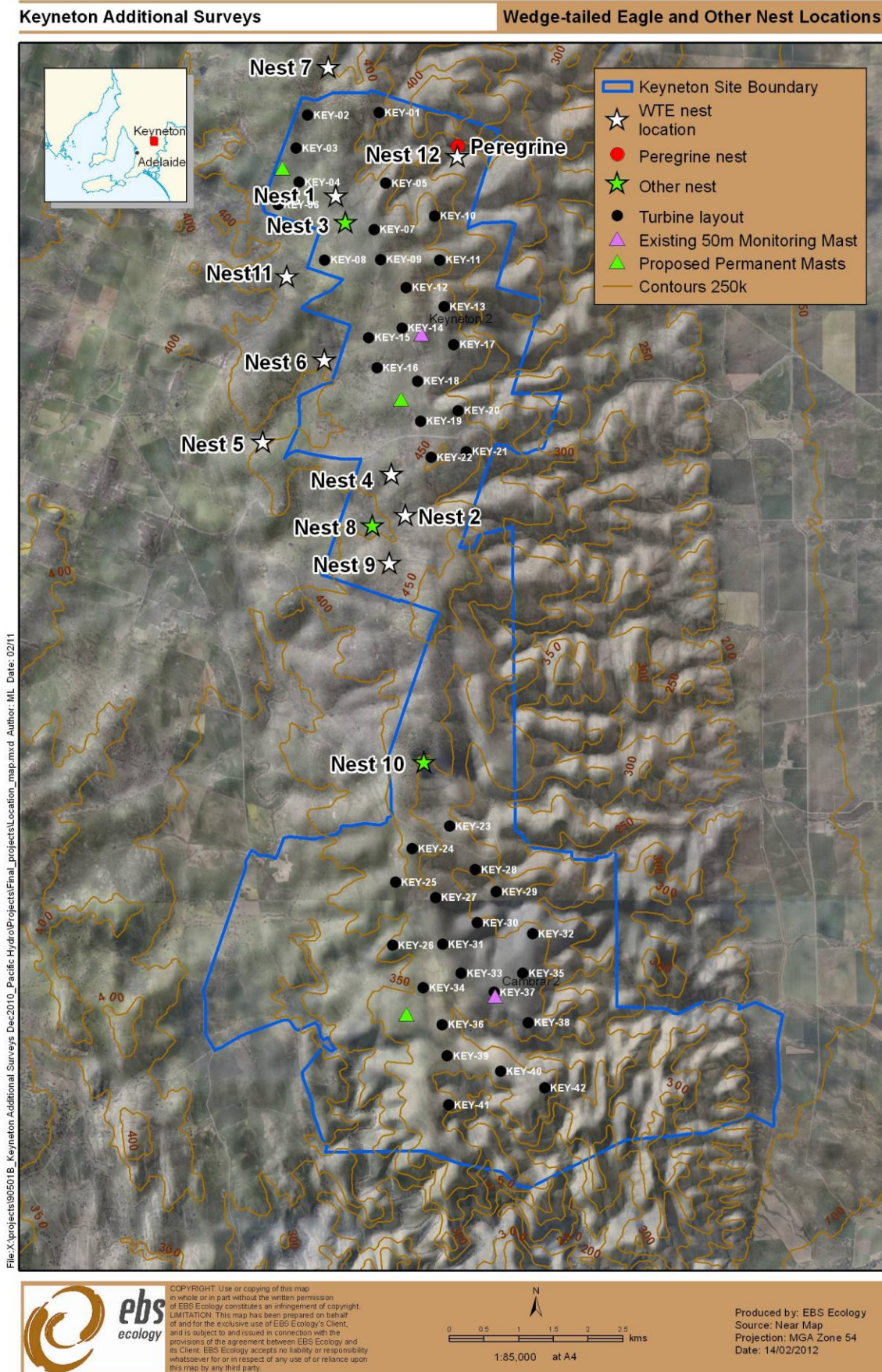


Figure 6. Wedge-tailed Eagle nest sites across the proposed Keyneton Wind Farm.



### 3.7.1 Nest 1

Nest 1 was a large well built nest in a large eucalypt (Figure 23), situated on the top of the prominent ridge line, with good views of the surrounding farmland. It was located just south of survey Site K1 (Figure 4). The use of this nest site could not be confirmed during the spring 2009 survey, as there were no Wedge-tailed Eagles sighted at the nest. A pair of eagles were however, regularly observed flying within a few hundred metres of this site during the spring 2009 survey. Whilst a small scat was observed on the main tree trunk during the summer 2010 survey, there was no other evidence to suggest this nest had been active during the 2010 season. No eagles were observed in or around the nest location during the summer survey period.



Figure 7. Wedge-tailed Eagle Nest 1.

### 3.7.2 Nest 2

Nest 2 was situated in the fork of a solid branch in a large eucalypt (Figure 23). The nest tree was situated in a shallow valley to the west of the prominent ridge line. Wedge-tailed Eagles were not sighted in the vicinity of the nest during the spring 2009 survey, thus the use of this nest site could not be confirmed. Nest material and white wash were absent during the summer 2010 survey. Sticks were displaced from the nest bowl and it was generally in a dilapidated condition, which suggests it may not have been in use for some length of time.



Figure 8. Wedge-tailed Eagle Nest 2.

### 3.7.3 Nest 3

Although Nest 3 was originally thought to have been partially built by a Wedge-tailed Eagle, subsequent inspection revealed that it is more likely that a smaller raptor such as a Kite species built this nest. It is a smaller size compared with other eagle nests and located in a precarious position on a small outer branch (Figure 23). This was a new nest at the time of the winter 2009 survey, with no active signs recorded during the spring 2009 survey. The nest was too large to be a Raven or Magpie nest, but may belong to either a Whistling or *Elanus axillaris* (Black-shouldered Kite) (both of which have been recorded within the project site). During the summer 2010 survey, there were signs to suggest that this nest had been active during the 2010 breeding season. Signs included moderate/intact condition of the nest with some nest material and white wash present around the nest bowl. A fledgling or parent eagle was not recorded in or around the nest site.





Figure 9. Nest 3 – probable Kite nest.

#### 3.7.4 Nest 4

Nest 4 was a large nest, situated on a substantial branch in an old-growth eucalypt (Figure 23). It was located just off the top of the prominent ridge line near survey Site K7 (Figure 4). The use of this nest site during the spring 2009 breeding season could not be confirmed, as there were no Wedge-tailed Eagles sighted at the nest. A pair of Wedge-tailed Eagles was observed to the south around Nest 9 during spring 2009 (Figure 23). Whilst the nest appeared intact and in moderate to good condition, there were no signs to suggest the nest had been used during the 2010 breeding season.



Figure 10. Wedge-tailed Eagle Nest 4.

### 3.7.5 Nest 5

Nest 5 was situated on the horizontal branch of a large eucalypt (Figure 23). The nest tree was located in a creek line situated 1.7km west of Site K7 (Figure 23). This nest was active at the time of the spring 2009 survey as new sticks had been added since the winter 2009 survey, and a single Wedge-tailed Eagle was observed leaving the nest bowl as the observer approached the tree. Whilst the nest appeared uniform and intact during the summer 2010 survey, no active signs were evident and no eagles were observed within the vicinity.



Figure 11. Wedge-tailed Eagle Nest 5.

### 3.7.6 Nest 6

Nest 6 was a partially built nest, situated in the fork of a moderate sized eucalypt (Figure 23). The nest tree was located in a small cluster of trees that occur within rolling paddocks to the west of the prominent ridgeline (Figure 23). The nest comprised of a small cluster of sticks during the winter 2009 survey and had not been built on by the time of the spring 2009 survey. Although Wedge-tailed Eagles were regularly sighted flying along the ridge line in the vicinity of this nest, no eagles were sighted at the nest site. Breeding signs were not identified at this nest location during either the spring 2009 or the summer 2010 surveys. No additional nesting material or sticks appeared to have been added during the summer 2010 survey and no eagles were observed flying within the vicinity of the nest site.





Figure 12. Wedge-tailed Eagle Nest 6.

#### 3.7.7 Nest 7

Nest 7 was a large nest and was situated in the fork of a large eucalypt (Figure 23). The nest tree was located on a north-facing hill, situated just outside of the proposed Keyneton Wind Farm boundary (Figure 23). This nest was active at the time of the winter 2009 survey and during the spring 2009 survey, a single Wedge-tailed Eagle was observed sitting on the nest before flying to a neighbouring tree when the observer approached. Nest 7 appeared to be in good condition during the summer 2010 survey however there were no signs of eagle activity during the 2010 breeding season. The nest was situated within a protected woodland area with easterly views to the valley below. It is considered likely that this nest will be used by Wedge-tailed Eagles in future breeding seasons.

The likelihood of the nest being active during upcoming breeding seasons is based on a number of factors: the size and healthy condition of the nest, positioning of the nest within the large eucalypt tree, favourable views of the landscape for the eagle to search for prey, the advantage of the nest being situated within woodland to allow protection of offspring on the nest and a vantage point in which to view prey. The nest was determined as active during winter 2009; an eagle was observed on the nest during spring 2009 and it is likely to be used by resident eagles in the future.



Figure 13. Wedge-tailed Eagle Nest 7.

#### 3.7.8 Nest 8

Nest 8 was identified during the winter 2009 survey as a possible Wedge-tailed Eagle nest, however closer inspection during the spring 2009 survey revealed it was more likely to be a large Raven nest. Nest 8 was situated north of Nest 9 where there is a valley situated to the south below the nest site (Figure 23). There is also a creekline surrounded by a row of planted trees and large eucalypt trees just south of Nest 8. During the summer 2010 survey, the nest bowl did not appear complete, a smaller one was situated just above the larger raven nest and no eagles were observed within the vicinity of the nest site (Figure 23).



Figure 14. Nest 8 – Probable Australian Raven Nest.



### 3.7.9 Nest 9

Nest 9 was a moderate sized nest built in the fork of a large eucalypt (Figure 23) that was located on hills to the west of the prominent ridge (Figure 23). The nest was determined as active at the time of the spring 2009 survey, as a Wedge-tailed Eagle was observed perching on a branch of the nest tree with a second Wedge-tailed Eagle flying approximately 100 metres away. Nest 9 was also considered active during the 2010 breeding season. A Wedge-tailed Eagle was observed approximately 400 metres from the nest site. By the silhouette of the eagle it appeared to be female, and she displayed definite territorial behaviour by dipping into the valley below, soaring and then circling again above the nest. A male eagle was observed approximately two kilometres from the nest site, circling high above in a range of between 500-800 metres above ground. The female appeared to fly between 100-600 metres above the ground (determined using a range finder). The observer lost sight of both eagles. The nest site is situated amongst a protective scattering of trees, near three other nests, one of which is of raven origin (Nests 8, 2 and 4) (Figure 23).



Figure 15. Wedge-tailed Eagle Nest 9.

### 3.7.10 Nest 10

Nest 10 was recorded during the winter 2009 survey as a possible Wedge-tailed Eagle nest, although closer inspection during the spring 2009 survey suggested it was more likely a large Raven nest. The nest appeared dilapidated and in poor condition during the summer 2010 survey, with no sign that it was active during the 2010 breeding season (Figure 23).



Figure 16. Nest 10 - Probable Australian Raven Nest.

#### 3.7.11 Nest 11

Nest 11 was identified during the spring 2009 survey and was located approximately 1.36 kilometres west of survey Site K4 (Figure 4, Figure 23). Recent activity could not be confirmed during the spring 2009 survey as Wedge-tailed Eagles were not sighted at the nest. Although a small scat was observed on a branch below the large nest, no other active signs were observed during the summer 2010 survey. The nest appeared intact and in good condition, however new sticks did not appear to have been added to the nest bowl (Figure 23). No eagles were observed in or around the nest location.



Figure 17. Wedge-tailed Eagle Nest 11.



### 3.7.12 Nest 12

Nest 12 was identified during the summer 2010 survey and was located within the north eastern extent of the project site (Figure 23). A Peregrine Falcon was first observed during the spring 2009 survey flying along the same creekline where this nest was located. A possible nest was viewed along the creekline but not confirmed. During the summer 2010 survey, it was first thought that the Wedge-tailed Eagle nest was being utilised by a pair of Peregrine Falcon that were observed flying towards the nest site (refer to Section 3.8 for further details). The rocky ledge located adjacent to the eagle nest was in fact the Peregrine Falcon nesting site (I. Falkenberg, pers.comm.2011). Whilst falcons are known to use Wedge-tailed Eagle nests to breed in, it was apparent that the falcon pair was using Nest 12 to cache prey to probably feed to their offspring at the adjacent nesting location.



Figure 18. Eagle nest where a pair of Peregrine Falcon was observed perched.

### 3.7.13 Opportunistic surveying – summer 2010

A number of opportunistic observations were recorded during the summer 2010 survey when travelling between nest sites. Specific observations included:

- Direction: north, south, east and west
- Distance: distance from the observer
- Movement: number of movements completed by the species
- Height: height above the ground the species was observed
- Behaviour:
  - FLM: Flying straight
  - FLC: Flying over circling
  - FLH: Flying over hovering
  - FLS: Soaring when flying



- ROT: Resting on tree
- Flying:
  - OS: slope can be described as an inclined portion of ground or the side of slope of a hill (in the instance of project site, the slope before reaching the ridge top)
  - OR: ridge can be described as a long narrow raised land formation with sloping sides
  - OV: valley floor can be described as a broad, flat bottom of a valley (valleys were located along the eastern edge of the project site – Figure 23).

Seven movements from nine individual Wedge-tailed Eagles (possibly two eagle pairs) were observed during opportunistic observations in the summer 2010 survey. These observations were made on a limited sample size. Height ranged between 300-800 metres above the ground, which was estimated using a range finder. Eagle behaviour was focussed on soaring and circling mainly over the valley (open grassland) as well as three movements recorded over the ridgeline (Table 21).

Priority species such as the Wedge-tailed Eagle are considered significant when assessing bird interactions with wind farms. Wedge-tailed Eagles conduct regular flights at heights coinciding with turbine rotor swept areas (where turbine blades operate). Where the risk of impact of a wind farm on a priority species is considered to be medium to high, mitigation actions can be implemented to reduce this risk to an acceptable level (AusWEA Report 2005).

Table 21. Wedge-tailed Eagles recorded flying across the Keyneton project site during opportunistic observations.

Species	No. Ind	Dir	Dist	Move	Height	Behaviour	Flying	Habitat	Comment
WTE	2	NE	600	1	800	FLS	OV	open grassland	Observed 4.5km south west of Nest 3.
WTE	2		266	1	600	FLS	OV	open grassland	2 eagles (one juvenile & one male).
WTE	2		800	1	600	FLC	OV	open grassland	Observed flying 200-800m away from the observer before it was lost in sight over hill/ridge.
WTE	2	S / SW	300	3	300	FLC	OR	open grassland	Crossed ridgeline close to powerline (running north / south), circled valley.
WTE	1	W	400	1	600	FLS	OV	open grassland	Soaring up high, flew west.

### **3.8 Peregrine Falcon nest locations**

#### **3.8.1 Winter 2009 survey**

Peregrine Falcons were sighted a total of four times. Each observation was of a single bird, recorded during surveys at sites K8, K10, and opportunistically near site K8 and K1 (Figure 4). Whilst it was difficult to interpret whether single observations of this species belonged to a falcon pair, it does indicate that this species was resident to the project site. These observations were spaced across the project site; site K1 in the north, site K8 toward the middle and site K10 toward the southern extent (Figure 4). Whilst speculative, this may suggest that four observations of the Peregrine Falcon may have belonged to at least one pair of falcons utilising the project site.

#### **3.8.2 Spring 2009 survey**

A Peregrine Falcon was observed opportunistically on 9 September 2009 at Site K9. It flew at a height of 15 metres over the ridge from a north westerly direction and perched near the top of a large electricity lattice tower (Figure 23). The tower was situated between Sites K9 and K8 (Figure 4). Site K8 was situated under power lines on top of a bare hill, with 360 degree views of bare paddocks and scattered woodland to the west. A second Peregrine Falcon was observed on 6 November 2009 (E334784, N6178289) with a possible nest viewed along a creek line (Figure 23) to the east of Site K1; the falcon was observed within Vegetation Association 12 (Figure 4) (EBS 2010).

The two Peregrine Falcons sightings were within different areas of the proposed wind farm site. One sighting was near point count site K1, which was situated within scattered Blue Gum over cropping land, and the other falcon was observed at point count site K9, which was amongst exotic grassland (Figure 4).

#### **3.8.3 Summer 2010 survey**

Further investigation into the presence of Peregrine Falcons on site was undertaken during the summer 2010 survey. This was aimed at determining the overall abundance of falcons within the project site and identifying any breeding sites and activity on site.

A pair of Peregrine Falcons was sighted early during the summer 2010 survey (E335029 / N6178270). They were recorded within close proximity to where a Peregrine Falcon was observed during the spring 2009 survey. This suggested that Nest 12, situated within the gully to the east of the spring 2009 sighting, may have been being utilised by the pair (Figure 23). A Peregrine Falcon nest was later verified as being within the rock crevice near Nest 12 (Figure 23), with two chicks observed during a seasonal check in October 2010 (I. Falkenberg, pers. comm. 2011).

Two additional nests belonging to Peregrine Falcon breeding pairs, were located south outside of the project site boundary (I. Falkenberg, pers. comm. 2011) (Figure 2). One of the two southern nest

locations was also identified as having chicks present during the 2010 breeding season (I. Falkenberg, pers. comm. 2011). Although the Peregrine Falcons utilising these southern nest sites were not observed on site, it is quite possible that they may fly across the site in search of food. Peregrine Falcons are known to have a home range of 20-30 square kilometres, which would place the falcons nesting in the south in range of foraging within the project site. Foraging may more frequently focus on valleys and the Marne River to the south, but it may also overlap into the project boundary.



Figure 19. Peregrine Falcon was located at the top of a transmission tower during the spring 2009 survey.



Figure 20. A possible Peregrine Falcon nest was located during the spring 2009 survey within a valley creek line east of Site K1.



Figure 21. The rock crevice where two chicks were observed in October 2010 (I. Falkenberg pers.comm.2011) is indicated by the red arrow. The rock crevice was situated adjacent to Nest 12.

#### 3.8.4 Peregrine Falcon Observation Records

A number of flight details of the Peregrine Falcon pair, observed during the summer 2010 survey, were recorded (Table 22). These were recorded on a Raptor Observation Sheet which included:

- Reference of crossing point (labelled by a letter) across or just situated off the ridgeline e.g. the majority of letters were representative of where the observer was sitting so that the falcons could be observed flying to and from the study area. The observer attempted to use the same letter from where they were situated, for each observation
- Distance along ridge (m) – estimated distance of crossing point in relation to a fixed point e.g. tree or topography slope
- Height (m) – estimated crossing height
- Flight direction (north, south, east or west)
- Behaviour - activity was described as soaring (S), flying (F), displaying (D), conflict (C), circling or perched
- Coupled – multiple crosses by one bird. If a falcon continued to cross the ridge and fly between reference points, then multiple movements were recorded.

During the summer 2010 survey, the observer was placed approximately 346 m from where the Peregrine Falcon was first recorded in spring 2009. When the observer initially approached the nest location, the female Peregrine Falcon displayed conflict behaviour. The Peregrine Falcon pair was observed utilising the ridgeline at various heights and distances along the ridge (Table 22). Much of their behaviour can be described as flying straight (FLM), compared with typical eagle behaviour of flying over circling (FLC) and flying over hovering (FLH). Flight activity was recorded to the north, east and south



however there were no flights recorded to the west (Table 22). The pair appeared to focus their activity around Nest 12 situated within a gully, often appearing to rest on top of the nest (Figure 23). The female was also observed landing on the rocky crevice adjacent to the eagles nest.

The Peregrine Falcon pair was observed flying along the ridge in the range of 80-200m above ground. They were also recorded as flying between the heights of 20-200m (Table 22). Flights that are performed above 40 metres over the top of the ridge are considered at-risk movements. Based on flights being at risk if performed over the ridge above 40 m, six out of the nine movements performed by the Peregrine Falcons, would be classified as at-risk movements. The area where flight movements were recorded for the Peregrine Falcon corresponds / overlaps with the possible presence of Wedge-tailed Eagles (Figure 23). Nest 12 may or may not be utilised by eagles in seasons to come.

Table 22. Raptor Observation sheet recording flight movements of the Peregrine Falcon pair.

Sunny 24°  
windy

Raptor Observation Record Sheet

Date: 15/12/10 Observer ID: AD Start Time: 1230 End Time: 1420 Sheet ID: \_\_\_\_\_ (office use only)

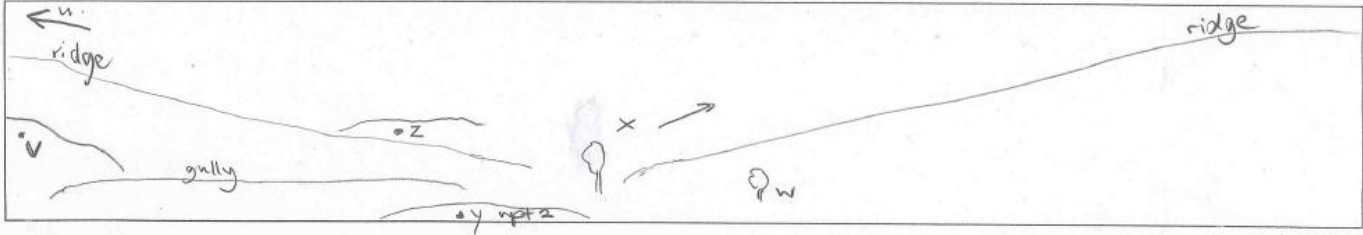
Observer Location: wpt 2 kit 4 - WTE nest in Enc, PF nest rocky ledge

y = observer (out in open, no trees to hide from PF)  
340m from PF wpt from previous survey

x = WTE nest in tree

z = rocky ledge observed & landed

w = potential other nest, kestrel observed.



Ref	Species	Age	Time	Height (m)	Distance Along Ridge (m)	Flight Direction	Behaviour†	Coupled With (ref)	Wind Speed (m/s)	Wind Direction
V	PF	—	13.15	150	100	N	F	—	—	—
V	PF	—	1250	100	150	E	F	Z	—	—
W	Kestrel	—	13.15	20	200	S	F	—	kestrel flew to small tree W	
Z	PF	—	13.20	200 <sup>u</sup>	80	N	F	U	1st flight up behind ridge at U	
Z	PFs x 2	—	13.25	100	150	E, N, E	S, F, D	V	for 10 min, 2nd flew from z to V, V to Z, dipping each other (adult + young) on foot, circling, gliding, landing	
V								Z	see above	
Z								V		
V	PF x 1	—	13.35	80	<del>100</del> 200	SE	F	X	lost sight of WPF, other glides to WTE in X then behind ridge	
X	PF x 2	—	13.37	80	200	N	Sitting on WTE nest / F	—	both reappeared from behind ridge, landed on nest, dancing on nest, over prey? Caching food?	

End of Shift Comment: V - ♀ sat watching observer at y.  
V to Z calling defensively (rocky ledge above WTE nest visible from above) SLR 4267 - 4274

† Behaviour is one or more of: (S)oaring, (F)lying, (D)isplaying or (C)onflict.

### 3.9 Comparisons of Flight Heights for at-risk species

Tables 14 and 18 summarised the minimum and maximum heights for species recorded in flight during point count surveys during winter and spring 2009. The table above (Table 22) summarises flight height and behaviour of the Peregrine Falcon pair observed during the summer 2010 survey. Results show birds performing at-risk flights (determined as flights above 40 m over the top of the ridge). Appendices 2 and 3 tabulate inter-site comparisons of bird abundance and diversity during the winter and spring 2009 surveys respectively. Four species were determined as at risk based on the height of their flight movements during the winter 2009 survey: the Wedge-tailed Eagle, Common Starling, Little Raven and Welcome Swallow. The spring 2009 survey identified nine species as performing flights that were considered at-risk movements: the Wedge-tailed Eagle, Little Raven, Brown Falcon, Nankeen Kestrel, Peregrine Falcon, Australian Magpie, Elegant Parrot, Tree Martin and Adelaide Rosella.

The bird species listed above, which were identified as performing flights that were considered at-risk movements (above 40 m), are discussed in Section 5 (Risk Assessment), which determines the potential impact and significance of the proposed Keyneton Wind Farm on these bird species. The movements performed by two state conservation rated species and one priority species, are summarised below:

#### **Peregrine Falcon:**

- Two movements with flight height range of 20-50m, 100% of movements over ridge – spring 2009
- Nine movements with flight height range of 20-200m over valley and ridge – summer 2010
- Observed at Site K7 and K10 – winter 2009 (Appendix 2)
- Observed at Site K1 – spring 2009 (Appendix 3).

#### **Elegant Parrot:**

- One movement with a flight height of 100m – spring 2009
- Observed at Site K1 – winter 2009 (Appendix 2)
- Observed at Site K13 – spring 2009 (Appendix 3).

#### **Wedge-tailed Eagle:**

- Twenty-seven movements with flight height range of 33-90m, 40% of movements over the ridge – winter 2009
- Nine movements with flight height range of 2-300m, 80% of movements over the ridge – spring 2009
- Seven movements with flight height range of 300-800m over valley – summer 2010
- Observed at Sites K1, K2, K4, K5, K6, K10, K11 – winter 2009 (Appendix 2)
- Observed at Sites K3, K4, K9 and K11 – spring 2009 (Appendix 3).

These three species have been recorded within scattered Blue Gum over exotic grassland and within exotic grassland (Figure 4). This can be summarised by detailing where these species occurred within the site and which turbines were proposed within direct vicinity of the survey site.

The Peregrine Falcon was observed during winter and spring 2009 at:

- Site K7 – middle section of the proposed wind farm (closest turbines 22, 21) in exotic grassland
- Site K10 – southern section of the proposed wind farm (closest turbines 23 and 24) in South Australian Blue Gum woodland
- Site K1 – northern section of the proposed wind farm (closest turbines 3 and 4) in scattered South Australian Blue Gum over exotic grassland.

The Elegant Parrot was observed during winter and spring 2009 at:

- Site K1 - northern section of the proposed wind farm (closest turbines 3 and 4) in scattered South Australian Blue Gum over exotic grassland.
- Site K13 – northern section of the proposed wind farm (closest turbine 17) in exotic grassland.

The Wedge-tailed Eagle was observed during winter and spring 2009 at:

- Sites K1, K2, K4 and K5 – northern section of the proposed wind farm (turbines 1 to 15) in exotic grassland and in scattered South Australian Blue Gum over exotic grassland.
- Sites K6 – southern section of the proposed wind farm (turbines 36 and 39) in exotic grassland
- Sites K10 and K11 – southern section of the proposed wind farm (turbines 23 and 24 and 26 and 31 respectively) in exotic grassland in scattered South Australian Blue Gum over exotic grassland.

### **3.10 Habitat Utilisation by Species Groups (spring 2008, winter 2009, spring 2009 and summer 2010 surveys)**

#### **3.10.1 Birds of prey**

##### **Spring 2008**

A number of raptor species were recorded during the spring 2008 survey, in scattered trees that covered hill tops, situated in the north western sector of the proposed wind farm site (Figure 3). This included the *Accipiter fasciatus* (Brown Goshawk), Brown Falcon and Black-shouldered Kite. In addition, Wedge-tailed Eagles and Nankeen Kestrels were commonly observed foraging over bare hilltops on the eastern side of the range, and in the mid and southern sector of the site. These birds are commonly observed flying over hill tops and steep sided gullies, as they use the updrafts created by the site's topography. These birds are attracted to these areas as they employ hovering, gliding and soaring modes of flight when foraging (Debus 1998).

### Winter 2009

A total of four species of birds of prey were recorded within the project site. The state conservation rated Peregrine Falcon was observed four times during the winter 2009 survey. The most commonly recorded raptor species was the Wedge-tailed Eagle with 20 observations, which were attributed mostly to a single pair of birds flying together, suggesting they were breeding partners. Wedge-tailed Eagles performed the highest flights of any species, and performed at-risk flights over the ridge top (Table 14). Wedge-tailed Eagles were recorded from eight of the 13 survey sites, but most records were from Sites K5 and K6 (Appendix 2). The Brown Falcon and Nankeen Kestrel were the other two raptor species recorded on site.

### Spring 2009

Five species of birds of prey were recorded within the project site. Twenty-four (24) out of the total 26 sightings recorded during the spring 2009 survey were during point count surveys (Appendix 3 and Appendix 4). The most commonly recorded species was the Nankeen Kestrel with 11 observations. The Nankeen Kestrel and Wedge-tailed Eagle performed the highest flights of any species (with a maximum of 300m recorded for both species), and performed at-risk flights over the ridge top (Table 18). Nankeen Kestrels were recorded at six of the 13 survey sites with two individuals being the maximum number of kestrels observed at any one time (Appendix 3).

Wedge-tailed Eagles were recorded at four of the 13 survey sites (compared with eight out of 13 during the winter 2009 survey), with most observations recorded from Site K11 (Appendix 3). While activity was concentrated around eagle nest sites during the spring 2009 survey, they were also likely to fly over the remaining survey sites at times.

Peregrine Falcons were observed during both the winter and spring 2009 surveys. They were recorded flying over the ridge top at a range of 20-200 metres (Table 14 and Table 18), putting this species at risk of turbine collision (based on the at-risk level of any movements being above 40 m).

The Brown Falcon was sighted on three occasions from Site K1 and K2 (Appendix 3). The movements of the Brown Falcon were concentrated over the ridge top, recording a minimum height of 10 metres and a maximum of 70 metres. This also placed this species at risk of collision with turbines (Table 18).

One record of the Black-shouldered Kite was recorded at Site K7 during the spring 2009 survey. One movement was recorded across the ridge top with a minimum height of 6 m and a maximum of 15 m.

### Summer 2010

A Peregrine Falcon pair was observed caching food at Nest 12 and utilising the rocky ledge opposite the eagle nest for breeding. Nest 12 was located in a gully consisting of South Australian Blue Gum, *Eucalyptus odorata* (Peppermint Box) open woodland over exotic grassland (Figure 4 and 5). Nine eagle



observations were recorded opportunistically across the site during the 2010 survey, all of which were within open grassland (Table 18).

### 3.10.2 Waterbirds

A number of waterfowl were recorded during the spring 2008 survey: Australasian Grebe, White-faced Heron, Australian Wood Duck and *Anas gracilis* (Grey Teal) were recorded at small farm dams scattered across the wind farm site.

Five species of waterbird were recorded during the winter 2009 survey, the most common being the Australian Wood Duck with 66 records (Appendix 1). Most of these observations were made opportunistically, when travelling past a number of small farm dams, to the west of the major ridgeline. The Grey Teal were also recorded at these dams.

Two species of waterbird were recorded during the spring 2009 survey, with both species recorded once at a singular site. These were the Australian Wood Duck with two records at Site K4 and White-faced Heron with one record at Site K13 (Appendix 3).

No waterbirds were observed during the summer 2010 survey, whilst travelling across the project site. The survey was however focussed on recording raptor observations, as well as finding possible Peregrine Falcon nesting sites.

### 3.10.3 Nectar feeding birds

Thirty-two (32) nectar feeding birds of three species were recorded during the winter 2009 survey, primarily at Sites K1, K2, K4, K10 within scattered Blue Gum over exotic grassland, South Australian Blue Gum/Peppermint Box open woodland and exotic grassland (Figure 4, Appendix 2). The most common nectivore was *Lichenostomus penicillatus* (White-plumed Honeyeater) with 20 records. This species primarily performs flights among the canopy of woodlands as they travel between foraging sites, therefore this species is unlikely be at risk of collision with turbines. Similarly, the Yellow-throated Miner and *Lichenostomus virescens* (Singing Honeyeater) that were also recorded on site are unlikely to come into contact with turbines due to their flight behaviour. They most commonly fly low to the ground, or up to the height of the canopy, or tops of trees. As such nectar feeding birds are at minimal risk of collision with turbines as they infrequently fly above the at risk height of 40 m. The White-plumed Honeyeater was the only nectar feeding species recorded during the spring 2009 survey, with five individuals recorded at Sites K1 and K2 (Figure 4).

### 3.10.4 Seed-eating-birds

Five species of parrot were recorded during the winter 2009 survey, all of which were seed-eating birds. The most common seed eating bird was the Galah, with 192 records (Appendix 1). Galahs were regularly observed flying between trees or from trees to the ground, where they were foraging. Adelaide

Rosellas were the next most common species, with 53 records. The Rosellas were recorded at five woodland sites or within scattered trees during the winter 2009 survey. Red-rumped Parrots and Elegant Parrots were also recorded in the northern sector of the site in areas supporting scattered eucalypt trees (Figure 4).

The majority of parrot flight activity recorded during the winter 2009 survey was over the top of the ridge in the northern sector of the site where *Eucalypt* trees were situated. Areas surrounding Sites K1 and K2 were most frequented by parrots as many of the mature *Eucalypt* trees in the area contain numerous large hollows (Figure 22).



Figure 22. Tree Hollows on the ridge top near Site K1 provide potential nesting habitat for numerous parrot species.

Seven species of parrot were recorded during the spring 2009 survey, all of which were seed-eating birds. The most common was the Galah, with 382 records (Appendix 3). Galahs were recorded at all 13 point count sites. Red-rumped Parrot, closely followed by the Adelaide Rosella, was the next common species with 19 and 17 records consecutively. Red-rumped Parrots were recorded at four out of the 13 point count sites, with two sites located within scattered Blue Gum and the other two evenly spread within scattered trees and pasture grass sites. The Adelaide Rosella was recorded in almost identical sites which were Sites K1, K2 and K4 (all similarly located in woodland habitat and pasture grass sites) (Figure 4).

The majority of flight activities performed by parrots, recorded over the top of the ridge during the spring 2009 survey, were in the northern sector of the site where eucalypt trees were located on the top of the ridge. As per the winter 2009 survey, areas surrounding Sites K1 and K2 were most frequented by

parrots, as many of the mature eucalypt trees in the area contained large hollows. Breeding status for species such as Galahs and the Adelaide Rosella remained unknown.

Most parrot species' flights were below the at risk height of 40 m. However, parrot species were recorded performing flights between 5 – 60 m (Table 18), which places them within the risk height. Of the parrot species likely to utilise the site, the Galah and Elegant Parrot are at some risk of collision with turbines, with the Elegant Parrot recorded flying at a maximum height of 100m (Table 18).

#### **3.10.5 Small insect-feeding birds**

Four species of insectivores were recorded during the winter 2009 survey. This included low numbers of *Acanthiza chrysorrhoa* (Yellow-rumped Thornbill), Brown Thornbill, *Aphelocephala leucopsis leucopsis* (Southern Whiteface) and Superb Fairy-wren (Appendix 1). They were recorded across five sites (Appendix 2) which were located in woodland or pasture areas containing scattered trees. These species fly low to the ground and are not likely to be impacted upon by turbines.

Three species of small insect-feeding birds were recorded during spring 2009 point count surveys. This included low numbers of the Yellow-rumped Thornbill, Southern Whiteface and Superb Fairy-wren (Appendix 3). They were recorded at Sites K1, K2, K10, K11 and K12 (Appendix 4), which was located in woodland or pasture areas containing scattered trees. Small insect-feeding bird species typically fly low to the ground and are not likely to be impacted by turbines.

### **3.11 Threatened Bird Species**

#### **3.11.1 EPBC listed species**

No EPBC listed bird species were recorded during any of the survey periods. An EPBC background database search revealed that three migratory species were recognised as having suitable habitat and possible likelihood of utilisation of the project site (Table 2). These were the Rainbow Bee-eater, Great Egret and Cattle Egret. The Cattle Egret also has a State rare rating. A species profile, outlining the potential for these species to occur on-site, is provided below.

#### **Rainbow Bee-eater**

The Rainbow Bee-eater is distributed across much of mainland Australia. The number of locations that the Rainbow Bee-eater occurs in is unknown, and has not been estimated. It is assumed that the species is widespread given its ability to undertake long-distance movements (Barrett *et al.* 2003) however it is difficult to predict localised populations. The Rainbow Bee-eater occurs in open woodlands and shrublands, including mallee, and in open forests that are usually dominated by eucalypts. It also occurs in grasslands (Gibson 1986) and, especially in arid or semi-arid areas, in riparian, floodplain or wetland vegetation assemblages (Badman 1989). Its ability to undertake long-distance movements makes this species highly mobile. Given that the Rainbow Bee-eater is predictably an infrequent visitor to the project

site, it is unlikely regional populations would be impacted upon by the proposed wind farm. Flight height and behaviour is generally unknown for this species to be able to make further conclusions.

### **Great and Cattle Egrets**

The Great Egret is partially migratory, with northern hemisphere birds moving south from areas with cold winters. The overall population trends of the Great Egret is not well understood (Maddock 2000). This may be attributed in part to the difficulty associated with assessing trends for a species that occupies individual sites erratically, and often in highly variable numbers across a wide geographic area (Wetlands International 2006). Populations across Australia fluctuate in size due to the highly variable availability of suitable wetland habitat.

Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area including damp grasslands. The Great Egret has been reported in a wide range of wetland habitats (e.g. inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial) (Kushlan & Hancock 2005). Great Egrets can be seen alone or in small flocks, often with other egret species at night that roost in groups.

Like many other egrets, the Cattle Egret nests in trees in colonies with other water birds. This species will typically remain within low-lying areas feeding on insects disturbed by grazing stock. They are common in northern Australia but are uncommon in most of their range in southern Australia. The Cattle Egret is found in grasslands, woodlands and wetlands, and has a preference for moist areas with tall grass, shallow open wetlands and the margins of wetlands. It also uses pastures and croplands, especially where drainage is poor. They are partially migratory, moving during winter. Neither species has been recorded in the project area and they are unlikely to be impacted upon.

#### **3.11.2 NPW listed species**

Four State rare bird species were identified from surveys conducted within the proposed Keyneton Wind Farm site. The Peregrine Falcon was recorded over three survey periods, winter and spring 2009 and a breeding site was confirmed in summer 2010. The Elegant Parrot was recorded on site during the winter and spring 2009 surveys. The White-winged Chough was observed in spring 2008. A single observation of a Jacky Winter was recorded opportunistically during the winter 2009 survey. Species profiles are discussed for these species below. Six additional bird species of conservation significance were identified as likely to occur within in the Keyneton project site from the BDBSA search (Table 6), given that there is suitable habitat for these species on site, as well as previous BDBSA records found within and surrounding the project site (Figure 23). Species profiles for these seven species are also listed below.

#### **Peregrine Falcon**

As detailed in Sections 3.8.2 and 3.8.3, the Peregrine Falcon was observed during the spring 2009 and summer 2010 surveys. A Peregrine Falcon nesting site was also identified during the 2010 survey in an

extensive sandstone gorge located approximately 2km from the southern boundary of the site along the banks of the Marne River (I. Falkenberg, pers.comm.2011).

The Peregrine Falcon is found across Australia. Although these birds are not common, they have successfully spread worldwide. It is found in most habitats, from rainforests to the arid zone, and at most altitudes, from the coast to alpine areas. They are also known to nest on artificial structures such as the window ledges of high buildings. The Peregrine Falcon mates for life and pairs maintain a home range of about 20 to 30 square kilometres throughout the year. Rather than building a nest, the Peregrine Falcon typically lays its eggs in recesses of cliff faces, tree cavities or in the abandoned nests of other species (Olsen 1995). Peregrine Falcons commonly occur at windy sites along ranges. This species has a distinctive flight and call, and is often observed flying above the tree canopy or in open areas between patches of woodland, or over wetlands. Their preference for nesting on cliff faces, particularly in the Mount Lofty Ranges, enables observers to target surveys. A nest was found in the northern section of the proposed wind farm and is located deep in a gully. Turbines and associated infrastructure will not be located within this area and Pacific Hydro has adopted a minimum 1000 m buffer from the nest site. A number of flight movements were recorded across the ridgeline during the summer 2010 survey. The main threat to Peregrine Falcons at this site would be the risk associated with individual birds (rather than to the species itself); bird strike and disturbance from the construction of the wind farm may be some of the associated risks. A nest buffer has been recommended to minimise the likelihood of disturbance to the nest site and to individual birds.

### **Elegant Parrot**

The State rated Elegant Parrot has a preference for open woodland, cropland and open country, feeding on the seeds of native and introduced grasses. The species was recorded within exotic grassland (Site K13) during the spring 2009 survey and within scattered Blue Gum over exotic grassland (Site K1) during the winter 2009 survey (Appendix 3 and Appendix 1) (Figure 4). There were also 26 opportunistic records of the Elegant Parrot observed during the winter 2009 survey. It cannot be said whether the Elegant Parrot favours one habitat over the other across the project site, with records observed in both habitat types.

The Elegant Parrots were observed flying high, approximately 100 metres above the ridge (Table 18) which places them at risk of collision with turbines. Elegant Parrots are most often encountered in flocks of 20-100 or more, except in the breeding season when they tend to be found either in pairs or small flocks. Due to the high number of trees with hollows within the project site, it is highly likely that this species may breed on or near the site. This was not confirmed during either the winter or spring 2009 survey.

They are locally nomadic, preferring heathland and open woodland, cropland and semi-arid scrub. They feed on the seeds of native and introduced grasses as well as shrubs and herbaceous plants. Woodland areas with tree hollows will be avoided during the construction of the wind farm and existing tracks will be



used where possible, rather than creating new tracks through pasture grass sites and cropland. Given that none of the preferred habitat of this species will be removed, the overall risk to this species is low.

### **White-winged chough**

The White-winged Chough, listed as State rare under the *NPW Act 1972*, was recorded with 13 individuals (2% of all observations) recorded on site during the spring 2008 survey. White-winged Choughs are found in open forests and woodlands. Potential habitat exists for this species within the wind farm site, with a preference for vegetated woodland. They tend to prefer the wetter areas, with lots of leaf-litter, for feeding, and mud available for nest building. They forage through the leaf litter and their diet includes termites, beetles, worms, insects, grain, and snails. The most suitable habitat for this species occurs at the very northern end of the wind farm site within patches of open woodland around survey Site K2 (Figure 4). Although typical flight height of the White-winged Chough is unknown, most choughs commonly fly at the height of the canopy, or lower to the ground, when travelling between patches of woodland. The White-winged Chough's preferred habitat of woodland areas will be avoided by the proposed turbine layout. Impact on this species is therefore likely to be negligible as their preferred habitat will not be removed and the species typically flies below canopy height.

### **Jacky Winter**

One observation of a Jacky Winter was recorded opportunistically during the winter 2009 survey. Two sub species live in South Australia. *M. f. barcoo* is the most widespread while *M. f. fascinans* occurs in the south-east of the state, with their northern most extent in the Mount Lofty Ranges. Within the Mount Lofty Ranges, the Jacky Winter has a patchy distribution from the Barossa to Port Willunga, east to Monarto and south to Victor Harbor. Where they do occur in South Australia, they are particularly sedentary. The species prefers open woodland with an open shrub layer and a lot of bare ground. They are often observed in farmland and parks. Within the Adelaide Mount Lofty Ranges, the preferred broad vegetation groups are Grassy Woodland and Mallee. An occasional broad vegetation group it also frequents is shrubland (G. Carpenter pers. comm. 2008).

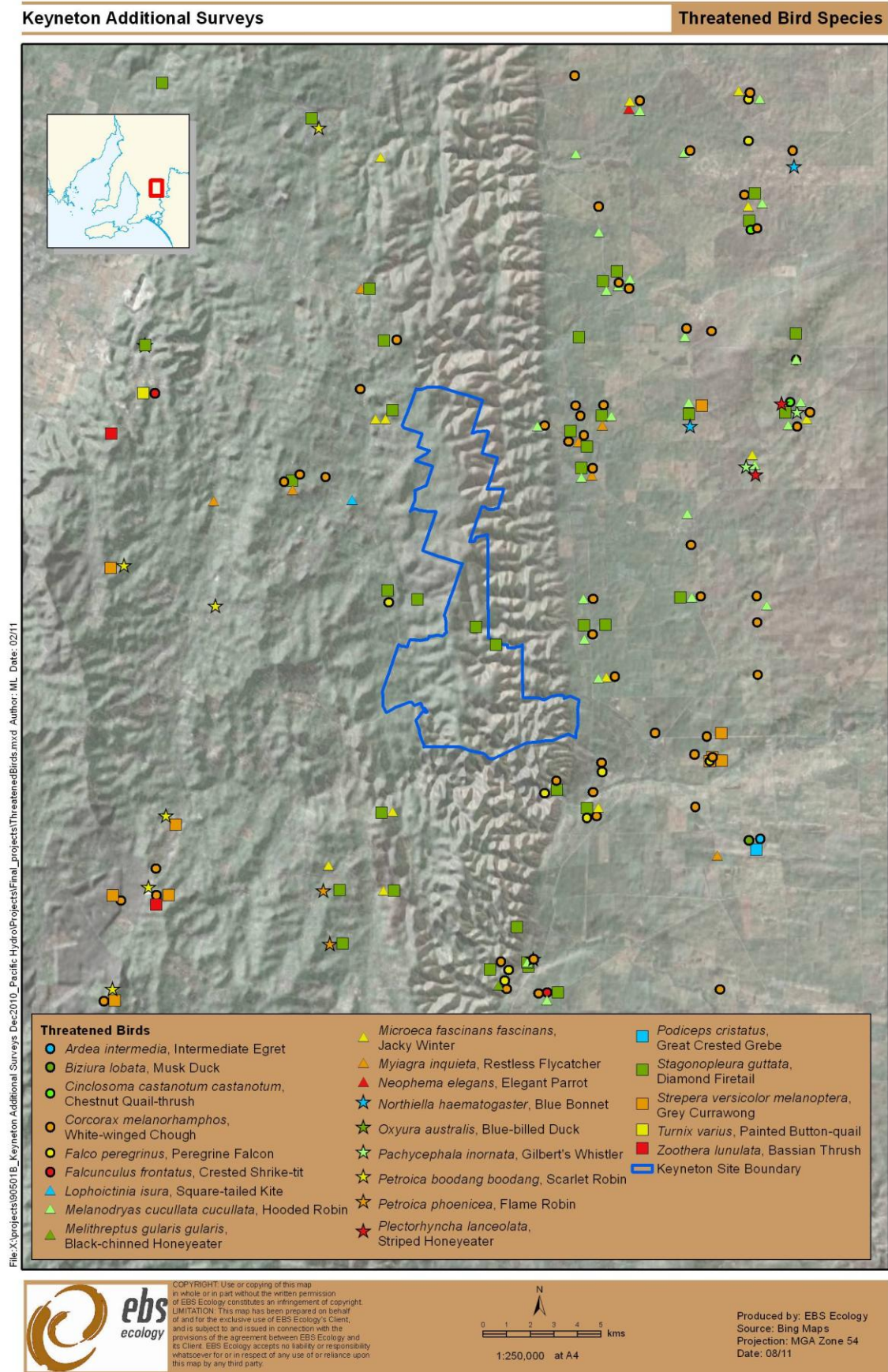


Figure 23. Threatened species identified from the Biological Database of South Australia (BDBSA) search.

Preferred habitat of open woodland will be avoided by the proposed turbine layout. This species would most likely be confined to woodland areas where it typically fly low and below canopy height. The likely impact will be negligible, based on the proposed layout as their preferred habitat will not be removed and the species typically flies below canopy height.

### **Hooded Robin**

Four sub-species are recognised by Schodde and Mason (1999). The eastern sub species *M. c. cucullata* occurs across south-eastern Australia, most of New South Wales, Victoria and south-eastern South Australia (including the Mount Lofty Ranges). This subspecies is still relatively widespread and numerous however declines are continuing in the eastern sheep-wheat belt (Willson and Bignall 2008). The eastern sheep-wheat belt can be described as the bordering of pasture and cropland, which extends across areas such the Mount Lofty Ranges (where the project site is located), mid north, Yorke Peninsula and as far as the southern tip of the Eyre Peninsula. Throughout their range, *Melanodryas cucullata cucullata* (Hooded Robin) occur in lightly timbered habitats, especially eucalypt woodlands, mallee and *Acacia* shrublands. They prefer woodlands with a mosaic of open ground, shrub patches or stands of sapling eucalypts and woody debris to provide foraging, cover and perching (Cale 1994). Much of the habitat of the south-eastern sub-species has been cleared, and a large part of their remaining habitat has been fragmented (Garnett and Crowley 2000). This species would most likely be confined to woodland areas where it would fly under canopy height. Preferred habitat of eucalypt woodlands and acacia shrubland will be avoided as part of the proposed turbine layout. Impact on this species is therefore likely to be negligible as their preferred habitat will not be removed and the species typically flies below canopy height.

### **Blue Bonnet**

There are four subspecies of *Northiella haematogaster* (Blue Bonnet) which may occur within the region of the proposed Keyneton Wind Farm. They usually feed on seeds on the ground, but also feed on berries, fruits and flowers in trees. The Blue Bonnet often occurs in pairs, but may be seen in small flocks. They prefer lightly timbered grassland habitat of mulga, mallee and sheoak, and can be found along watercourses and in scattered paddock trees. It is unknown what flight height this species occurs. Impact on this species is likely to be negligible (if it is actually present on site) as the proposed wind farm layout avoids woodland habitat, and woodland areas will not be removed during the construction of the proposed wind farm.

### **Scarlet and Flame Robin**

*Petroica boodang boodang* (Scarlet Robin) is most commonly found in eucalypt woodland and forest from sea level to elevations of 1000 metres above sea level. During the breeding season they prefer forest and woodlands with dense understorey and ground cover, but during winter they prefer more open habitats with grassy and shrubby understoreys. Like *Petroica phoenicea* (Flame Robin), Scarlet Robins forage extensively on *Eucalyptus viminalis* (Manna Gum), which are likely to support high invertebrate



abundance. The Scarlet Robin adjusts its foraging behaviour seasonally, feeding mostly on the ground during the winter. It will sit on a perch and fly down to the ground to catch prey, and sometimes forages in mixed flocks with other small insect-eating birds, such as Flame and Hooded Robins, *Smicronis brevirostris* (Weebills), *Rhipidura fuliginosa* (Grey Fantails) and Thornbills. In the summer and spring, prey is more commonly snatched from bark and foliage (Robinson 1992, Cale 1994). The major threatening process to the Scarlet and Flame Robins is likely to be the degradation of remnant habitat, via the removal of suitable leaf litter for foraging. The preferred habitat of this species was not recorded during the flora survey conducted on site (EBS 2010), however species such as the Yellow-rumped Thornbill were recorded (Appendix 1), suggesting that robins may inhabit the area. This species feeds mostly from the ground, suggesting it would typically fly low and below canopy height. The likely impact will be negligible, based on the proposed layout as their preferred habitat will not be removed and the species typically flies below canopy height.

### **Diamond Firetail**

*Stagonopleura guttata* (Diamond Firetails) live in a wide range of eucalypt dominated vegetation communities that have a grassy understorey, including woodland, forest and mallee. They are ground-feeders that predominantly eat ripe and half-ripe seeds of various grasses but are also known to feed on seeds of herbs, bushes and trees (Immlermann 1982, Read 1994). They prefer habitat that includes *Eucalyptus camaldulensis* (River Red Gum), *E. leucoxylon* (Blue Gum), *Callitris gracilis* (Cypress pine) and *Allocasuarina luehmannii* (Buloke). Across Australia, much of the Diamond Firetail's preferred habitat has been cleared and what remains is highly fragmented and degraded due to the increase in edge effects, grazing by domestic stock and rabbits, and the removal of firewood (Garnett and Crowley 2000). Factors that adversely affect Diamond Firetails include: loss of key food plants and habitat (as a result of invasion by exotic grasses), habitat degradation (particularly overgrazing of the grass understorey) and an increase in the abundance of predators such as Pied Currawongs and the Australian Raven. The latter may increase nest predation in fragmented woodland remnants (Major *et al.* 1996). Previous records of this species occur within the boundary of the project site (Figure 23). Considering that both preferred eucalypt species are found within the proposed Keyneton Wind Farm site (EBS 2011), the Diamond Firetail is likely to occur here. This species feeds mostly from the ground, suggesting it would typically fly low and below canopy height. The likely impact will be negligible, based on the proposed layout as their preferred habitat will not be removed and the species typically flies below canopy height.

### **Grey Currawong**

*Strepera versicolor melanoptera* (Grey Currawong) has a regional listing of uncommon in the mid north of South Australia. It inhabits a wide range of habitats from the coast to the semi-arid region, including forests, woodlands, mallee, coastal heathland and other heathland habitats. They are also found in remnant vegetation on roadsides and farms, in orchards, and in suburban areas. As with the Australia Raven, this species can fly high across the ridgeline, putting it at some risk of collision with wind turbines. The Grey Currawong was not detected on site during surveys conducted by EBS Ecology. Preferred



habitat will be avoided as part of the proposed turbine layout. Impact on this species is therefore likely to be negligible as their preferred habitat will not be removed.

### 3.12 Inter-year comparisons

Fifty-eight (58) bird species were recorded across the three bird utilisation surveys; spring 2008, winter 2009 and spring 2009 (Table 22). Eighteen (18) out of the 58 bird species were recorded across all three survey periods: *Acanthiza chrysorrhoa* (Yellow-rumped Thornbill), *Anthus novaeseelandiae* (Richard's Pipit), Wedge-tailed Eagle, Galah, *Cacatua sanguine* (Little Corella), Australian Wood Duck, *Climacteris picumnus* (Brown Treecreeper), *Dacelo novaeguineae* (Laughing Kookaburra), *Egretta novaehollandiae* (White-faced Heron), Brown Falcon, Nankeen Kestrel, Australian Magpie, *Hirundo neoxena* (Welcome Swallow), *Pardalotus striatus* (Striated Pardalote), *Petrochelidon nigricans* (Tree Martin), Adelaide Rosella, *Psephotus haematonotus* (Red-rumped Parrot) and *Rhipidura leucophrys* (Willie Wagtail).

Nineteen (19) out of the 58 bird species were recorded during only one survey period (Table 22). These included:

- Brown Thornbill – winter 2009
- Mallard – winter 2009
- *Anthochaera chrysoptera chrysoptera* (Little Wattlebird) – spring 2008
- Australian Raven – spring 2008
- Grey Butcherbird – winter 2009
- Emu – winter 2009
- Musk Lorikeet – spring 2008
- *Glossopsitta porphyrocephala* (Purple-crowned Lorikeet) – spring 2008
- *Grallina cyanoleuca* (Magpie-lark) – spring 2008
- *Haliastur sphenurus* (Whistling Kite) – spring 2008
- *Malurus lamberti* (Variegated Fairy-wren) – spring 2008
- Yellow-throated Miner – winter 2009
- *Manorina melanocephala* (Noisy Miner) – spring 2008
- Jacky Winter – winter 2009
- *Ocyphaps lophotes* (Crested Pigeon) – spring 2009
- *Pachycephala rufiventris* (Rufous Whistler) – spring 2008
- *Petroica goodenovii* (Red-capped Robin) – spring 2008
- *Turdus merula* (Eurasian Blackbird) – spring 2008
- *Vanellus miles* (Masked Lapwing) – spring 2008.

Twelve out of the 19 species recorded during singular survey periods, were from the spring 2008 survey. Many of these records may be attributable to the seasonal use of the project site by birds. The results highlight the value of repeated surveys across the project site during different seasons.

Table 23. Bird species recorded during each of the survey periods at the Keyneton Wind Farm site.

Scientific name	Common name	Recorded in spring 2008	Recorded in winter 2009	Recorded in spring 2009
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	X	X	X
<i>Acanthiza pusilla</i>	Brown Thornbill		X	
<i>Accipiter fasciatus</i>	Brown Goshawk	X		
<i>Alauda arvensis</i>	Eurasian Skylark*			X
<i>Anas gracilis</i>	Grey Teal	X	X	
<i>Anas platyrhynchos</i>	Mallard		X	
<i>Anthochaera carunculata</i>	Red Wattlebird	X		X
<i>Anthochaera chrysoptera chrysoptera</i>	Little Wattlebird	X		
<i>Anthus novaeseelandiae</i>	Richard's Pipit	X	X	X
<i>Aphelocephala leucopsis leucopsis</i>	Southern Whiteface		X	X
<i>Aquila audax</i>	Wedge-tailed Eagle	X	X	X
<i>Cacatua roseicapilla</i>	Galah	X	X	X
<i>Cacatua sanguine</i>	Little Corella	X	X	X
<i>Chenonetta jubata</i>	Australian Wood Duck	X	X	X
<i>Cincloramphus cruralis</i>	Brown Songlark	X		X
<i>Climacteris picumnus</i>	Brown Treecreeper	X	X	X
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	X		
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	X		X
<i>Corcorax melanorhamphos</i>	White-winged Chough	X	X	
<i>Corvus coronoides</i>	Australian Raven	X		
<i>Corvus mellori</i>	Little Raven		X	X
<i>Cracticus torquatus</i>	Grey Butcherbird		X	
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	X	X	X
<i>Dromaius novaehollandiae</i>	Emu		X	
<i>Egretta novaehollandiae</i>	White-faced Heron	X	X	X
<i>Elanus axillaris</i>	Black-shouldered Kite	X		X
<i>Falco berigora</i>	Brown Falcon	X	X	X
<i>Falco cenchroides</i>	Nankeen Kestrel	X	X	X
<i>Falco peregrinus</i>	Peregrine Falcon		X	X
<i>Glossopsitta concinna</i>	Musk Lorikeet	X		
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet	X		
<i>Grallina cyanoleuca</i>	Magpie-lark	X		
<i>Gymnorhina tibicen</i>	Australian Magpie	X	X	X
<i>Haliastur sphenurus</i>	Whistling Kite	X		
<i>Hirundo neoxena</i>	Welcome Swallow	X	X	X
<i>Lalage sueurii</i>	White-winged Triller	X		X
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater		X	X
<i>Lichenostomus virescens</i>	Singing Honeyeater	X	X	
<i>Malurus cyaneus</i>	Superb Fairy-wren		X	X
<i>Malurus lamberti</i>	Variegated Fairy-wren	X		
<i>Manorina flavigula</i>	Yellow-throated Miner		X	
<i>Manorina melanocephala</i>	Noisy Miner	X		
<i>Microeca fascinans fascinans</i>	Jacky Winter		X	
<i>Neophema elegans</i>	Elegant Parrot		X	X

# Proposed Keyneton Wind Farm: Avifauna and raptor nest assessment

Scientific name	Common name	Recorded in spring 2008	Recorded in winter 2009	Recorded in spring 2009
<i>Ocyphaps lophotes</i>	Crested Pigeon			X
<i>Pachycephala rufiventris</i>	Rufous Whistler	X		
<i>Pardalotus striatus</i>	Striated Pardalote	X	X	X
<i>Petrochelidon nigricans</i>	Tree Martin	X	X	X
<i>Petroica goodenovii</i>	Red-capped Robin	X		
<i>Platycercus elegans</i>	Crimson Rosella			X
<i>Platycercus elegans adalaidae</i>	Adelaide Rosella	X	X	X
<i>Psephotus haematonotus</i>	Red-rumped Parrot	X	X	X
<i>Rhipidura leucophrys</i>	Willie Wagtail	X	X	X
<i>Sturnus vulgaris</i>	Common Starling*	X	X	X
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	X	X	
<i>Turdus merula</i>	Eurasian Blackbird*	X		
<i>Vanellus miles</i>	Masked Lapwing	X		
<i>Vanellus tricolor</i>	Banded Lapwing		X	X

\*denotes an introduced species.

## **4 DISCUSSION**

### **4.1 Summary of Bird Utilisation**

Bird utilisation of the proposed Keyneton Wind Farm site varied markedly across the site, with the highest activity most often occurring within exotic grassland (K11 and K6) at the southern end of the wind farm (Figure 4). However by exception, the winter 2009 survey recorded highest activity within woodland habitat in the northern end of the wind farm (Figure 3). Bird utilisation also remained relatively high at a number of other survey sites in areas of pasture grass, located within the middle and northern sector of the proposed wind farm. Wedge-tailed Eagles, Brown Falcons, Nankeen Kestrels and Elegant Parrots performed the highest flights, many of which were concentrated over the main ridgeline on site. Due to the scattered distribution of remnant patches of low woodland, birds that use these habitats regularly cross open areas of grassland and pasture grasses. It is assumed that bird activity in these areas would be increased when the eucalypts are in flower, with an increased abundance of honeyeaters, lorikeets, and parrots attracted to the area. Common species such as the Australian Magpie, Galah, Little Raven, Common Starling and Tree Martin were observed in large numbers within the majority of survey sites.

### **4.2 Targeted Wedge-tailed Eagle surveys**

The spring 2009 survey and summer 2010 survey showed that several nests were active across both breeding seasons. Furthermore, those nests that showed no active signs of utilisation may become active in future seasons. Nevertheless, a valuable approach would be to continue to monitor nest usage and breeding success (i.e. survival of chicks) before and post construction. This would assist in determining if the presence and operation of turbines has an impact on breeding Wedge-tailed Eagles i.e. both directly by observing continued and successful nest use, or potentially indirectly by the redistribution of breeding pairs from the project site to other areas within the Keyneton region.

### **4.3 Targeted Peregrine Falcon surveys**

A targeted Peregrine Falcon survey was undertaken during summer 2010, after several observations of this species were recorded in winter and spring 2009. One nest location was identified as well as a number of flight movements recorded for this species. Additional to the 2010 survey, two breeding locations have been previously identified to the south of the project area (I. Falkenberg pers. comm. 2011). Continuing to monitor nest utilisation and breeding success at the known breeding site as before and post construction is recommended. This would assist in determining if the presence and operation of turbines has an impact on Peregrine Falcons at the site.

### **4.4 Possible impacts on birds from the proposed wind farm**

A range of direct and indirect impacts of wind farms on birds have been recognised in recent years. Direct collision with turbines can result in mortality (summarised by Madders and Whitfield 2006). Other



potential effects include bird displacement due to habitat loss and disturbance impacts (Drewitt and Langston 2006). Further discussion on potential impacts on birds using the proposed Keyneton Wind Farm site is addressed below.

Avoidance of turbines, by a species such as the Wedge-tailed Eagle, is possible. Avoidance behaviour refers to how a bird may respond when they encounter a wind turbine, or as Smales and Muir (2005) define 'avoidance', the rate at which birds attempt to avoid colliding with a structure. Birds can commonly modify their flight behaviour to avoid turbines (summarised by Barrios and Rodriguez 2004). Barrios and Rodriguez (2004) measured bird mortality, analysed the factors that led birds to fly close to turbines, and proposed mitigation measures at two wind farms installed in the Straits of Gibraltar. Despite the large number of migrating birds in the study area, most follow routes that are displaced from the facilities. Consequently only a small fraction of birds on migratory flights was actually exposed to turbines (Barrios and Rodriguez 2004). It was obvious that vultures adjusted their movements to avoid the revolving rotor blades (Barrios and Rodriguez 2004).

Peregrine Falcons use aerial avoidance manoeuvres to escape pursuit by Red-tailed Hawks (Kirkwood 2007). It has been suggested by Inces and Associates (2010) that falcons are therefore likely to be able to avoid collision with turbine blades, which move comparatively slowly, provided they are conscious of the blade's location. In contrast to this, when Peregrines are diving in pursuit of prey, they are often so focused on their prey that they do not appear to notice potential threats (White *et al* 2002). Collision with turbine blades may be more likely if the falcon enters the blade swept area in the course of its attack path (Inces and Associates 2010). Anderson and Osmek (2005) report that the most vulnerable group of raptors consists of recently fledged individuals, largely due to their inexperience and being relatively weak flyers.

Successful breeding has been recorded in a nest located in a woodland patch 400 m from a turbine situated at Pacific Hydro's Challicum Hills Wind Farm in Victoria. Resident Wedge-tailed Eagles have continued to utilise the site for over five years without incident, suggesting that Wedge-tailed Eagles do adopt avoidance behaviour (Brett Lane and Associate Pty Ltd 2009).

#### **4.4.1 Habitat loss**

The potential loss or alteration of habitat associated with construction of wind farms can result in the loss of feeding and breeding habitat for a range of other birds. For example, numerous bird species identified in the spring 2008 survey require tree hollows for nesting. These include the Galah, Little Corella, and Tree Martin, as well as the regionally uncommon Red-rumped Parrot and Musk Lorikeet. Some of the large old *Eucalyptus odorata*, *E. leucoloxylon*, and *E. camaldulensis* on site had numerous tree hollows of a range of different sizes. These eucalypts are also likely to be heavily utilised by nectar feeding birds such as parrots and honeyeaters when they are in flower. One hundred and forty-five (145) nectar feeding bird observations of six species were recorded during the spring 2008 survey. The most common nectar feeders recorded were Adelaide Rosellas, White-plumed Honeyeaters, Musk Lorikeets and Red

Wattlebirds. The majority of these birds were observed feeding in flowering trees, predominantly *E. odorata* (Peppermint Box).

The grassland habitat on site and in the surrounding area may also provide suitable habitat for numerous bird species. A wide range of native grasses are known occur in the area, such as *Austrostipa* sp. (spear grasses), *Austrodanthonia* sp. (wallaby grasses), *Microlaena stipoides* (weeping rice grass), *Aristida behriana* (brush wire grass), and *Panicum effusum* (panic grass) (EBS 2010). These grasses, as well as a range of exotic species, may provide food for the Elegant Parrot which was recorded on site during both winter and spring 2009.

Clearing of grassland habitat during the construction of roads and the building of infrastructure associated with the development of wind farms has the potential to directly impact native grasslands via habitat removal. However, the potential impact on key habitats and on the bird groups mentioned above, can be avoided or reduced through the wind farm design developed by Pacific Hydro. Existing woodlands and mature trees will be avoided and minimised where possible, and turbines will be constructed within previously cleared sites.

#### **4.4.2 Disturbance Effects: bird collisions with turbines.**

Most studies of bird and bat interactions on wind farms focus on wind turbines. The principal risk to birds believed to be posed by turbines, is the potential for individuals to be killed as a result of collision with moving rotor blades (Smales 2006). The vast majority of studies have been conducted overseas, with limited published studies within an Australian context. There is little data based on long-term, standardised, and systematic assessments on the consequences of bird-strike (Drewitt and Langston 2006).

As described by Drewitt and Langston (2006) the number and behaviour of birds, topography and the nature of a wind farm, are all factors influencing collision risk. Whilst birds commonly modify their flight behaviour to avoid turbines (summarised by Barrios and Rodriguez 2004), bird collisions have been recorded at a wide range of wind farms both in Australia (Dennis 2006, Lane 2008), and overseas (Drewitt and Langston 2006). Results from these studies show that the bird species most at risk of collisions are those that fly at heights corresponding to the rotor-swept area of turbines (at-risk height of at least 40 m in the case of the Keyneton site). Where these birds are also large-bodied they are considered more collision prone (Barclay *et al.* 2007).

Any elevated structure presents some level of bird collision risk and it is well documented that fixed structures including buildings and windows account for millions of bird deaths each year (Sovacool 2009). In United States, the death of 3000 birds killed in one night when colliding with the chimneys of a thermal power station has been documented. The Australian experience to date show lower bird mortality numbers than in the Northern Hemisphere, which has been attributed to the lower concentrations of night migrating birds.

The collision of large numbers of bird migrants with illuminated structures, especially during overcast nights with drizzle or fog, have also been well documented by Erickson *et al.* (2001). Communication towers in the United States have been responsible for mass nocturnal mortality events of migrant birds, with up to 10 000 birds killed in a single night (Evans 1998). The single biggest attractant seems to be the lighting on the towers, with taller, better lit towers responsible for more fatalities.

Numerous medium to large-bodied birds were recorded at the site during the spring 2008 survey. For example, Galahs, parrots, rosellas, and honeyeaters were observed flying from tree to tree in the western half of the northern sector of the site. Most of these flights were relatively low, as birds travelled between patches of eucalypt trees, or to solitary eucalypts scattered across paddocks. A number of waterfowl, including the Australasian Grebe, White-faced Heron, Australian Wood Duck, and Grey Teal, were recorded using small farm dams scattered across the wind farm site. It is highly likely that small flocks of waterfowl fly through the area on a regular basis as they move between these farm dams. Flight heights of these species were not recorded during the 2008 survey, so it is difficult to conclude whether they flew at heights deemed at risk (above 40 m).

A number of raptor species were recorded in the north western sector of the wind farm site, where scattered trees covered the hill tops. This included the Brown Goshawk, Brown Falcon, and Black-shouldered Kite. These birds are commonly observed flying over hilltops and steep sided gullies as they use the updrafts created by this topography. These birds are attracted to these areas as they employ hovering, gliding and soaring modes of flight when foraging (Debus 1998). This flight behaviour increases their flight efficiency, enabling them to spend long periods of time flying over hill tops in search of prey. The foraging behaviour of raptors places them at risk of colliding with turbines. While activity may be concentrated across many areas of the ridge line and surrounding hills within a Wedge-tailed Eagles foraging territory, it is certain that ridges within close proximity to nest sites will be heavily used.

With respect to Wedge-tailed Eagles, it is understood that young birds, before they are adept flyers, are at greater risk of collision than adult eagles. However, as noted in Section 4.4 above, successful breeding has been recorded in an eagles nest located at Challicum Hills Wind Farm in Victoria. As such it has been observed that Wedge-tailed Eagles can continue to use a wind farm site successfully during operation. Nevertheless, whilst avoidance behaviour has been demonstrated and successful breeding observed on an operational wind farm in Victoria, the risk of bird collision with turbines cannot be entirely eliminated. As such it is prudent that nest buffers are adopted to minimise the potential for impacts at the more highly utilised areas near nests, and those same areas which are more frequently utilised as young birds leave the nest.

It is possible that during the construction phase of the proposed wind farm, raptors and other species may incur some level of temporary disturbance. Wedge-tailed Eagles are notoriously fussy nesters and

may abandon nests if disturbed. The recommended 500 m buffer around eagle nests will assist with lessening disturbance levels to this species during the construction phase.

Wedge-tailed Eagles (WTE) are territorial birds and it is understood that breeding pairs will defend their territory from rival adult WTEs, particularly during the breeding season. On the other hand Wedge-tailed Eagle pairs are understood to tolerate the temporary use of their territory by their off-spring and juvenile WTEs. Breeding pairs are known to have and use a number of nests within their range and may change nest use from season to season. There is limited certainty about Wedge-tailed Eagle territory sizes however it is generally understood that they are in the range of 10 km<sup>2</sup>. It is likely that any surviving off-spring (Wedge-tailed Eagles have high natural mortality rates) utilise the site for up to 3-4 years post birth and other juvenile or adult WTEs searching for their own territory would also be present on the site at least temporarily. It is not known how many WTEs occupy the proposed Keyneton Wind Farm site, however given its size (15 km from north to south) and the number of nests identified, it is probable that at least two resident WTE pairs use the site as a part of their wider range (Smales 2006).

Section 3.9 of this report, comparison of flight heights for at-risk species, summarised the at-risk flights for the Peregrine Falcon, Wedge-tailed Eagle and Elegant Parrot. It also summarised where these three species were found across the site during the winter and spring 2009 surveys (Appendix 2 and Appendix 3). The three species have been recorded within turbine swept areas and therefore fly at heights that could potentially collide with turbines (above 40 m has been adopted as the at risk flight height for the purposes of this report).

Peregrine Falcons were recorded during two surveys (winter and spring 2009) at three different locations across the Keyneton project site. The species was also found to be breeding on site during the 2010 survey, with two possible nest locations also located to the south of the proposed wind farm boundary (I. Falkenberg pers. comm. 2011) Peregrine Falcons mostly eat flocking birds, particularly starlings, pigeons and parrots, but they also prey on larger species including herons, ibis and waterfowl (Debus 1998). Within the project site there were many species of rosellas and parrots which are likely to be important prey items which may occur along the ridge top in the open woodland. The summer 2010 survey found that the Peregrine Falcons conducted regular flights over the top of the ridge line in the north east corner of the project site, possibly to capture prey. This behaviour may place individual birds at risk of collision with turbines if they do not adopt avoidance behaviour.

#### **4.4.3 Barrier effects**

A barrier effect is a term used to describe how birds alter their migration flyways to avoid wind farm infrastructure (Drewitt and Langston 2006). As described by Drewitt and Langston (2006) the barrier effect on birds is variable and can depend on species, type of bird movement, flight height and variables such as the time of day, wind force and wind direction. The barrier effect may be an issue for local birds who regularly traverse a ridge line when moving between foraging, roosting and/or breeding sites or along migration paths. If impacts on foraging occur, this may impact on breeding success. Birds

commonly move across the landscape between seasons travelling from spring breeding grounds to summer and winter feeding areas.

The current design has two distinct clusters of turbines with a spacing of 5 km between them. Spacing between turbines in the current layout is generally in order of 400-500 m (K. Derriman pers.comm. 2011). The distance between turbine clusters and also the distance between individual turbines, is likely to allow for safe bird passage between turbines for birds that utilise “avoidance” behaviour.

#### **4.4.4 Other impacts on birds**

All energy generating sources can impact on birds. When considering the potential impacts on birds associated with wind farms, it is also important to consider the existing and on-going impacts on all forms of wildlife from other energy sources.

In the context of the Australia-wide Wedge-tailed Eagle population, the population may be subject to natural and environmentally variable mortality, in addition to an unknown level of anthropogenic deaths e.g. vehicle and powerline collisions and secondary poisoning (Smales *et al* 2010). Sovacool (2009) attempted to ascertain the relative impacts on birds of various forms of electricity generation. Wind power has one of the lowest impacts on birds and that they are more than an order of magnitude lower than fossil-fuelled power generation (Sovacool 2009).

An assessment was conducted of known and documented effects of electricity generation on vertebrate wildlife in the New York/New England region by Newman and Zillioux (2009). Results were used to construct a Comparative Ecological Risk Assessment in order to make objective comparisons amongst six types of electricity generation important to the region. Overall, non-renewable electricity generation sources, such as coal and oil, pose significantly higher risks to wildlife than renewable electricity generation sources, such as hydro and wind (Newman and Zillioux 2009).

### **4.5 Reducing impacts to raptors via nest buffers**

A cluster of three eagle nests, within the middle of the project site, have been identified as an area of high eagle activity (Figure 4 and 5). Nest 9 was identified as active during the 2009 and 2010 breeding seasons. A number of eagle movements were also observed within the north eastern corner of the project site, along with the presence of a pair of Peregrine Falcons. As a consequence the turbine layout has been modified to avoid the cluster of three eagle nests as well as the falcon nest with recommended buffers of 500 m and 1000 m respectively. These changes to the site layout will assist in limiting the potential impacts on both these species.

The proposed buffers around nests are primarily aimed at reducing the disturbance experienced during breeding and when juveniles are near fledging and at greater risk than adults. Older birds can generally



learn to avoid the vicinity of turbines over time however juvenile birds are generally considered to be at higher risk of collision (G. Carpenter pers.comm. 2011).

Mitigation options include embedded mitigation such as modifications to the wind farm layout e.g. to buffer nest sites or avoid areas of high activity, or additional mitigation measures such as alterations to the construction schedule to reduce potential disturbance on breeding birds. Each bird species and/or individuals response to turbines is likely to differ based on their own sensitivities or tolerances. The buffer requirements around nest sites may also differ based upon the topography in which they are located.

### **Peregrine Falcon**

Most USA states have Peregrine Falcon management plans which involve protective buffers designed to protect the birds from disturbance at a range of 150 – 800 m (no disturbance around active nests), with an advised buffer of 800 m set back from the top of the nest cliff (Ellis 1982, Hayes & Buchanan 2002). US Fish & Wildlife Service guidance on forestry activities indicated that individual cases should be assessed where potentially disturbing activity is required within 400 m (non breeding season) and within 800 m (breeding season) of a known nesting site (USFWS 1982).

Olsen & Olsen (1980) considered that disturbance and development activities within 400 – 800 m have greatest impact and hence power lines should not be sited within 400 – 800 m of nests due to collision risk.

Based on the foraging behaviour of the Peregrine Falcon and the fact a pair have successfully bred on site within the north eastern corner of the Keyneton project site for numerous years (I. Falkenberg pers.comm.2010), it is recommended that a 1000 m buffer is placed around the nest site to reduce the likelihood of disturbance from, or collision with, wind turbines.

A case study on the potential interactions between Peregrine Falcons and wind turbines, at the Big Thunder Wind Park (in Ontario, Canada), has been detailed by Ince and Associates (2010). Based on the information provided in the report, noise from the turbines at the proposed wind farm is not expected to adversely affect Peregrine Falcons based on several reasons, one of which was the placement of a one kilometre buffer zone from potential nests.

A buffer of between 500-1000 m has also been recommended by the Department of Environment and Natural Resources (DENR) within a draft management plan on the monitoring of Peregrine Falcon nests within the Keyneton region (I.Falkenburg pers.comm. 2011). Whilst it is unclear as to the rationale behind the buffer range, in the absence of verifiable data, a precautionary approach has been taken with the implementation of a buffer of 1000 m recommended by EBS and adopted by Pacific Hydro.

Breeding Peregrine Falcons are most likely disturbed by human activities taking place around the nest (Herbert & Herbert 1969, Ellis 1982, Hustler 1983, Ruddoch and Whitfield 2007). From anecdotal observations, referenced in Herbert and Herbert (1969), this species was more likely to be disturbed by human activities near a nesting site compared with Wedge-tailed Eagles. Therefore a precautionary buffer of 1000 m would ensure minimal disturbance around the Peregrine Falcon nesting site.

### **Wedge-tailed Eagle**

In Tasmania a buffer of between 500-1000 m was applied to nests of the endangered Tasmanian subspecies of the Wedge-tailed Eagle (*Aquila audax fleayi*) when conducting forestry operations during the breeding season. The majority of nests for *Aquila audax fleayi* occur in forests that are dominated by eucalypts; forest habitats used by the eagle for nesting usually have a closed canopy (Bell and Mooney 1998). In comparison, the mainland species (*Aquila audax*) is not as restricted in its nesting preference and breeds in open woodland and forested land. A buffer of 500 m (if any) is seen as suitable for mainland Wedge-tailed Eagles (G. Carpenter - DENR pers. comm. 2011), in the case of wind turbines and their location in relation to nest sites.

A buffer of 1000 m around nests of *Aquila audax fleayi* has been recommended at the Cattle Hill Wind Farm in Tasmania to avoid impacts to this species (Hydro Tasmania Consulting 2010). This buffer size was developed using site-specific utilisation data to model collision risk zones at the site, with an area within 1000 m of an active nest deemed to be an area of “high risk”. This is one of the few studies that has utilised data to develop specific buffers (Biosis pers. comm. 2011). The 1000 m buffer is particularly relevant to the Tasmanian subspecies and less applicable to the mainland species which is not reliant on a close canopy forest for nesting suitability.

The establishment of spatial buffers around nesting sites of raptors during the breeding season, to protect them from disturbance during the breeding lifecycle, has been recommended by the United States Fish and Wildlife Service (USFS 2011). The size of the buffer should be sufficient to minimise visual and auditory impacts to birds that are associated with human activity, and are species specific (Biosis pers comm. 2011). The buffer distance recommended for *Aquila chrysaetos* (Golden Eagle), the most closely related species to the Wedge-tailed Eagle, is 0.5 miles (800 metres).

Of concern for Wedge-tailed Eagles is the fact birds tend to spend much of their time flying/gliding in windy spots at the head of gullies, preferring the updraft of thermals. This can also be the same location where turbines are located (G. Carpenter, pers.comm.2011). Eagles have also shown a preference for thermal updrafts over a slope (rather than the ridge top) for soaring. Smales (2010) described some of the factors that effect the availability of nest trees in large trees for Wedge-tailed Eagles at the Yaloak South Wind Farm. Updrafts from the escarpments offer reliable aerial environment for soaring eagles.

We can assume that eagles do not just favour gully heads for gliding/flying but rather favour the updraft of thermals wherever available, including slopes, ridge tops or other landscape forms. The data collected from EBS Ecology has not been analysed with respect to location of preferred thermals, and therefore cannot speculate.

A nest may be a considerable distance from a turbine, but young will fly to the windiest spots anyway. A nest is situated approximately 200 m from a turbine at Cape Jervis, in South Australia (G. Carpenter pers.comm. 2011). The nest is located just below the head of a gully and adults approach the nest up the gully so as to avoid the turbine. Several young have been produced but at least two have been killed by turbine blades (G. Carpenter pers.comm. 2011).

A buffer of 500 m (if any) is seen as suitable for mainland Wedge-tailed Eagles (G. Carpenter - DENR pers. comm. 2011), given that WTE have successfully bred within 200 m of a turbine in South Australia. The recommended 500 m buffer, around eagle nest sites located within the project site, is aimed at decreasing disturbance to WTEs and the risk to WTEs (especially juveniles) colliding with wind turbines. It is recommended that the minimum 500 m buffer be applied to all nine Wedge-tailed Eagle nest locations. Breeding pairs often switch between multiple nest sites within their territory from one year to the next so it is recommended that all nine nest locations on site are provided with the buffer, not just active nests. Pacific Hydro has adopted these recommendations in the reduced 42 turbine layout.

## 5 RISK ASSESSMENT

The risk assessment determines the potential impact of the proposed wind farm on bird species which undertake at-risk movements, where the risk element of concern is collision. The bird species that were identified as performing flights considered to be at-risk movements of above 40 m (at or above rotor blade height) are discussed below and detailed in Table 24.

In addition to some common species performing at-risk movements, the state rare Peregrine Falcon and Elegant Parrot, and priority species, the Wedge-tailed Eagle, were also recorded performing at-risk flights. Two other conservation rated species recorded on site, the White-winged Chough and Jacky Winter, were included in the risk assessment although at-risk heights of above 40 m were not observed for these two species. Finally, those species determined as likely to occur on site (from the BDBSA search) but were not recorded during any of the surveys, were also assessed (Table 6).

The methodology used in determining the potential risk to these bird species is described in Tables 3 and 4 (replicated from Section 2.5). The overall level of risk for all species was determined as low.

The likelihood of collision causing mortality was determined as likely (C) for one species, the Australian Magpie. The likelihood of collision causing mortality was determined as unlikely (D) for four raptor species: Wedge-tailed Eagle, Brown Falcon, Nankeen Kestrel and Peregrine Falcon. Collision causing mortality could occur at some time for these species. The likelihood of collision causing mortality was determined as rare (E) for 14 species, where the event may occur in exceptional circumstances.

The consequence of mortality at a species/population level was determined as minor (4) for two species, the Peregrine Falcon and Elegant Parrot. The consequence of mortality may impact on the local population of these two species, however with no impact on the species. Consequence was determined as insignificant (1) for 17 species; individuals may be affected, but viability of a local population for these species are not impacted upon.

### Wedge-tailed Eagle (WTE)

There were a number of factors that influenced the risk assessment of this species:

- WTE were observed flying at at-risk height (Table 14 and Table 18);
- WTE have been known to modify their flight behaviour to avoid turbines. This has been demonstrated at an operational wind farm in Victoria where successful breeding has also been observed;
- Whilst WTE can be agile in flight it is understood that young birds, before they are adept flyers, are at greater risk of collision than adult eagles;

- While it is unknown how many WTEs occupy the proposed Keyneton Wind Farm site, given the size of the project site (15km north to south) and the number of nests identified (nine were of WTE origin, of which two were active), it is probable that at least two resident WTE pairs utilise the site (exclusive of young that may fledge each breeding season).

With regard to the definition of a 'local population', it is noted that Smales (2010), at the Yaloak South Wind Farm hearings, stated that there was no defined "local population for the Wedge-tailed Eagle" species across mainland Australia. This was tested and ultimately accepted in Yaloak South hearings associated with this wind farm. Based on the factors above, the likelihood of collision causing mortality is unlikely, the consequence at a species/population level is insignificant and the overall level of risk is low. See Tables 3, 4 and 24 for definitions.

### **Peregrine Falcon**

There were a number of factors that influenced the risk assessment of this species:

- While it is unknown how many Peregrine Falcons occupy the proposed Keyneton Wind Farm site, it is likely that up to four Peregrines may utilise the site at any given time. A pair was observed utilising the north-east section of the site and it is likely that a second pair utilise the southern section of the site for foraging. This assumption is based on the fact two nesting sites were recorded south of the project site. Ongoing telemetry-based studies in Nunavut, conducted by researchers at the University of Alberta, have indicated that although Peregrines may forage up to 30km from their nest site, 80% of their activity occurs within about 5km of the nest site (Ratcliff in Ince and Associates 2010);
- The Peregrine Falcon has a state rare conservation rating, which suggests that localised populations of this species may be more significant within South Australia compared with other common raptor species;
- The Peregrine Falcon was observed flying at at-risk height (Table 18). The species is known for its high speed during flight which may influence its manoeuvrability when capturing prey and affect its ability to avoid permanent structures such as wind turbines. The latter is relevant when a peregrines attention is focussed exclusively on the identified prey while in pursuit (White *et al* 2002). Raptors are very successful in avoiding turbines when they are flying and soaring, but not hunting (Ratcliff in Ince and Associates 2010). Peregrines are opportunists and can switch to hunting mode in an instant if they observe prey they are interested in. Young falcons are particularly susceptible when they practice diving for a kill at high speeds.
- There have been no known deaths of the Peregrine Falcon at three operational wind farms operated by Pacific Hydro (K. Derriman pers.comm.2012). Raptor mortality has been consistently lower in Europe compared with the United States, which has been linked to the use of lattice towers in the United States versus conical steel towers in Europe (USFWS 2003).



Although many articles and reports identify the potential for wind energy facilities to increase Peregrine Falcon mortality, Kingsley and Whittam reported in 2001 that “there is only one previous record of a turbine kill, in the Orkney Islands (Meek *et al.* 1993).” Only one other reference to another Peregrine Falcon mortality was made by Ince and Associates (2010). A report issued by the New Jersey Department of Environmental Protection in 2009, reported a death discovered during the first year of post-construction monitoring at a five-turbine project near Atlantic City (Mizrahi *et al.* 2008).

Based on the factors above, the likelihood of collision causing mortality is unlikely, the consequence at a species/population level is minor and the overall level of risk is low. See Tables 3, 4 and 24 for definitions.

#### **Other birds at risk**

A total of 27 Elegant Parrot observations were recorded within the project site, with small flocks observed within scattered Eucalypts. This species was observed flying at at-risk height (Table 18) and has a state rare conservation rating. This suggests that localised populations of this species may be fragmented within South Australia, given that Elegant Parrots are not as widely distributed as they used to be. The proposed wind farm will not impact on the preferred habitat of this species. Based on these factors, the likelihood of collision causing mortality is rare, the consequence at a species/population level is minor and the overall risk is low.

The Australian Magpie was the most common species observed on site and was recorded flying at at-risk height on site (Table 18). Given these two factors, the likelihood of collision causing mortality is likely with the viability of the local population of this species not impacted. The overall level of risk was low (Table 24).

Table 24. Risk assessment matrix of the proposed Keyneton Wind Farm on birds.

Species name	Common name	Aus status	SA status	Likelihood of utilising project site	Likelihood of an event causing mortality	Consequence at a species / population level	Level of risk
<b>At-risk species (winter 2009)</b>							
<i>Aquila audax</i>	Wedge-tailed Eagle			Known	Unlikely	Nil/Insignificant	Low
<i>Sturnus vulgaris</i>	Common Starling			Known	Rarely	Nil/Insignificant	Low
<i>Corvus mellori</i>	Little Raven			Known	Rarely	Nil/Insignificant	Low
<i>Hirundo neoxena</i>	Welcome Swallow			Known	Rarely	Nil/Insignificant	Low
<b>At-risk species (spring 2009)</b>							
<i>Aquila audax</i>	Wedge-tailed Eagle			Known	Unlikely	Nil/Insignificant	Low
<i>Corvus mellori</i>	Little Raven			Known	Rarely	Nil/Insignificant	Low
<i>Falco berigora</i>	Brown Falcon			Known	Unlikely	Nil/Insignificant	Low
<i>Falco cenchroides</i>	Nankeen Kestrel			Known	Unlikely	Nil/Insignificant	Low
<i>Falco peregrinus</i>	Peregrine Falcon		R	Known	Unlikely	Minor	Low
<i>Gymnorhina tibicen</i>	Australian Magpie			Known	Likely	Nil/Insignificant	Low
<i>Neophema elegans</i>	Elegant Parrot		R	Known	Rarely	Minor	Low
<i>Petrochelidon nigricans</i>	Tree Martin			Known	Rarely	Nil/Insignificant	Low
<i>Platycercus elegans flaveolus</i>	Adelaide Rosella			Known	Rarely	Nil/Insignificant	Low
<b>Other species</b>							
<i>Corcorax melanorhamphos</i>	White-winged Chough		R	Known	Rarely	Nil/Insignificant	Low
<i>Microeca fascians fascians</i>	Jacky Winter		R	Known	Rarely	Nil/Insignificant	Low
<b>BDBSA determined as 'Likely to occur on site'</b>							
<i>Melanodryas cucullata cucullata</i>	Hooded Robin		R	Likely	Rarely	Nil/Insignificant	Low
<i>Northiella haematogaster</i>	Blue Bonnet		R	Likely	Rarely	Nil/Insignificant	Low
<i>Petroica boodang boodang</i>	Scarlet Robin		R	Likely	Rarely	Nil/Insignificant	Low
<i>Petroica phoenicea</i>	Flame Robin		V	Likely	Rarely	Nil/Insignificant	Low
<i>Stagonopleura guttata</i>	Diamond Firetail		V	Likely	Rarely	Nil/Insignificant	Low

Species name	Common name	Aus status	SA status	Likelihood of utilising project site	Likelihood of an event causing mortality	Consequence at a species / population level	Level of risk
<i>Strepera versicolor melanoptera</i>	Grey Currawong		U	Likely	Rarely	Nil/Insignificant	Low

Conservation Ratings: EN, E = endangered; VU, V = vulnerable; R = rare,

Likelihood definitions (how likely is mortality from collision to occur):

Chronic – the event is expected to occur in most circumstance

Frequent - the event probably will occur in most circumstances

Likely - the event should occur at some time

Unlikely – the event could occur at some time

Rarely – the event may occur only in exceptional circumstances

Consequence definitions (significance of associated impact on species viability)

Catastrophic disaster – the event has the potential to lead to collapse of species

Major– critical event, very likely to have significant impact on species

Moderate– likely to have impact on population, potential to impact on long term viability under some scenarios

Minor – the event may impact on local population, no impact on species

Nil/Insignificant - individuals may be affected, but viability of local population not impacted.

## 6 BIRD IMPACT MITIGATION MEASURES

Taking into consideration the results of four survey periods, undertaken at the proposed Keyneton Wind Farm site, the following mitigation measures are recommended to avoid and reduce impacts on birds associated with the construction and operation of a wind farm.

### ➤ **Implement a 1000 m buffer around the Peregrine Falcon nesting site**

It is recommended that the Peregrine Falcon nesting site, in the north eastern corner of the project area, have a 1000 m buffer placed around the nest location on rocky cliff face. The benefit of a 1000 m nest buffer would be as follows:

- Buffers are generally focussed around areas of high activity, in this instance where the Peregrine Falcon is known to nest.
- During the construction of the proposed wind farm, Peregrine Falcons are more likely to be at risk of disturbance from activities conducted within close proximity to nest locations. By implementing a buffer distance of 1000 m, this would contribute to decreasing disturbance levels to this species.
- Peregrine Falcons are territorial and typically return to nest locations each year. By placing a buffer distance around the nest location, this would assist with lessening disturbance levels to this species.

*The recommended 1000 m Peregrine Falcon nest buffer has been included within Pacific Hydro's revised 42 turbine layout.*

### ➤ **Implement a 500 m buffer around known Wedge-tailed Eagle nests**

It is recommended that each of the nine nests, identified as being of eagle origin, have a 500 m buffer placed around the nest site (active and inactive). The benefit of a 500 m nest buffer would be as follows:

- Buffers are generally focussed around areas of high activity, in this instance where Wedge-tailed Eagles may potentially nest.
- During the construction of the proposed wind farm, eagles are likely to be at risk of disturbance from activities conducted near to nest locations. By implementing a buffer distance of 500 m, this would contribute to decreasing disturbance levels to this species.
- Wedge-tailed Eagles are territorial and typically return to nest year after year to the same nest location. By placing a buffer distance around the nest location, this would assist with lessening disturbance levels to this species.
- Juvenile eagles are particularly susceptible to collision risk as newly fledged chicks haven't learned how to forage on their own or avoid structures such as turbines. Placing a 500 m buffer around nest sites, will assist in decreasing the chance of a juvenile eagle colliding with a turbine.

*Pacific Hydro's revised 42 turbine layout has incorporated this 500 m Wedge-tailed Eagle nest buffer.*

➤ **Avoid scattered Blue Gum over exotic grassland and South Australian Blue Gum/Peppermint Box Open Woodland over exotic grassland**

Mature scattered Blue Gum and SA Blue Gum/Peppermint Box trees (trees most likely to have hollows) have been avoided as far as possible within the wind farm design. Existing tracks will be used where possible, rather than creating new tracks through exotic grassland. Impacts on bird species utilising woodland areas are likely to be negligible as their preferred habitat will not be removed.

➤ **Monitor the breeding activity at all known nest locations**

Where construction is planned between 500 and 1000 m of known eagle and falcon nests respectively during their breeding seasons, nest checks should be employed to determine their breeding status and if necessary buffers put in place. Where possible, it is recommended that construction within these distances be undertaken outside of the peak breeding times (egg-laying and chick fledging) for both the Peregrine Falcon and Wedge-tailed Eagle.

➤ **Eagle and falcon breeding surveys during and post construction**

Repeating breeding success surveys for the Wedge-tailed Eagle and Peregrine Falcons would provide a means of assessing actual disturbance effects on both species, which could be incorporated into future environmental risk assessments for wind farms.

➤ **Regular long-term bird-strike monitoring program**

Bird-strike monitoring is encouraged including conducting searches on a regular basis to identify bird mortalities as a result of the proposed wind farm. Bird-strike monitoring programs should be conducted by suitably trained, on-ground staff. A formal reporting procedure to an external environmental agency is also recommended to allow data collection to help inform the development of future mitigation measures at wind farm sites across South Australia / Australia.

➤ **Perform scavenger and detectability trials to correct bird-strike monitoring results**

It is recommended that scavenger and detectability trials are performed at the wind farm prior to the construction of turbines. These trials will measure the influence of scavenging activity and the detectability of bird carcasses at the Keyneton site. Results from bird-strike monitoring programs conducted during the operation of a wind farm are more accurate when the detectability of bird carcasses and the extent of scavenging activity at the site are determined pre-construction, and are factored into the bird-strike monitoring results.



## 7 CONCLUSION

A series of bird surveys were carried out between 2008 and 2010 across the extent of the proposed wind farm site. Following these, a risk assessment was carried out resulting in all 18 species at risk or priority bird species being deemed to be at low risk of impact from the proposed Keyneton Wind Farm. . Nevertheless, a number of bird impact mitigation measures have been recommended to further reduce risk. Nest buffers have been recommended and adopted for the state rare Peregrine Falcon and a priority species, the Wedge-tailed Eagle. Pacific Hydro has also embedded mitigation measures into the site design by reducing turbine numbers in order to avoid woodland areas and use existing tracks where possible. Provided that these mitigation measures are implemented, the resultant impacts are likely to be nil/insignificant for those species targeted within the risk assessment. In summary:

- Common bird species, the Common Starling, Little Raven and Welcome Swallow were recorded as performing at-risk movements during the winter 2009 surveys. The Little Raven, Brown Falcon, Nankeen Kestrel, Australian Magpie, Tree Martin and Adelaide Rosella, were recorded as performing at-risk movements during the spring 2009 survey. Flights that are performed above 40 metres over the top of the ridge are considered at-risk movements, as this air-space generally corresponds with the rotor-swept area of turbines.

The conservation significant Peregrine Falcon and Elegant Parrot and priority species, the Wedge-tailed Eagle, also performed at-risk movements. The Peregrine Falcon was recorded over three survey periods (winter 2009, spring 2009 and summer 2010) performing flights of between 20-200 m largely over the main ridgeline and over valleys. The Wedge-tailed Eagle was recorded during the same survey periods with flight height ranging from 2-800 m and mostly over ridge and valley aspects. The Elegant Parrot performed one movement of 100 m in height during the spring 2009 survey.

- From the risk assessment completed on those species that recorded at-risk flights or were identified as potentially occurring on site from the BDBSA search, the following level of impacts were concluded:
  - all species determined as at-risk species – low risk.
  - Other species (White-winged Chough and Jacky Winter) – low risk.
  - BDBSA determined as 'likely to occur on site' (Hooded Robin, Flame Robin, Scarlet Robin, Blue Bonnet, Diamond Firetail and Grey Currawong) – low risk.
- Of these species considered at-risk, the Peregrine Falcon and Elegant Parrot are listed under the NPW Act. The Wedge-tailed Eagle is not a listed species however it is iconic, readily identifiable to many people and thus is often attributed special value.

Breeding Peregrine Falcons may be disturbed by human activities taking place around their nest, which may include disturbance during the construction of the wind farm. It has been reported that mature Wedge-tailed Eagles can learn to avoid the vicinity of turbines over time however juvenile birds are more likely to be at risk of collision. There have been cases in South Australia and in Victoria mentioned within this report, that demonstrate that eagles can successfully breed close to turbines within operational wind farms.

- The following mitigation and monitoring measures have been recommended (and some already adopted) in order to reduce the potential for impacts on bird species:
  - Nest buffers for the Peregrine Falcon and Wedge-tailed Eagle (adopted within design)
  - Avoid scattered blue gum over exotic grassland habitats (adopted within design)
  - Monitor breeding activity at known nests e.g. Wedge-tailed Eagle and Peregrine Falcon breeding surveys during and post construction
  - Bird strike monitoring (recording actual impacts may assist to reduce risk in the future)
  - Scavenger and detectability surveys (to ensure accurate bird-strike monitoring).

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## 9 APPENDICES

Appendix 1. All species recorded during Point Counts (PC) and Opportunistically (OPP) when travelling around the site during the winter 2009 survey. Species in **red** were recorded OPP across the site, but not sighted during PC.

Species	Common species	Point count	Opportunistic
<i>Platycercus elegans flaveolus</i>	Adelaide Rosella	44	9
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe		6
<i>Gymnorhina tibicen</i>	Australian Magpie	643	117
<i>Chenonetta jubata</i>	Australian Wood Duck	22	44
<i>Vanellus tricolor</i>	Banded Lapwing		4
<i>Falco berigora</i>	Brown Falcon	2	
<i>Acanthiza pusilla</i>	Brown Thornbill		1
<i>Climacteris picumnus</i>	Brown Treecreeper	2	10
<i>Sturnus vulgaris</i>	Common Starling	163	
<i>Neophema elegans</i>	Elegant Parrot	1	26
<i>Dromaius novaehollandiae</i>	Emu	2	3
<i>Cacatua roseicapilla</i>	Galah	138	54
<i>Cracticus torquatus</i>	Grey Butcherbird		1
<i>Anas gracilis</i>	Grey Teal		21
<i>Microeca fascians</i>	Jacky Winter		1
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	1	6
<i>Cacatua sanguinea</i>	Little Corella	35	
<i>Corvus mellori</i>	Little Raven	128	
<i>Anas platyrhynchos</i>	Mallard	1	
<i>Falco cenchroides</i>	Nankeen Kestrel	2	
<i>Falco peregrinus</i>	Peregrine Falcon	2	2
<i>Psephotus haematonotus</i>	Red-rumped Parrot		4
<i>Anthus novaeseelandiae</i>	Richard's Pipit	27	
<i>Lichenostomus virescens</i>	Singing Honeyeater	3	
<i>Aphelocephala leucopsis leucopsis</i>	Southern Whiteface	5	15
<i>Pardalotus striatus</i>	Striated Pardalote	1	
<i>Malurus cyaneus</i>	Superb Fairy-wren	7	7
<i>Petrochelidon nigricans</i>	Tree Martin	7	8
<i>Aquila audax</i>	Wedge-tailed Eagle	18	2
<i>Hirundo neoxena</i>	Welcome Swallow	77	
<i>Egretta novaehollandiae</i>	White-faced Heron		2
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	14	6
<i>Rhipidura leucophrys</i>	Willie Wagtail	3	
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	12	12
<i>Manorina flavigula</i>	Yellow-throated Miner	2	7
<b>Total Number of Observations</b>		<b>1362</b>	<b>368</b>
<b>Species Diversity</b>		<b>27</b>	<b>24</b>

## Appendix 2. Inter-site comparisons of bird abundance and diversity – winter 2009 survey.

Scientific name	Common name	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	Total
<i>Platycercus elegans flaveolus</i>	Adelaide Rosella	12	24						1	2	5				44
<i>Gymnorhina tibicen</i>	Australian Magpie	24	34	47	67	59	14	225	50	18	5	64	4	32	643
<i>Chenonetta jubata</i>	Australian Wood Duck		15		7										22
<i>Falco berigora</i>	Brown Falcon					2									2
<i>Climacteris picumnus</i>	Brown Treecreeper	1	1												2
<i>Sturnus vulgaris</i>	Common Starling	22	10	115	14	2									163
<i>Neophema elegans</i>	Elegant Parrot	1													1
<i>Dromaius novaehollandiae</i>	Emu									2					2
<i>Cacatua roseicapilla</i>	Galah	24	17	24	31	15	6	7		2		2		10	138
<i>Dacelo novaeguineae</i>	Laughing Kookaburra							1							1
<i>Cacatua sanguinea</i>	Little Corella	2					29				4				35
<i>Corvus mellori</i>	Little Raven	16	4	4	28	28	17	6	2	6		3		14	128
<i>Anas platyrhynchos</i>	Mallard			1											1
<i>Falco cenchroides</i>	Nankeen Kestrel							1	1						2
<i>Falco peregrinus</i>	Peregrine Falcon								1		1				2
<i>Anthus novaeseelandiae</i>	Richard's Pipit			6	1	5	3			4		2	6		27
<i>Lichenostomus virescens</i>	Singing Honeyeater		3												3
<i>Aphelocephala leucopsis leucopsis</i>	Southern Whiteface		3											2	5
<i>Pardalotus striatus</i>	Striated Pardalote										1				1
<i>Malurus cyaneus</i>	Superb Fairy-wren	1	2								4				7
<i>Petrochelidon nigricans</i>	Tree Martin	4	2	1											7
<i>Aquila audax</i>	Wedge-tailed Eagle	1	2		1	5	6				1	2			18
<i>Hirundo neoxena</i>	Welcome Swallow	5	37	2	8					2	21		1	1	77
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	1	4		4						5				14

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Scientific name	Common name	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	Total
<i>Rhipidura leucophrys</i>	Willie Wagtail	2											1		3
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill		5			4					3				12
<i>Manorina flavigula</i>	Yellow-throated Miner		2												2
<b>Total Number of Observations</b>		116	165	200	161	120	75	240	55	36	50	73	12	59	1362
<b>Species Diversity (Number of species recorded)</b>		14	16	8	9	8	6	5	5	7	10	5	4	5	27



## Appendix 3. Inter-site comparisons of bird abundance and diversity – spring 2009 survey.

Scientific name	Common name	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	Total
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	4									2				6
<i>Alauda arvensis</i>	Eurasian Skylark						3					16	26		45
<i>Anthochaera carunculata</i>	Red Wattlebird		1					4							5
<i>Anthus novaeseelandiae</i>	Richard's Pipit											3	2		5
<i>Aphelocephala leucopsis leucopsis</i>	Southern Whiteface		2									8	6		16
<i>Aquila audax</i>	Wedge-tailed Eagle			2	2					1		3			8
<i>Cacatua roseicapilla</i>	Galah	6	5	15	21	26	94	58	44	15	18	73	1	6	382
<i>Cacatua sanguinea</i>	Little Corella	3	4												7
<i>Chenonetta jubata</i>	Australian Wood Duck				2										2
<i>Cincloramphus cruralis</i>	Brown Songlark											3			3
<i>Climacteris picumnus</i>	Brown Treecreeper		3												3
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	1													1
<i>Corvus mellori</i>	Little Raven	6	14	5	2	2	84	38	71	31	35	90	9	10	397
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	2													2
<i>Egretta novaehollandiae</i>	White-faced Herron													1	1
<i>Elanus axillaris</i>	Black-shouldered Kite							1							1
<i>Falco berigora</i>	Brown Falcon	2	1												3
<i>Falco cenchroides</i>	Nankeen Kestrel		2		2		2	1		2				2	11
<i>Falco peregrinus</i>	Peregrine Falcon	1													1
<i>Gymnorhina tibicen</i>	Australian Magpie	1	7	18	78	132	65	59	41	17	30	110	5	40	603
<i>Hirundo neoxena</i>	Welcome Swallow		3												3
<i>Lalage sueurii</i>	White-winged Triller			3											3
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	3	2												5

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Scientific name	Common name	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	Total
<i>Malurus cyaneus</i>	Superb Fairy-wren										2				2
<i>Neophema elegans</i>	Elegant Parrot													2	2
<i>Ocyphaps lophotes</i>	Crested Pigeon										2				2
<i>Pardalotus striatus</i>	Striated Pardalote	7	7								1				15
<i>Petrochelidon nigricans</i>	Tree Martin	14	5					3			28		2	2	54
<i>Platycercus elegans</i>	Crimson Rosella							1		1	7				9
<i>Platycercus elegans adalaidae</i>	Adelaide Rosella	13	2		2										17
<i>Psephotus haematonotus</i>	Red-rumped Parrot	4	6	2		7									19
<i>Rhipidura leucophrys</i>	Willie Wagtail		2												2
<i>Sturnus vulgaris</i>	Common Starling	22	1	2	4	2	4	7	5		2	3	3		55
<i>Vanellus tricolor</i>	Banded Lapwing												22		22
<b>Total Number of Observations</b>		<b>89</b>	<b>67</b>	<b>47</b>	<b>113</b>	<b>169</b>	<b>252</b>	<b>172</b>	<b>161</b>	<b>67</b>	<b>127</b>	<b>309</b>	<b>76</b>	<b>63</b>	<b>1712</b>
<b>Species Diversity (Number of species recorded)</b>		<b>15</b>	<b>17</b>	<b>7</b>	<b>8</b>	<b>5</b>	<b>6</b>	<b>9</b>	<b>4</b>	<b>6</b>	<b>10</b>	<b>9</b>	<b>9</b>	<b>7</b>	<b>34</b>

Appendix 4. Inter-site comparisons of bird abundance and diversity (Opportunistic surveys) – spring 2009 survey.

Scientific name	Common name	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	Total	% of total observations
<i>Cacatua roseicapilla</i>	Galah								6	9					15	15.2
<i>Corvus mellori</i>	Raven						31		1	4	10		4		50	50.5
<i>Falco cenchroides</i>	Kestrel											2			2	2
<i>Falco peregrinus</i>	Peregrine Falcon									1					2	1
<i>Gymnorhina tibicen</i>	Magpie									9	7		7		23	23.2
<i>Petrochelidon nigricans</i>	Tree Martin								8						8	8.2
<b>No. of Observations</b>							<b>31</b>		<b>15</b>	<b>23</b>	<b>17</b>	<b>2</b>	<b>11</b>		<b>99</b>	
<b>Species Diversity</b>							<b>1</b>		<b>3</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>2</b>		<b>6</b>	

**Appendix 5. Co-ordinates of all 11 nest sites, assessed as potential Wedge-tailed Eagle nests, located within the proposed Keyneton Wind Farm.**

Nest ID	Easting	Northing
Nest 1	333035	6177588
Nest 2	334039	6172996
Nest 3	333177	6177208
Nest 4	333839	6173584
Nest 5	331986	6174046
Nest 6	332874	6175225
Nest 7	332930	6179440
Nest 8	333561	6172846
Nest 9	333807	6172306
Nest 10	334303	6169443
Nest 11	332333	6176430
Nest 12	334790	6178157
Peregrine	335029	6178270

**Appendix 6. Bird species identified as occurring in the proposed Keyneton Wind Farm project area from the BDBSA search.**

Species	Class Name	Common Name	Conservation rating		Exotic
			AUS	SA	
<i>Cracticus tibicen</i>	aves	Australian Magpie			
<i>Rhipidura leucophrys</i>	aves	Willie Wagtail			
<i>Falco cenchroides</i>	aves	Nankeen Kestrel			
<i>Petrochelidon nigricans</i>	aves	Tree Martin			
<i>Anthochaera carunculata</i>	aves	Red Wattlebird			
<i>Manorina flavigula</i>	aves	Yellow-throated Miner			
<i>Cinchoramphus cruralis</i>	aves	Brown Songlark			
<i>Epthianura albifrons</i>	aves	White-fronted Chat			
<i>Falco berigora</i>	aves	Brown Falcon			
<i>Acanthiza chrysorrhoa</i>	aves	Yellow-rumped Thornbill			
<i>Petroica goodenovii</i>	aves	Red-capped Robin			
<i>Phaps chalcoptera</i>	aves	Common Bronzewing			
<i>Ocyphaps lophotes</i>	aves	Crested Pigeon			
<i>Lichenostomus virescens</i>	aves	Singing Honeyeater			
<i>Grallina cyanoleuca</i>	aves	Magpie-lark			
<i>Pomatostomus superciliosus</i>	aves	White-browed Babbler			
<i>Circus assimilis</i>	aves	Spotted Harrier			
<i>Nymphicus hollandicus</i>	aves	Cockatiel			
<i>Eolophus roseicapillus</i>	aves	Galah			
<i>Chalcites basalis</i>	aves	Horsfield's Bronze-cuckoo			
<i>Coturnix pectoralis</i>	aves	Stubble Quail			
<i>Colluricincla harmonica</i>	aves	Grey Shrike-thrush			
<i>Falcunculus frontatus</i>	aves	Crested Shrike-tit		R	
<i>Psephotus haematotus</i>	aves	Red-rumped Parrot			
<i>Stagonopleura guttata</i>	aves	Diamond Firetail		V	
<i>Cacatua sanguinea</i>	aves	Little Corella			
<i>Malurus lamberti</i>	aves	Variegated Fairy-wren			
<i>Pardalotus punctatus</i>	aves	Spotted Pardalote			
<i>Smicromis brevirostris</i>	aves	Weebill			
<i>Corvus mellori</i>	aves	Little Raven			
<i>Cracticus torquatus</i>	aves	Grey Butcherbird			
<i>Meliphaga brevirostris</i>	aves	Brown-headed Honeyeater			
<i>Cacatua galerita</i>	aves	Sulphur-crested Cockatoo			
<i>Barnardius zonarius</i>	aves	Australian Ringneck			
<i>Lichenostomus penicillatus</i>	aves	White-plumed Honeyeater			
<i>Merops ornatus</i>	aves	Rainbow Bee-eater			
<i>Geopelia placida</i>	aves	Peaceful Dove			
<i>Aegotheles cristatus</i>	aves	Australian Owlet-nightjar			
<i>Tribonyx ventralis</i>	aves	Black-tailed Native-hen			
<i>Manorina melanocephala</i>	aves	Noisy Miner			
<i>Dicaeum hirundinaceum</i>	aves	Mistletoebird			
<i>Dacelo novaeguineae</i>	aves	Laughing Kookaburra			
<i>Threskiornis spinicollis</i>	aves	Straw-necked Ibis			
<i>Elanus axillaris</i>	aves	Black-shouldered Kite			
<i>Platycercus elegans</i>	aves	Crimson Rosella			
<i>Melopsittacus undulatus</i>	aves	Budgerigar			
<i>Hieraaetus morphnoides</i>	aves	Little Eagle			
<i>Vanellus miles</i>	aves	Masked Lapwing			



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Species	Class Name	Common Name	Conservation rating		Exotic
			AUS	SA	
<i>Anas superciliosa</i>	aves	Pacific Black Duck			
<i>Rhipidura albiscapa</i>	aves	Grey Fantail			
<i>Chenonetta jubata</i>	aves	Australian Wood Duck			
<i>Falco peregrinus</i>	aves	Peregrine Falcon		R	
<i>Corcorax melanorhamphos</i>	aves	White-winged Chough		R	
<i>Acrocephalus australis</i>	aves	Australian Reed-Warbler			
<i>Hirundo neoxena</i>	aves	Welcome Swallow			
<i>Aquila audax</i>	aves	Wedge-tailed Eagle			
<i>Pardalotus striatus</i>	aves	Striated Pardalote			
<i>Strepera versicolor melanoptera</i>	aves	Grey Currawong		U	
<i>Anas castanea</i>	aves	Chestnut Teal			
<i>Malurus cyaneus</i>	aves	Superb Fairy-wren			
<i>Petroica boodang</i>	aves	Scarlet Robin		R	
<i>Malacorhynchus membranaceus</i>	aves	Pink-eared Duck			
<i>Acanthiza nana</i>	aves	Yellow Thornbill			
<i>Phylidonyris pyrrhopterus</i>	aves	Crescent Honeyeater			
<i>Zosterops lateralis</i>	aves	Silvereye			
<i>Lichenostomus ornatus</i>	aves	Yellow-plumed Honeyeater			
<i>Daphoenositta chrysoptera</i>	aves	Varied Sittella			
<i>Egretta novaehollandiae</i>	aves	White-faced Heron			
<i>Phalacrocorax sulcirostris</i>	aves	Little Black Cormorant			
<i>Cincloramphus mathewsi</i>	aves	Rufous Songlark			
<i>Phylidonyris novaehollandiae</i>	aves	New Holland Honeyeater			
<i>Melanodryas cucullata cucullata</i>	aves	Hooded Robin		R	
<i>Anthus novaeseelandiae</i>	aves	Australasian Pipit			
<i>Acanthiza uropygialis</i>	aves	Chestnut-rumped Thornbill			
<i>Pachycephala rufiventris</i>	aves	Rufous Whistler			
<i>Acanthagenys rufogularis</i>	aves	Spiny-cheeked Honeyeater			
<i>Cacomantis flabelliformis</i>	aves	Fan-tailed Cuckoo			
<i>Coracina novaehollandiae</i>	aves	Black-faced Cuckoo-shrike			
<i>Haliastur sphenurus</i>	aves	Whistling Kite			
<i>Pelecanus conspicillatus</i>	aves	Australian Pelican			
<i>Fulica atra</i>	aves	Eurasian Coot			
<i>Porphyrio porphyrio</i>	aves	Purple Swamphen			
<i>Platalea flavipes</i>	aves	Yellow-billed Spoonbill			
<i>Climacteris picumnus</i>	aves	Brown Treecreeper			
<i>Cygnus atratus</i>	aves	Black Swan			
<i>Phalacrocorax varius</i>	aves	Pied Cormorant			
<i>Milvus migrans</i>	aves	Black Kite			
<i>Aphelocephala leucopsis</i>	aves	Southern Whiteface			
<i>Petroica phoenicea</i>	aves	Flame Robin		V	
<i>Anas gracilis</i>	aves	Grey Teal			
<i>Tachybaptus novaehollandiae</i>	aves	Australasian Grebe			
<i>Microcarbo melanoleucos</i>	aves	Little Pied Cormorant			
<i>Acanthiza pusilla</i>	aves	Brown Thornbill			
<i>Glossopsitta concinna</i>	aves	Musk Lorikeet			
<i>Glossopsitta porphyrocephala</i>	aves	Purple-crowned Lorikeet			
<i>Lichenostomus chrysops</i>	aves	Yellow-faced Honeyeater			
<i>Acanthiza lineata</i>	aves	Striated Thornbill			
<i>Zoothera lunulata</i>	aves	Bassian Thrush		R	

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Species	Class Name	Common Name	Conservation rating		Exotic
			AUS	SA	
<i>Glyciphila melanops</i>	aves	Tawny-crowned Honeyeater			
<i>Acanthorhynchus tenuirostris</i>	aves	Eastern Spinebill			
<i>Pachycephala pectoralis</i>	aves	Golden Whistler			
<i>Ardea intermedia</i>	aves	Intermediate Egret		R	
<i>Artamus superciliosus</i>	aves	White-browed Woodswallow			
<i>Mirafra javanica</i>	aves	Horsfield's Bushlark			
<i>Accipiter fasciatus</i>	aves	Brown Goshawk			
<i>Artamus cyanopterus</i>	aves	Dusky Woodswallow			
<i>Microeca fascinans fascinans</i>	aves	Jacky Winter		R	
<i>Corvus coronoides</i>	aves	Australian Raven			
<i>Struthidea cinerea</i>	aves	Apostlebird			
<i>Tyto javanica</i>	aves	Eastern Barn Owl			
<i>Vanellus tricolor</i>	aves	Banded Lapwing			
<i>Ninox novaeseelandiae</i>	aves	Southern Boobook			
<i>Podargus strigoides</i>	aves	Tawny Frogmouth			
<i>Myiagra inquieta</i>	aves	Restless Flycatcher		R	
<i>Himantopus himantopus</i>	aves	Black-winged Stilt			
<i>Dromaius novaehollandiae</i>	aves	Emu			
<i>Todiramphus pyrrhopygius</i>	aves	Red-backed Kingfisher			
<i>Cheramoeca leucosterna</i>	aves	White-backed Swallow			
<i>Eurostopodus argus</i>	aves	Spotted Nightjar			
<i>Phaps elegans</i>	aves	Brush Bronzewing			
<i>Cacatua tenuirostris</i>	aves	Long-billed Corella			
<i>Cacomantis pallidus</i>	aves	Pallid Cuckoo			
<i>Psephotus varius</i>	aves	Mulga Parrot			
<i>Falco longipennis</i>	aves	Australian Hobby			
<i>Lalage sueurii</i>	aves	White-winged Triller			
<i>Melithreptus lunatus</i>	aves	White-naped Honeyeater			
<i>Elseyornis melanops</i>	aves	Black-fronted Dotterel			
<i>Poliiocephalus poliocephalus</i>	aves	Hoary-headed Grebe			
<i>Sugomel niger</i>	aves	Black Honeyeater			
<i>Neochmia temporalis</i>	aves	Red-browed Finch			
<i>Cormobates leucophaea</i>	aves	White-throated Treecreeper			
<i>Platycercus elegans 'adelaidae' (NC)</i>	aves	'Adelaide Rosella'			
<i>Acanthiza reguloides</i>	aves	Buff-rumped Thornbill			
<i>Epthianura tricolor</i>	aves	Crimson Chat			
<i>Lophoictinia isura</i>	aves	Square-tailed Kite		E	
<i>Aythya australis</i>	aves	Hardhead			
<i>Malurus splendens</i>	aves	Splendid Fairy-wren			
<i>Pomatostomus ruficeps</i>	aves	Chestnut-crowned Babbler			
<i>Plectorhyncha lanceolata</i>	aves	Striped Honeyeater		R	
<i>Malurus leucopterus</i>	aves	White-winged Fairy-wren			
<i>Anthochaera chrysoptera</i>	aves	Little Wattlebird			
<i>Pachycephala inornata</i>	aves	Gilbert's Whistler		R	
<i>Lichenostomus leucotis</i>	aves	White-eared Honeyeater			
<i>Cinclosoma castanotum castanotum</i>	aves	Chestnut Quail-thrush		R	
<i>Todiramphus sanctus</i>	aves	Sacred Kingfisher			
<i>Gallinula tenebrosa</i>	aves	Dusky Moorhen			
<i>Turnix varius</i>	aves	Painted Button-quail		R	
<i>Megalurus grammurus</i>	aves	Little Grassbird			

# Proposed Keyneton Wind Farm: Avifauna and raptor nest assessment

Species	Class Name	Common Name	Conservation rating		Exotic
			AUS	SA	
<i>Hirundapus caudacutus</i>	aves	White-throated Needletail			
<i>Pumella albiglans</i>	aves	White-fronted Honeyeater			
<i>Trichoglossus haematodus</i>	aves	Rainbow Lorikeet			
<i>Erythronyx cinctus</i>	aves	Red-kneed Dotterel			
<i>Oxyura australis</i>	aves	Blue-billed Duck		R	
<i>Accipiter cirrocephalus</i>	aves	Collared Sparrowhawk			
<i>Artamus personatus</i>	aves	Masked Woodswallow			
<i>Northiella haematogaster</i>	aves	Blue Bonnet		R	
<i>Acanthiza apicalis</i>	aves	Inland Thornbill			
<i>Neophema elegans</i>	aves	Elegant Parrot		R	
<i>Meliphaga gularis gularis</i>	aves	Black-chinned Honeyeater		V	
<i>Circus approximans</i>	aves	Swamp Harrier			
<i>Podiceps cristatus</i>	aves	Great Crested Grebe		R	
<i>Biziura lobata</i>	aves	Musk Duck		R	
<i>Corvus sp.</i>	aves				
<i>Taeniopygia guttata</i>	aves	Zebra Finch			
<i>Eurystomus orientalis</i>	aves	Dollarbird			
<i>Phalacrocorax carbo</i>	aves	Great Cormorant			
<i>Pyrholaemus brunneus</i>	aves	Redthroat			
<i>Oreocitta gutturalis</i>	aves	Crested Bellbird			
<i>Turnix velox</i>	aves	Little Button-quail			
<i>Threskiornis molucca</i>	aves	Australian White Ibis			
<i>Petrochelidon ariel</i>	aves	Fairy Martin			
<i>Artamus cinereus</i>	aves	Black-faced Woodswallow			
<i>Nycticorax caledonicus</i>	aves	Nankeen Night-Heron			
<i>Coracina maxima</i>	aves	Ground Cuckoo-shrike			
<i>Alauda arvensis</i>	aves	Eurasian Skylark			*
<i>Columba livia</i>	aves	Rock Dove			*
<i>Sturnus vulgaris</i>	aves	Common Starling			*
<i>Passer domesticus</i>	aves	House Sparrow			*
<i>Carduelis carduelis</i>	aves	European Goldfinch			*
<i>Turdus merula</i>	aves	Common Blackbird			*

## KEY

### Regions:

AUS = Australia

SA = South Australia

### Conservation Status Codes:

X = Extinct/Presumed extinct: not located despite thorough searching of all known and likely habitats; known to have been eliminated by the loss of localised population(s); or not recorded for more than 50 years from an area where substantial habitat modification has occurred.

EN or E = Endangered: Rare and in danger of becoming extinct in the wild.

T = Threatened: likely to be either Endangered or Vulnerable but insufficient data for a more precise assessment.

VU or V = Vulnerable: Rare and at risk from potential threats or long term threats which could cause the species to become endangered in the future.

K = Uncertain: likely to be either Threatened or Rare but insufficient data for a more precise assessment.

R = Rare: has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant threats, but warrants monitoring and protective measures to prevent reduction of population sizes.

U = uncommon: less common species of interest but not Rare enough to warrant special protective measures



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