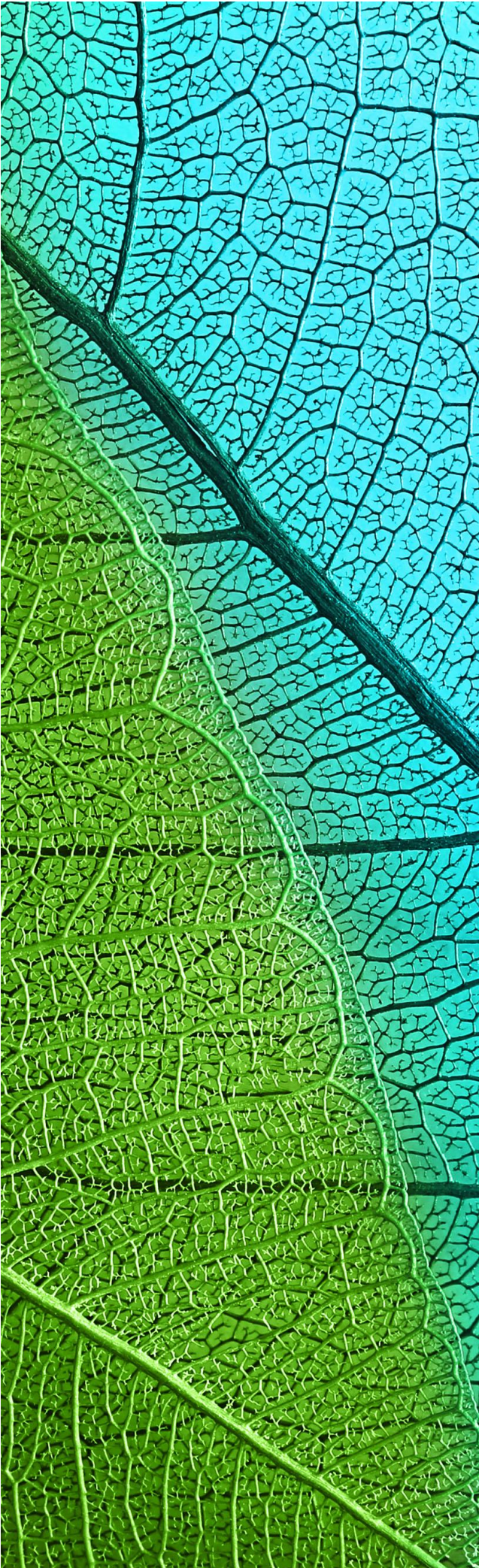




Dulacca Renewable Energy Project

Bird and Bat Management Plan

**Prepared for
Dulacca Energy Project Co Pty Ltd as
trustee for the Dulacca Energy
Project Trust**

July 2021
Report No. 19103 (2.14)



**Nature
Advisory**

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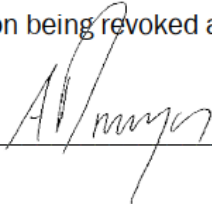
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Declaration of Accuracy

In making this declaration, I am aware that section 491 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the *Environment Protection and Biodiversity Conservation regulations 2000* (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed: _____



Full Name: Annette Deveson

Organisation and Position: Director – Dulacca Energy Project Co Pty Ltd as a trustee for the Dulacca Energy Project Trust

Date: 27/07/2021

1. Introduction

1.1. Background

Nature Advisory Pty Ltd was commissioned by AECOM Australia Pty Ltd (AECOM) on behalf of RES Australia Pty Ltd (RES) to develop a Bird and Bat Management Plan (BBMP), to guide the development and operations of the Dulacca Renewable Energy Project (DREP). DREP is located seven kilometres east of the township of Dulacca within the Brigalow Belt bioregion of Queensland (Figure 1 and Figure 2).

State Development Approval was granted to RES Australia Pty Ltd by the Queensland Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) on 8th March 2019 (Ref. SDA-1812-8802) for a wind farm with up to 56 turbines at this location, an energy storage facility, supporting ancillary facilities, and native vegetation clearing. In the detailed design process DREP has been optimised by RES to a 43-turbine layout. The State Development Approval was granted subject to conditions. An updated approval for the Project was granted on the 14th July 2021 (Ref: 2106-23116 SPD).

The Project was approved by the Department of Agriculture, Water and the Environment (DAWE) under sections 130(1) and 133(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), on 21 August 2020 (Ref. EPBC 2018/8368) (the EPBC Act Approval). The EPBC Act Approval approved the taking of the action for the purpose of each relevant controlling provisions of the EPBC Act, as follows:

- Listed threatened species and communities (sections 18 and 18A)
- Listed migratory species (sections 20 and 20A).

The EPBC Act Approval includes conditions specific to the action and standard administrative conditions. This BBMP reflects the relevant conditions of the State Development Approval and EPBC Act Approval, as further described in Sections 1.2-1.4.

The Approval Holder for DREP is Dulacca Energy Project Co Pty Ltd as trustee for the Dulacca Energy Project Trust. This entity replaced RES Australia Pty Ltd as the Approval Holder during Q2 2021.

This BBMP was prepared by a team of suitably qualified ecologists from Nature Advisory Pty Ltd (formerly Brett Lane & Associates Pty Ltd) including; Eamon O'Meara (Zoologist), Tom Cotter (Zoologist), Curtis Doughty (Senior Zoologist), Bernard O'Callaghan (Senior Ecologist and Project Manager) and Brett Lane (Principal Consultant). CV's for the persons involved in the development of this BBMP have been provided under separate cover to DAWE.

This BBMP focusses wholly on monitoring and mitigating the impacts on birds and bats from the wind turbine component of the DREP, primarily as a result of collision.

This BBMP has benefited from regular review and feedback from the Queensland Department of Environment and Science (DES) and the Commonwealth Department of Agriculture, Water and Environment (DAWE). Specifically, comments were received and changes accepted by DES in November and December 2019. Two sets of comments were additionally received on the BBMP from DAWE in February and May 2020 (respectively), and on birds and bats more generally as part of the 'controlled action' notice for the approval under the EPBC Act. The May 2020 version of the BBMP was approved by DAWE in August 2020. The approved BBMP, inclusive of the final conditions of the EPBC Act Approval, was submitted to DAWE in April 2021 for an updated approval. This current version of the BBMP responds to an additional set of DAWE comments received in May and July 2021.

1.2. Requirements of this Bird and Bat Management Plan (BBMP)

The DREP has received State Development Approval by DSDMIP and condition 9 relevant to the preparation of this BBMP is outlined below:

Condition 9 (a): Prepare a Bird and Bat Management Plan (BBMP) certified by a suitably qualified ecologist. The BBMP must include:

- i. Identification of 'at risk' bird and bat groups (i.e. all threatened and common species), seasons, and areas within DREP site which may attract high levels of mortality
- ii. Incorporate baseline data, including additional pre-operational surveys
- iii. The identification of threshold (trigger) levels for species
- iv. Identification of mitigation measures and implementation strategies in order to reduce impacts on bird and bat groups
- v. Monitoring requirements
- vi. A decision-making framework, including the trigger for operational shut-down

9(b) Submit the BBMP to Department of State Development, Manufacturing, Infrastructure and Planning (windfarms@dsdmip.q1d.gov.au).

9(c) Operate the development in accordance with the BBMP

The DREP has received EPBC Act Approval from DAWE. Conditions 6–14 of the EPBC Act Approval relevant to the preparation of this BBMP are outlined below. Note: the bold text reflects words with prescribed meanings within Part C of the EPBC Act Approval:

6. To minimise risk of injury or mortality of **EPBC Act listed threatened species** and **EPBC Act listed migratory species** as a result of turbine strike within the **study area**, the approval holder must implement the **Bird and Bat Management Plan (BBMP)** for the duration of this approval. In particular, the approval holder must engage a **suitably qualified ecologist** to undertake:
 - a. bird and bat utilisation surveys over a period of at least 24 months (or another timeframe agreed to in writing by the **Department**) prior to the **first full operation**, including at least two surveys undertaken at or adjacent to survey points and reference sites (as identified in the **BBMP**) over at least one wet season and one dry season in succession;
 - b. bird and bat utilisation surveys over a period of at least 24 months commencing within 3 months after **first full operation**, including at least one survey undertaken at or adjacent to survey points and reference sites (as identified in the **BBMP**) over at least two wet seasons and two dry seasons in succession; and
 - c. **turbine strike monitoring** in accordance with the **BBMP** at monitoring sites identified in the **BBMP**, and at all high-risk turbines identified as required under condition 9, for a minimum of 24 contiguous months within 30 months after **first full operation**.
7. The approval holder must conduct at least one survey for the presence of **White-throated Needletail** and **Fork-tailed Swift** and in respect of each species, in each 12-month period of bird and bat utilisation surveys (as required under condition 6) during the **migratory periods** of the **White-throated Needletail** and **Fork-tailed Swift**.
8. The approval holder must report on the results of the bird and bat utilisation surveys required under condition 6 in each annual **compliance report** required under condition 27 until all bird and bat utilisation surveys have been completed and so reported.
9. To inform **turbine strike monitoring**, the approval holder must engage a **suitably qualified ecologist** to:

- a. assign a **risk profile** to each turbine within the **study area** prior to **first full operation** using the results of the bird and bat utilisation surveys required under condition 6(a); and
 - b. re-assign a turbine to be a **high-risk turbine** within five **business days** if, during the bird and bat utilisation surveys required under condition 6(a), or any other monitoring or incidental observation during **operation**, one or more individual/s of an **EPBC Act listed threatened species** or **EPBC Act listed migratory species** is detected within the **vicinity** of that turbine.
10. Upon completion of the bird and bat utilisation surveys required under condition 6, the approval holder must engage a **suitably qualified ecologist** to revise the **BBMP** to include the following:
 - a. the results of the bird and bat utilisation surveys required under condition 6;
 - b. the **risk profile** of each turbine within the **study area**; and
 - c. any additional or improved **mitigation measures** (including timing, frequency and longevity) that will be implemented to ensure that **impacts** on **EPBC Act listed threatened species** and **EPBC Act listed migratory species** are minimised.

The revision of the **BBMP** must be completed within 3 months of the completion of the bird and bat utilisation surveys required under condition 6.
11. The approval holder must implement the revised **BBMP** revised in accordance with condition 10 from the date that the revised **BBMP** is published on the website. If subsequently the revised **BBMP** is revised under s143 of the **EPBC Act**, the approval holder must implement the revised **BBMP** revised under s143 of the **EPBC Act** from the date the revised **BBMP** is approved by the **Minister**.
12. If an **impact trigger** is reached or exceeded, the approval holder must provide a report to the **Minister** on the steps taken and outcomes of implementing the relevant commitments in the **adaptive management framework** in the first annual **compliance report** required under condition 27 that follows each instance of reaching or exceedance of an **impact trigger** and/or the implementation of **mitigation measures**. Each such report must include details of the **mitigation measures** that have been or will be implemented and an assessment of their likely effectiveness.
13. If the **Minister** writes to the approval holder stating that he/she considers that the **mitigation measures** will not prevent further reaching or exceedance of an **impact trigger**, then the approval holder must **curtail** the operation of any wind turbine that presents an ongoing risk of reaching or exceeding an **impact trigger** within an identified **period of risk** to the **impacted EPBC Act threatened listed species** or **EPBC Act listed migratory species** until such time as alternate mitigation measures can be identified to support the ongoing operation of the turbine. Where **mitigation measures** cannot be identified, the approval holder must engage a **suitably qualified person** to develop a species-specific **curtailment** protocol for the turbine to allow the turbine to be operated for periods outside of identified **period of risk** to the **impacted species**.
14. Any requests to the **Minister** by the approval holder to cease or reduce a **curtailment** required under condition 13 must include an **evidence-based** assessment by a **suitably qualified ecologist** demonstrating how the ceasing or reducing of the **curtailment** will not reasonably be expected to result in any subsequent reaching or exceedance of an **impact trigger**.

This BBMP incorporates a process and trigger levels (including justification) for assessing if a significant impact has occurred to state listed or EPBC Act listed threatened bird and bat species.

1.3. Compliance

The table below (Table 1) summarises where this BBMP addresses the requirements of the State Development Approval and EPBC Act Approval.

Table 1: Sections within the BBMP that respond to the State Development Approval and EPBC Act Approval

Condition number	Permit condition requirements	BBMP Plan Sections
Queensland Planning Act approval conditions		
9(a)	Prepare a Bird and Bat Management Plan (BBMP) certified by a suitably qualified ecologist. The BBMP must include:	As below
(i)	Identification of at risk' bird and bat groups (i.e. all threatened and common species), seasons, and areas within DREP site which may attract high levels of mortality	3.1
(ii)	incorporate baseline data, including additional pre-operational surveys;	2
(iii)	the identification of threshold (trigger) levels for species	5.1.1 and 5.1.2
(iv)	identification of mitigation measures and implementation strategies in order to reduce impacts on bird and bat groups	4 and 5.3
(v)	monitoring requirements	3.1 and 3.2
(vi)	a decision-making framework, including the trigger for operational shut-down	5
9(b)	Submit the BBMP to Department of State Development, Manufacturing, Infrastructure and Planning (windfarms@dsdmip.qld.gov.au).	Process to occur in accordance with the cited requirement
9(c)	Operate the development in accordance with the BBMP	Process to occur in accordance with the cited requirement
Commonwealth EPBC Act approval conditions		
6.	To minimise risk of injury or mortality of EPBC Act listed threatened species and EPBC Act listed migratory species as a result of turbine strike within the study area , the approval holder must implement the Bird and Bat Management Plan (BBMP) for the duration of this approval. In particular, the approval holder must engage a suitably qualified ecologist to undertake:	As below
a.	bird and bat utilisation surveys over a period of at least 24 months (or another timeframe agreed to in writing by the Department) prior to the first full operation , including at least two surveys undertaken at or adjacent to survey points and reference sites (as identified in the BBMP) over at least one wet season and one dry season in succession;	2.1
b.	bird and bat utilisation surveys over a period of at least 24 months commencing within 3 months after first full operation , including at least one survey undertaken at or adjacent to survey points and reference sites (as identified in the BBMP) over at least two wet seasons and two dry seasons in succession; and	3.1
c.	turbine strike monitoring in accordance with the BBMP at monitoring sites identified in the BBMP , and at all high-risk turbines identified as required under condition 9, for a minimum of 24 contiguous months within 30 months after first full operation .	3.2
7.	The approval holder must conduct at least one survey for the presence of White-throated Needletail and Fork-tailed Swift and in respect of	3.1

	each species, in each 12 -month period of bird and bat utilisation surveys (as required under condition 6) during the migratory periods of the White-throated Needletail and Fork-tailed Swift .	
8.	The approval holder must report on the results of the bird and bat utilisation surveys required under condition 6 in each annual compliance report required under condition 27 until all bird and bat utilisation surveys have been completed and so reported.	3.5
9.	To inform turbine strike monitoring , the approval holder must engage a suitably qualified ecologist to:	As below
a.	assign a risk profile to each turbine within the study area prior to first full operation using the results of the bird and bat utilisation surveys required under condition 6(a); and	2.1 & 2.2.4
b.	re-assign a turbine to be a high-risk turbine within five business days if, during the bird and bat utilisation surveys required under condition 6(a), or any other monitoring or incidental observation during operation , one or more individual/s of an EPBC Act listed threatened species or EPBC Act listed migratory species is detected within the vicinity of that turbine.	3.1
10.	Upon completion of the bird and bat utilisation surveys required under condition 6, the approval holder must engage a suitably qualified ecologist to revise the BBMP to include the following:	As below
a.	the results of the bird and bat utilisation surveys required under condition 6;	2.2.2 & 2.2.3
b.	the risk profile of each turbine within the study area ; and	2.2.4
c.	any additional or improved mitigation measures (including timing, frequency and longevity) that will be implemented to ensure that impacts on EPBC Act listed threatened species and EPBC Act listed migratory species are minimised.	5.1 & 5.3
	The revision of the BBMP must be completed within 3 months of the completion of the bird and bat utilisation surveys required under condition 6.	1.6 & 3.1.1
11.	The approval holder must implement the revised BBMP revised in accordance with condition 10 from the date that the revised BBMP is published on the website. If subsequently the revised BBMP is revised under s143 of the EPBC Act , the approval holder must implement the revised BBMP revised under s143 of the EPBC Act from the date the revised BBMP is approved by the Minister .	1.6 & 3.1.1
12.	If an impact trigger is reached or exceeded, the approval holder must provide a report to the Minister on the steps taken and outcomes of implementing the relevant commitments in the adaptive management framework in the first annual compliance report required under condition 27 that follows each instance of reaching or exceedance of an impact trigger and/or the implementation of mitigation measures . Each such report must include details of the mitigation measures that have been or will be implemented and an assessment of their likely effectiveness.	5.1.2
13.	If the Minister writes to the approval holder stating that he/she considers that the mitigation measures will not prevent further reaching or exceedance of an impact trigger , then the approval holder must curtail the operation of any wind turbine that presents an ongoing risk of reaching or exceeding an impact trigger within an identified period of risk to the impacted EPBC Act threatened listed	5.1.2

	species or EPBC Act listed migratory species until such time as alternate mitigation measures can be identified to support the ongoing operation of the turbine. Where mitigation measures cannot be identified, the approval holder must engage a suitably qualified person to develop a species-specific curtailment protocol for the turbine to allow the turbine to be operated for periods outside of identified period of risk to the impacted species.	
14.	Any requests to the Minister by the approval holder to cease or reduce a curtailment required under condition 13 must include an evidence-based assessment by a suitably qualified ecologist demonstrating how the ceasing or reducing of the curtailment will not reasonably be expected to result in any subsequent reaching or exceedance of an impact trigger .	5.1.2

1.4. BBMP objectives

Beyond meeting the requirement under the State Development Approval and EPBC Act Approval, the overall aim of this BBMP is to:

- Monitor the wind farm's impacts on bird and bat species,
- Identify if significant impacts are happening to species of concern; and
- Outline a strategy for managing and mitigating any significant impacts on species of concern during the operation of DREP.

This BBMP will be fully implemented from the first full operation of the wind farm, with incidental mortality monitoring to occur during the commissioning period (see Section 3.2.5). For the purposes of this BBMP, 'first full operation' is as defined in Part C of the EPBC Act Approval.

The key environmental objective for this plan will be to ensure no significant impact on White-throated Needletail (*Hirundapus caudactus*) or any other *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or *Nature Conservation Act 1992* listed bird or bat species. The monitoring program, implemented in accordance with this BBMP, will sample turbines and extrapolate an estimated number annual total number of White-throated Needletails affected from the number found at the DREP site. The impact assessments undertaken to date indicates that White-throated Needletail activity is low (none have been recorded during the 2018, 2020 and 2021 bird utilisation surveys). The statistical basis for the monitoring program described within this BBMP is provided in Appendix 1

The described aim and environmental objective of this BBMP will be achieved by establishing monitoring and management procedures consistent with the methods outlined by the Australian Wind Energy Association (AusWEA 2005) and endorsed in the Clean Energy Council's Best Practice Guidelines (CEC 2018). Queensland State Code 23 – Wind Farm Development (Department of Infrastructure, Local Government and Planning 2017), has also been considered in development of this BBMP.

Building on the described aim and environmental objective, the overall objectives of this BBMP, as derived from the State Development Approval and EPBC Act Approval, are set out below.

- To establish an adaptive management framework for managing and mitigating any significant impacts on birds and bats at the DREP, including those listed in the EPBC Act;
- To implement a monitoring program to estimate the impact of DREP on at-risk birds and/or bats, including those listed in the EPBC Act, that can reasonably be attributed to the operation of wind turbines at the DREP (Section 3);

- To record direct impacts on birds and bats through a statistically-designed program of carcass searches (Section 3.2 and Appendix 1);
- To document an agreed decision-making framework that identifies impact triggers requiring a management and response (Section 5.1 and 5.2);
- To detail potential mitigation measures and related implementation strategies to reduce impacts on birds and bats, and where required, ensure protection of EPBC Act listed threatened bird and bat species (Section 5.3); and
- To identify matters to be addressed in periodic reports on the outcomes of monitoring, the application of the decision-making framework, mitigation measures and performance criteria for their success (Section 5.4).

This BBMP adopts an adaptive management approach. An adaptive management approach, as opposed to a prescriptive and fixed approach, provides flexibility for the management measures set out in this BBMP to be amended to ensure effective mitigation is implemented in response to the findings of monitoring or as a result of an impact trigger being met. Any requirement to amend the management approach defined within this BBMP will be developed in consultation with the relevant regulators. Where the management approach needs to be amended, a suitably qualified ecologist will:

- design any amended monitoring or mitigation measures for consultation with the relevant regulators;
- train personnel supporting the implementation of the monitoring program to ensure any changes requires as part of the amended approach are adopted,
- analyse and interpret data resulting from the amended management approach to evaluate the effectiveness of the revised approach; and
- prepare reports to support the Approval Holder with its compliance reporting obligations under the EPBC Act Approval.

If a significant ongoing residual impact occurs to any EPBC Act listed species as a demonstrated result of the operation of the DREP, offsetting will be investigated and implemented in accordance with the EPBC Act Offsets Policy 2012. Any offset would be developed in consultation with, and approved by, DAWE.

1.5. Site Description

The DREP is located in the Brigalow Belt bioregion of Queensland and in the Western Downs Regional Council area (Figure 1), approximately seven kilometres east of the township of Dulacca. DREP has approval for up to 56 turbines, an energy storage facility, supporting ancillary facilities, and operational work for clearing native vegetation. The individual turbines are positioned across the site with elevations between 300 and 405 metres Australian Height Datum (AHD). In detailed design the Approval Holder, with support from RES, has optimised the wind farm layout from 56 to the 43 turbines identified within Appendix 1 of the EPBC Act Approval.

The majority of the DREP has been cleared for agricultural practices, specifically grazing and dryland cropping activities. Plains and lower slopes support remnant areas of original vegetation, such as *Acacia harpophylla* (Brigalow), *Casuarina cristata* (Belah) and/or *Eucalyptus populnea* (Poplar Box) communities, with semi-cleared hilltops and scarps containing communities with *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus fibrosa* (Dusky-leaved Ironbark) and *Acacia* spp (Sattler & Williams, 1999). DREP comprises primarily private farming properties used for grazing and some cropping. In areas of heavy grazing, native flora cover is minimal and dominated by introduced pasture. Remnant eucalyptus woodlands occurs within the north of the Study Area (Figure 1) predominantly along the ironstone jump-ups. The dominant canopy species there is Narrow-leaved Ironbark with small areas of Brigalow

dominated vegetation occurring along the Warrego Highway road reserve and along some property boundaries (AECOM 2019).

The bats and avifauna of the site are typical of this part of Queensland, with birds of open country, farmland and fragmented woodlands dominating. Some woodland remnants at the DREP site support a relatively intact tree canopy likely to provide foraging habitat for insectivorous bats.

Habitat quality for birds and bats is low in the largely cleared parts of the site, and moderate to high in the limited woodland areas of the site (Figure 2). Fauna habitats on the site are mapped in Appendix 3 of this BBMP. The fauna habitat mapping reflects the information provided in both the EPBC Act Referral and EPBC Act Preliminary Documentation (AECOM, 2019).

1.6. BBMP Review

In accordance with condition 10(a) of the EPBC Act Approval, a suitably qualified ecologist must be engaged to revise the BBMP at the conclusion of the bird and bat utilisation surveys required by condition 6(a) of the EPBC Act Approval.

At the conclusion of the pre-operational monitoring required under condition 6(a) of the EPBC Act Approval, recommended changes to the BBMP monitoring regime for the operational phase of the wind farm will be made and included in the revision of the BBMP. Specifically, the pre-operational monitoring results will be analysed and evaluated to identify whether White-throated Needletail activity during the pre-operational surveys warrants stratification of turbine selection to determine with greater accuracy the impact of the project on this species and, if relevant, any other detected listed bird or bat species. The results of these surveys will also inform the assignation of a risk profile to turbines as required by condition 9(a) and (b) of the EPBC Act Approval (section 2.2.4).

Further revisions of the BBMP are required:

- At the conclusion of the bird utilisation surveys required by condition 6(b) of the EPBC Act Approval; and
- At the conclusion of the turbine strike monitoring required by condition 6(c) of the EPBC Act Approval.

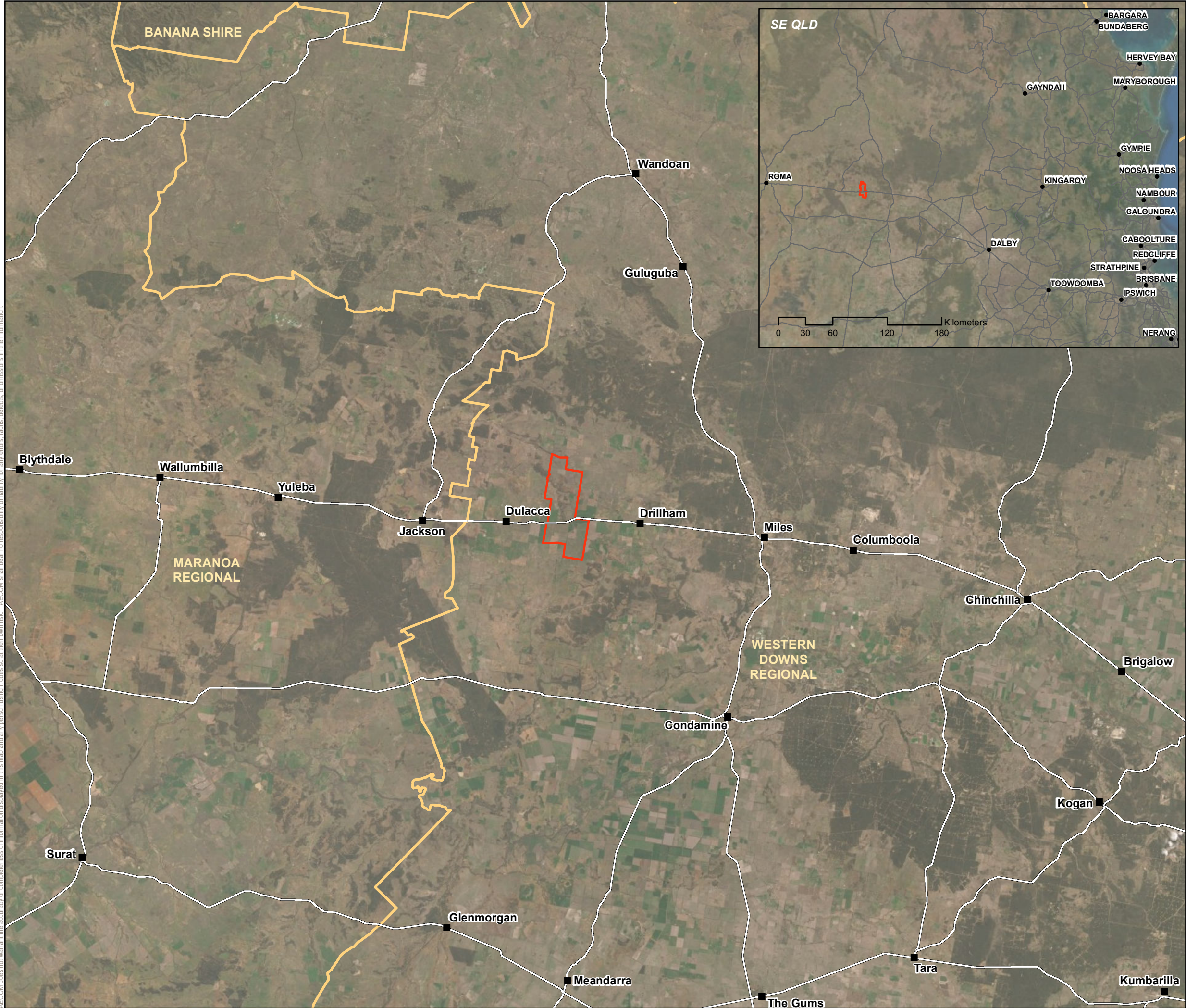
Where the timing of the monitoring under condition 6(b) and condition 6(c) of the EPBC Act Approval coincides, a single review of the BBMP encapsulating the results of both monitoring types (utilisation surveys and strike monitoring) will be made.

Revisions to the BBMP may also be required where an impact trigger is reached or exceeded and where, under the adaptive management framework, mitigation measures are required to be identified and implemented as prescribed in conditions 12 and 13 of the EPBC Act Approval. Revisions of the BBMP in this instance will be revisions made under section 143A of the *Environment Protection and Biodiversity Conservation Act 1999*.

As required by condition 10 of the EPBC Act Approval, the Approval Holder must complete the revision of the BBMP within 3 months of the completion of the respective bird utilisation surveys (pre and post operation). In accordance with condition 11 of the EPBC Act Approval, where the BBMP is updated in response to monitoring under condition 6 of the EPBC Act Approval, the Approval Holder must implement a BBMP from the date that the revised BBMP is published to the DREP website.

As set out in condition 11 of the EPBC Act Approval, if BBMP is revised under s143A of the EPBC Act, the Approval Holder must implement that revised BBMP from the date it is approved by the Minister.

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DATUM GDA 1994, PROJECTION MGA ZONE 55

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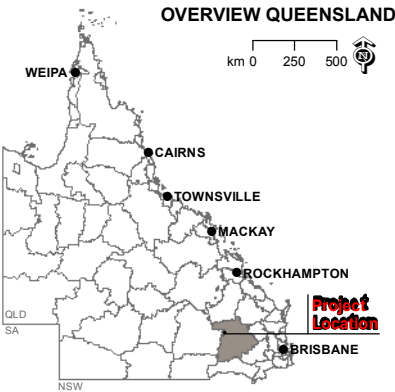
1 cm = 6,000 m (when printed @ A3)

Legend

Major Roads

Study Area (8,177 ha)

Local Government Area Boundary



- 1. Site layout elements © RES, 2019
- 2. Local Government Areas © State of Queensland (Department of Natural Resources and Mines) 2017
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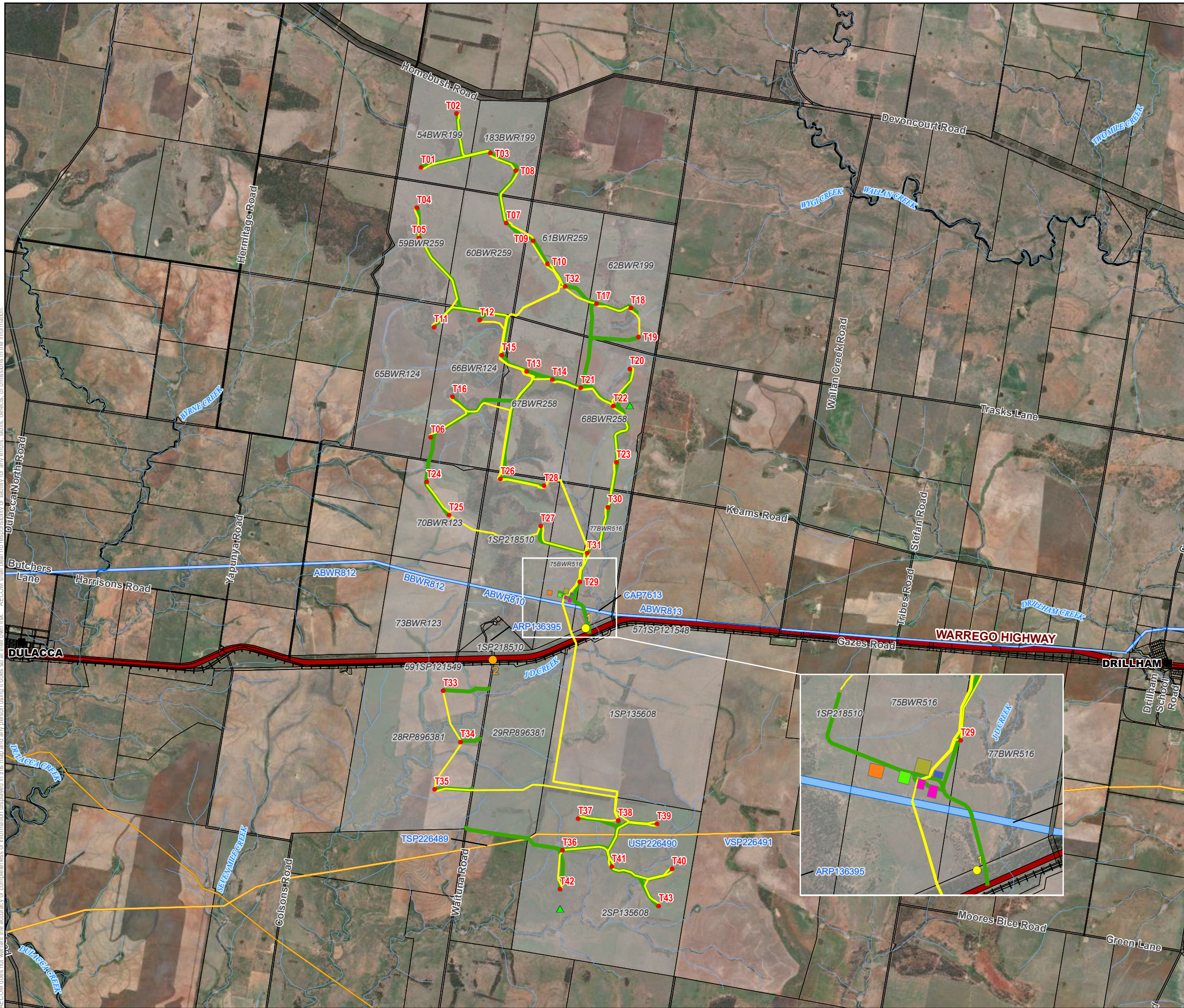
DULACCA RENEWABLE ENERGY PROJECT

STUDY AREA LOCAL AND REGIONAL CONTEXT

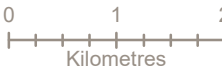
PROJECT #: 60567855
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Figure
1

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DATUM GDA 1994, PROJECTION MGA ZONE 55

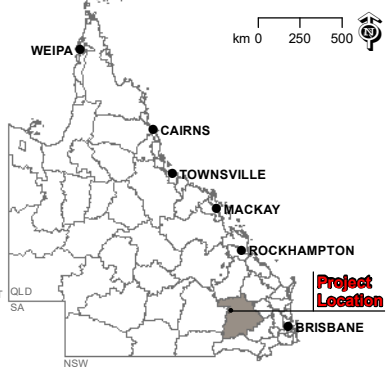


1 cm = 700 m (when printed @ A3)

Legend

- Study Area (8,177 ha)
- Highway
- Other Roads
- Existing 132kV Transmission Line and associated easement
- Petroleum Pipeline and associated easement
- Waterway
- Railway (Western System)
- Cadastral Boundary
- Proposed Infrastructure**
 - Site Access 1
 - Site Access 2
 - Turbines and Hardstand
 - Meteorology Mast
 - Underground or Overhead Cable/Transmission Line
 - Access Track
 - Battery Storage (Potential Stage 2)
 - Laydown
 - Operations and Maintenance
 - Site compound
 - Substation and Switchyard

OVERVIEW QUEENSLAND



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DULACCA RENEWABLE ENERGY PROJECT

PROJECT LOCATION AND LAYOUT

PROJECT #: 60567855
CREATED BY: AWS
LAST MODIFIED: 26/06/2020
VERSION: 1

Figure
2

2. Pre-operational bird and bat information

Several field assessments have been undertaken at the DREP, targeting birds and bats during flora and fauna investigations for the development application. These field assessments are outlined in detail in the Dulacca Renewable Energy Project - Fauna Technical Report (AECOM 2019) and are summarised below. These investigations provide valuable information and contribute to the baseline data at DREP site.

Pre-operational bird and bat monitoring recommenced at DREP in May 2020 and remain ongoing as part of the condition 6(a) requirements within the EPBC Act Approval.

2.1. Pre-operational survey methods

Prior to field surveys being conducted, a desktop assessment was undertaken to identify potential fauna species and habitat types that had the potential to occur in the study area. This information was used to prepare for the field survey component.

In the wet season of 2018, a flora and fauna survey of DREP site was undertaken over seven days, between 15th to 21st April 2018. These threatened flora, fauna, bird and bat surveys were undertaken by suitably qualified ecologists and in a manner consistent with the requirements of QLD State Code 23. The bird and bat related surveys consisted of the following:

- Bird Utilisation Surveys (BUS) using the fixed-point count method involving 15-minute observations at each of eight survey points on the DREP site and two reference sites at least 500 metres from turbine sites repeatedly at different times of the day recording the species, number of birds and height of the bird when first observed;
- Ultrasonic bat call detectors (Songmeter®) were placed at each of eight points throughout the DREP site representative of the broad habitat types (equivalent to 24 detector nights). Bat recorders were positioned at each of the fixed-point diurnal BUS locations, approximately 1.5 m above the ground, attached to a tree trunk with the microphone directed towards natural flyways;
- Incidental bird observations collected whilst traveling between fixed point survey locations and around the study area whilst completing other ecological surveys. Behavioural notes and height data were collected for birds exhibiting risk behaviour (e.g. raptors and waterbirds); and
- Spotlighting and call play-back was undertaken on three nights during the survey period. Meandering through representative habitat, targeting nocturnal, arboreal, and mega-bat species using the methodology consistent with industry standard guidelines (Eyre *et al.* 2018).
- Each turbine within the study area has been assigned a risk profile using the results of the pre-operation bird and bat utilisation surveys.

Detailed methods and results from earlier surveys can be found in the report provided to the Commonwealth for the EPBC Act approval process (see EPBC Act referral (2018/8368) Attachment C Fauna Technical Report_Final_27.11).

Pre-operational bird and bat utilisation surveys commenced in May 2020 and remain ongoing. In accordance with condition 6(a) of the EPBC Act Approval these surveys must be undertaken for at least 24 months (or another timeframe agreed to in writing by DAWE) prior to the first full operation of the project. In accordance with condition 6(a), at least two surveys are required to be undertaken at or

adjacent to survey points and reference sites identified within this BBMP over at least one wet season and one dry season in succession. The survey timeframe is adopted as follows:

- A Feb/March late wet season survey;
- A May/June and August/September survey (corresponding to the early and late dry season);
- A November/December early wet season survey; and
- Repeat surveys at these times until COD.

Some surveys will coincide with construction (civil works) of DREP as is supported by condition 6(a) of the EPBC Act Approval which links the monitoring obligation to the first full operation of the project. Surveys were commenced in May 2020 to minimise the potential for overlap with construction as far as practicable. Based on the current construction program (June 2021), monitoring will be completed prior to turbine erection activities (including the use of installation cranes) commencing.

This seasonal survey regime required by condition 6(a) of the EPBC Act Approval, recognises that at the latitude of Dulacca (26 deg 30 min South), the seasonal regime is more representative of two seasons (wet and hot, mild and dry) than the traditional four seasons at southern latitudes. Bird and bat seasonality, in particular breeding, is triggered at different times of year. For bats in tropical and sub-tropical locations, breeding occurs when food supplies are peaking (Churchill 1996), usually in the wet season. In birds, a similar phenomenon has been observed (Immelmann 1969). Therefore, as supported by condition 6 of the EPBC Act Approval, two surveys will be undertaken in each of the wet- and dry-seasons (4 surveys per year). This survey frequency captures the time when birds are territorial and spread out as well as the time of year they flock and are more or less abundant on the wind farm site. This also captures the periods when migratory bird and bat species are either present (wet season) or absent (dry season). As required by condition 7 of the EPBC Act Approval, monitoring includes surveys conducted during the migratory periods of the White-throated Needletail and Fork-tailed Swift.

The pre-operational bird and bat related surveys consist of the following:

- Seasonal bird site surveys (4 annually) involving:
 - Ten bird survey points (eight impact points and two reference points), established across the DREP site including (where relevant) stratification of points by habitat type;
 - 15-minute point based surveys counting and documenting the distance and flight height of each observed bird in accordance with a balanced sampling design involving two counts of each site and in each of the four periods of the day corresponding to different periods of bird activity (a total of eight surveys per site);
 - Compilation of bird species lists for the site from the formal counts and incidental observations, and mapping of the location (and behaviour) of any rare or threatened species.
- Seasonal bat surveys (2 annually) involving:
 - Six bat survey points (four impact points and two reference points) established across the DREP site including (where relevant) stratification of points by habitat type;
 - Deployment of Song Meters at the survey points for monitoring during the late wet season (Feb/March) and early wet season (November/December); and
 - Specialist analysis by a suitably qualified ecologist of threatened bat call recordings and compilation of bat species list for the site.
- Collation of the survey data including:
 - A summary tabulation of the results of each individual survey event;
 - Annual summary report for Year 1 of monitoring for provision to the Approval Holder; and

- Detailed report and analysis at the conclusion of Year 2 of monitoring for provision to the Approval Holder.

The results of this pre-operational monitoring required by condition 6(a) of the EPBC Act Approval will be analysed and evaluated by a suitably qualified ecologist, prior to the results being reported to DAWE in accordance with condition 8 of the EPBC Act Approval. Please refer to section 3.5 for further information on reporting obligations under this BBMP. Reporting from the suitably qualified ecologist will be provided to the Approval Holder who will be responsible for submitting any required reporting to the relevant regulators.

2.2. Pre-operational survey results

2.2.1. Desktop Assessment Results

The initial desktop assessment identified 16 bird species and two bat species listed under either the EPBC Act or Queensland *Nature Conservation Act 1992* (NC Act) which have the potential to occur within the wider study region. Those species and their conservation status are detailed below in Table 2.

Table 2: Threatened Bird and Bat species with the potential to occur within the study region

Common Name	Scientific Name	EPBC Act ¹	NC Act ²
Birds			
Curlew Sandpiper	<i>Calidris ferruginea</i>	CR, M	E
Red Goshawk	<i>Erythrotriorchis radiatus</i>	V	E
Painted Honeyeater	<i>Grantiella picta</i>	V	V
Squatter Pigeon	<i>Geophaps scripta scripta</i>	V	V
Australian Painted-snipe	<i>Rostratula australis</i>	E	V
Glossy black cockatoo	<i>Calyptorhynchus lathami</i>		V
White-throated Needletail	<i>Hirundapus caudacutus</i>	V, M	SLC
Fork-tailed Swift	<i>Apus pacificus</i>	M	SLC
Oriental Cuckoo	<i>Cuculus optatus</i>	M	SLC
Yellow Wagtail	<i>Motacilla flava</i>	M	SLC
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	M	SLC
Rufous Fantail	<i>Rhipidura rufifrons</i>	M	SLC
Common Sandpiper	<i>Actitis hypoleucos</i>	M	SLC
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	M	SLC
Latham's Snipe	<i>Gallinago hardwickii</i>	M	SLC
Pectoral Sandpiper	<i>Calidris melanotos</i>	M	SLC
Bats			
Corben's Long-eared Bat	<i>Nyctophilus corbeni</i>	V	v
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	V	v

1 EPBC Act Status: CE- Critically Endangered; E- Endangered; V- Vulnerable; Mi Migratory

2 NC Act Status: E Endangered; V- Vulnerable; SLC- Special Least Concern

2.2.2. Bird Utilisation Survey Results

During the 2018 onsite surveys, undertaken by suitably qualified ecologists from AECOM, sixty-six bird species were recorded during the fixed-point bird survey efforts, combining for a total of 2,050 individual birds throughout the 64 BUS (AECOM 2019).

Three bird species accounted for over 50% of all fixed-point bird counts. The utilisation survey results concluded that approximately 88% (58) of all bird species recorded during fixed point counts exhibited

low risk flight behaviour, occurring at heights lower than the Rotor Swept Area (RSA) height (80 m) on all recorded occasions (AECOM 2019).

Eight bird species were observed to exhibit moderate to high risk behaviours, flying at or above RSA height on more than one occasion (AECOM 2019), including:

- Fork-tailed Swift
- Torresian Crow
- White-browed Woodswallow
- White-breasted Woodswallow
- Straw-necked Ibis
- Nankeen Kestrel
- Wedge-tailed Eagle
- Australian Hobby

In its engagement to provide specialist avifauna support to DREP, including to support the development of a site specific BBMP, Nature Advisory undertook a detailed review of the ecological surveys and assessment undertaken to support the development of DREP. As part of this process, Nature Advisory undertook its own in depth assessment. As part of this assessment, Nature Advisory undertook a detailed assessment of the habitat types and identified further species of concern that were proactively considered during the EPBC Act approval process in addition to the species specifically identified by DAWE in the referral determination (September 2019).

As set out in the earlier desktop and site-based surveys undertaken by Ecology and Heritage Partners (2018) and by AECOM (respectively) a total of 103 bird species were recorded across the study area. These surveys included the Ecology and Heritage Partners preliminary assessment (2018) and the AECOM terrestrial fauna assessment as detailed in the Dulacca Renewable Energy Project - Fauna Technical Report (AECOM 2019).

During the 2020 and 2021 pre-operational bird utilisation surveys required by condition 6(a) of the EPBC Act Approval and as undertaken by suitably qualified ecologists from Nature Advisory, 92 bird species were recorded during the fixed-point bird survey efforts, combining for a total of 5,398 counts of birds across the 320 BUS (Nature Advisory 2020a, Nature Advisory 2020b, Nature Advisory 2020c, Nature Advisory 2020d).

Ten bird species accounted for over 50% of all fixed-point bird counts. The utilisation survey results concluded that approximately 89% (82) of all bird species recorded during fixed-point counts exhibited low risk flight behaviour, occurring at heights lower than the Rotor Swept Area (RSA) height (80 m) on all recorded occasions (Nature Advisory 2020a, Nature Advisory 2020b, Nature Advisory 2020c, Nature Advisory 2020d).

Seven bird species were observed to exhibit moderate to high risk behaviours, flying at or above RSA height on more than one occasion (Nature Advisory 2020a, Nature Advisory 2020b, Nature Advisory 2020c, Nature Advisory 2020d), including:

- Australian Raven
- Nankeen Kestrel
- Straw-necked Ibis
- Torresian Crow
- Tree Martin
- Wedge-tailed Eagle
- White-breasted Woodswallow.

Squatter Pigeon (Southern) was not observed by AECOM within the study area during bird utilisation surveys in 2018 or as an incidental during fauna surveys in 2018 as detailed in the EPBC Act referral (2018/8368) Attachment C Fauna Technical Report_Final_27.11. As outlined in the EPBC Act referral Attachment C, the likelihood of occurrence assessment for the species is low. The species has also not been recorded during four bird utilisation surveys or as an incidental by Nature Advisory in 2020 and 2021. The closest Atlas of Living Australia record of the species is approximately 25 to the north-west of the study area. The species is also ground-dwelling and its behaviour results in a very low risk of collision with turbines.

Based on the findings from all work by the suitably qualified ecologists engaged to support the DREP project over the last four years, no EPBC Act listed species has been found engaging in behaviour (i.e. regular flights by important numbers at turbine height) that could lead to a *significant* impact occurring. Notwithstanding this, impact will be carefully monitored for the residual pre-operational monitoring period required by condition 6(a) of the EPBC Act Approval and responded to through the implementation of this BBMP, including as required by any revisions to this BBMP.

2.2.3. Bat Utilisation Survey Results

The results of the bat utilisation survey confirmed the presence of 13 species or groups of species and the possible presence of two additional species at the locations of the bat recorders (AECOM 2019).

Bat species occurrence was similar across the sample sites (Table 3), with BUS02 recording a confirmed or possible call signature for all species.

Table 3: Bat Utilisation Survey Results (AECOM 2019)

Scientific Name	BUS01	BUS02	BUS03	BUS04	BUS05	BUS06	REF01	REF02
<i>Chalinolobus gouldii</i>	X	X	X	X	X	X	X	X
<i>Chalinolobus picatus</i>	X	X	X	X	X	X	X	X
<i>Nyctophilus species</i>	X	X	X	X	X	X	X	X
<i>Scotorepens balstoni</i>	X	X	X	X	X	X	X	X
<i>Scotorepens greyii</i>	X	X	X	X	X	X	X	X
<i>Vespadelus baverstocki</i>	X	X	X	P		X	X	X
<i>Vespadelus troughtoni</i>		P						
<i>Vespadelus vulturnus</i>	X	X	P	X		X	X	X
<i>Miniopterus orianae</i>		P			X			
<i>Austronomus australis</i>	X	X			X	X	X	X
<i>Ozimops lumsdenae</i>	X	X	X	X	X	X	X	
<i>Ozimops petersi</i>	X	P	P	P	X	X	X	X
<i>Ozimops ridei</i>	X	X	X	X	X		X	X
<i>Setirostris eleryi</i>	X	P			X			
<i>Saccolaimus flaviventris</i>	X	X	X	x	x	X	X	X

X: Confirmed; P: possible occurrence

Spotlighting surveys undertaken during the fauna assessment did not record any flying fox species, despite the presence of native vegetation. No threatened species of flying fox are expected to occur within the study area. Beyond an absence during onsite surveys, the absence of the Grey-headed Flying-fox (*Pteropus poliocephalus*) is also supported by the DAWE distribution prescribed within the Species Profile and Threats Database and records within the Atlas of Living Australia (ALA) with the closest record being 75km from the DREP site.

One threatened bat species was potentially recorded during surveys, the Corben's Long-eared Bat (*Nyctophilus corbeni*), which is listed as vulnerable under the NC Act and vulnerable under the EPBC Act. This species was recorded only as *Nyctophilus* spp. as the calls are difficult to distinguish accurately from other (least concern) *Nyctophilus* species. As a precaution these calls were assumed to include *Nyctophilus corbeni*. This species formed part of the 'controlled action' determination for the EPBC Act Approval.

2.2.4. Turbine risk profile

As required by condition 9(a)(i) of the State Development Approval, this BBMP is required to identify 'at risk' bird and bat species (i.e. all threatened and common species), seasons, and areas within the DREP site that may attract high levels of mortality.

Additionally, in accordance with condition 9(a) of the EPBC Act Approval, a risk profile will be assigned to each turbine within the study area at the conclusion of the bird and bat utilisation surveys required under condition 6(a) of the EPBC Act Approval. This risk profile will be assigned prior to the first full operation of DREP in accordance with condition 9(a) of the EPBC Act Approval. This risk profile assignment will be re-evaluated regularly during bird and bat utilisation surveys and turbine risk revised, if required, in accordance with condition 9 and the definitions of high and low risk turbines in Part C of the EPBC Act Approval.

According to the EPBC Act Approval, a turbine is considered a low risk turbine if there are no EPBC Act listed threatened species or EPBC Act listed migratory species recorded in the vicinity of a turbine for a minimum of two years, being within a 350 metre radius of any turbine as defined by Part C of the EPBC Act Approval. A turbine will be re-assigned to a high risk turbine if an EPBC Act listed threatened species or EPBC Act listed migratory species is recorded within the above described vicinity of that turbine. This turbine will remain a high risk turbine if any EPBC Act-listed species has been recorded during seasonal bird utilisation surveys in the vicinity of the turbine site as per the frequency indicated in Section 2.1. If no listed species are identified in the vicinity of this turbine for a minimum of two years, the turbine will be re-assigned to low risk. For the DREP, the only EPBC Act listed species likely to occur are Fork-tailed Swift (listed migratory species) and White-throated Needletail (listed threatened and migratory species). The status of the Squatter Pigeon and Grey-headed Flying Fox have been discussed earlier.

3. Bird and bat monitoring

A range of approaches will be utilised from commencement of commissioning of DREP, to meet the requirements of the State and Commonwealth conditions of approval. The following section gives effect to condition 9(a)(v) of the State Development Approval and conditions 6 to 9 of the EPBC Act Approval.

The main approaches to implementing the BBMP will be:

- Specific management contingencies for species and groups identified as a species 'of concern' (refer section 3.1) and/or initiated due to a specific impact trigger (Section 5);
- A statistically robust turbine strike monitoring program (random or stratified random sampling design) to detect birds and bats that collide fatally with operating turbines, as a basis for an estimate of overall bird and bat mortality rates at DREP (Section 3.2). This data will be utilised to inform any necessary revision to the risk rating for the species within the two years of post-operational monitoring;
- Mitigation measures to reduce the possible interactions between birds and bats, and operating turbines (Section 5.3).

In identifying a monitoring regime for the wind farm, the monitoring program has benefited from the experience of the Nature Advisory team at wind farms throughout eastern Australia since 2009 and from the statistical advice provided in Appendix 1. At the time of this BBMP revision, Nature Advisory has led the development and / or implementation of 14 wind farm bird and bat impact monitoring programs and undertaken over 8,000 turbine searches throughout eastern Australia.

Pre-operation Period

Pre operational data is being collected at the DREP as set out in Section 2, and as required by condition 6(a) of the EPBC Act Approval. This data will be referred to as the 'pre-operation phase' of the wider monitoring program required under this Approval. A report on results will be provided to the Approval Holder for inclusion in the compliance report required under condition 27 of the EPBC Act Approval. This pre-operational monitoring report will be provided to the Approval Holder on completion of this pre-operational monitoring work.

Commissioning Period

Sections 3.1 to 3.3 describe the survey methodologies to be implemented once DREP achieves its first full operation. Monitoring during the commissioning phase will focus on opportunistic / informal monitoring of turbines for carcasses (incidental finds) by onsite personnel with reporting through the incidental carcass find protocol (see Section 3.2.5), with the full turbine searches to commence from the first full operation of the wind farm and in accordance with condition 6 and condition 7 of the EPBC Act Approval.

Post First Full Operation/ Commencement of Operations

Turbine strike monitoring will be carried out in accordance with the BBMP and at all high-risk turbines identified as required under condition 9 of the EPBC Act Approval, for a minimum of 24 contiguous months within 30 months after first full operation, with a review and compilation of all monitoring data gathered in the first and second years. This is described in more detail below.

For the 24 months of operational Bird Utilisation Surveys (BUS), the surveys will replicate the BUS survey work previously completed on DREP site as part of the BUS completed prior to first full operation. This survey work is described in more detail in section 3.1.1.

3.1. Monitoring bird species and groups of concern

The bird species and groups of concern (*sensu* AusWEA 2005) are:

- Wedge-tailed Eagle;
- Fork-tailed Swift;
- White-throated Needletail;
- Common Raptor species; and
- White-striped Freetail Bat.

Impacts on any of these species will be identified through the carcass search protocols outlined in Section 3.2 below. In addition, specific monitoring will be undertaken for these species of concern as discussed further below.

In accordance with condition 9(a) of the EPBC Act Approval, a turbine risk profile will be allocated to the turbines at the DREP site prior to first full operation using the results of the pre-operation bird and bat utilisation survey (see Section 2.2.4). Furthermore, a turbine is to be re-assigned as a high risk turbine within five business days if one or more individuals of an EPBC Act listed species is recorded within the vicinity of a turbine, being within a 350 metre radius of an individual turbine. Compliance with condition 9(b) of the EPBC Act Approval will be based on observations made during the bird and bat utilisation surveys required under condition 6 of the EPBC Act Approval, during turbine strike monitoring and/or any incidental observations during operations.

In the event that threatened birds or threatened bats are found during turbine strike monitoring, or incidentally, it will trigger the response aligned to the procedure in Section 5 of this BBMP.

3.1.1. Operational Bird Utilisation Surveys

In the period before the first full operation of the wind farm pre-operational bird utilisation surveys are required to be undertaken in accordance with condition 6(a) of the EPBC Act Approval. Please refer to Section 2.1 for information on this pre-operational monitoring.

During the first two years of the operation of the wind farm (commencing within 3 months of the first full operation of the wind farm), in the same four periods as the pre-operational surveys (refer Section 2.1), BUS will be repeated as required by condition 6(b) of the EPBC Act Approval. These operational BUS will focus on all bird species (irrespective of species declarations) and will utilise methods consistent with those previously adopted at the DREP site and as described in Section 2.1.

In accordance with condition 9 of the State Development Approval, the BUS will additionally focus on collecting data on the utilisation of the wind farm by species at risk from operating turbines. These species include common raptors, Fork-tailed Swift, Wedge-tailed Eagle, White-throated Needletail and White-striped Freetail Bat. As required by condition 7 of the EPBC Act Approval, at least one BUS per year will be undertaken at a time when White-throated Needletail and Fork-tailed Swift are present in eastern Australia (November to March) during each 12 months of bird and bat utilisation surveys required under condition 6.

The results of the operational bird utilisation survey will be incorporated into the report prepared for the Approval Holder at the conclusion of the second year of monitoring. For further information on reporting required under this BBMP please refer to Section 3.5.

3.1.2. *Wedge-tailed Eagle, Fork-tailed Swift, White-throated Needletail, other raptors*

Once the project reaches first full operation and turbine strike monitoring commences, regular monthly monitoring will be undertaken of flight movements of the Wedge-tailed Eagle, Fork-tailed Swift, White-throated Needletail and raptors. This monitoring, undertaken by a suitably qualified ecologist, will be undertaken as part of the monthly turbine strike monitoring required by condition 6(c). As set out in condition 6(c), monitoring will be undertaken for a minimum 24 contiguous months within the first 30 months post the first full operation of the wind farm.

As this occurs at turbine sites chosen based on a statistically designed monitoring program (see Appendix 1) it will generate comparable findings between surveys. This observational data, together with the two-year bird and bat utilisation survey results (required by condition 6(b)) will contribute to a determination by a suitably qualified ecologist on whether operating turbines are having a significant impact on these species at the DREP site (see also Section 3.3). Incidental observations will also be recorded as the suitably qualified ecologist moves through the wind farm to the turbine search sites.

Information recorded by a suitably qualified ecologist during flight movement monitoring, will include, as a minimum:

- Date, location and duration of monthly observation period;
- Time and duration of flight;
- Number of birds, and approximate age (if known);
- Flight height above ground (range);
- Habitat over which the flight was observed;
- Flight behaviour observed, included soaring, directional flight (flapping), kiting, circling, gliding and diving; and
- Other occasional behaviours included feeding, territorial displays, fighting and perching.

Flight paths for these species will be plotted by the suitably qualified ecologist as accurately as possible on large-scale aerial photographs of the DREP site.

In addition, during the formal monthly turbine strike monitoring activities undertaken by the suitably qualified ecologist any eagle nests observed will be recorded with GPS location and revisited during the breeding season (from July to December) to monitor nesting activity and outcome.

3.1.3. *Other bird species*

Any other bird carcass found during the formal turbine strike monitoring (Section 3.2), or incidentally by Operations staff, will be reported and stored in a freezer on-site for confirmation of its identity and for use in scavenger trials. The incidental discovery of carcasses by Operations staff will be subject the recording requirements described in Section 3.2.5.

In the event the carcass of a listed species is identified incidentally, the protocols outlined in Section 3.2.5 will be implemented.

3.1.4. *Bat Surveys*

At least two bat surveys will be undertaken prior to first full operation of the wind farm within a two-year period in accordance with condition 6(b) of the EPBC Act Approval. At least one survey is to be undertaken in the wet season and one in the dry season. Pre-operational bat surveys in accordance with condition 6(b) of the EPBC Act Approval commenced in 2020 and will be completed prior to the

commencement of turbine construction. Please refer to Section 2.1 for information on this pre-operational monitoring.

During the first two years of the operation of the wind farm, in the same two periods as the pre-operational surveys (refer to Section 2.1), bat surveys will be repeated in accordance with Condition 6(c) of the EPBC Act Approval. This will focus on all bat species and will utilise methods consistent with those previously adopted at DREP site during the pre-operational monitoring.

The results of the bat utilisation survey will be incorporated into the report prepared for the Approval Holder at the conclusion of the second year of monitoring in accordance with conditions 8 and 27 of the EPBC Act approval.

3.2. Carcass searches / turbine strike monitoring

The purpose of carcass searches as part of the turbine strike monitoring required by condition 6(c) of the EPBC Act Approval, is to assist in determining the actual impact of DREP on birds and bats by attempting to estimate the annual number of birds and bats that collide fatally with operating turbines. Mortality rates can be estimated for all bird species combined, and all bat species combined. If threatened species are found underneath a turbine, the mortality rate for that particular threatened species will be estimated, subject to sufficient data being available.

Mortality is defined as any dead bird or bat detected under a turbine and within a distance of the turbine in which carcasses could be reasonably attributed to turbine strike. Detection of carcasses can be either during the formal turbine strike monitoring (designed to generate an estimate in accordance with a statistically rigorous sampling design) or informally (incidental discovery of a bird or bat carcass at the site, often reported by Operational staff, not used to generate mortality estimates). The protocol described in Section 3.2.5 is triggered whenever a carcass is found, either within the formal searches or incidentally to collect consistent and useful data on the fatality event (see below).

Collision by birds and bats with operating turbines will be monitored through a statistically rigorous carcass-search program for a period of 24 contiguous months within the first 30 months of the first full operation of the wind farm (see details below). This approach will ensure that when data is analysed at the end of the 24 months of post-operational carcass searches that statistically useable and robust results are generated from the carcass monitoring program that include an estimate of both bird and bat mortality rates, together with an estimate of sampling precision. The results of this 24 month monitoring period will be utilised to inform any necessary review of the risk assessment, to identify if any further targeted monitoring is required, and / or to inform any necessary changes to the mitigation measures or assigned turbine risk profile. Appendix 1 describes the statistical aspects of the monitoring program.

The search protocol outlined below (refer to Section 3.2.2) has been designed to detect species that have fatally collided with operating turbines at other wind farms. The consistent application of this protocol will ensure that statistically robust, spatially and temporally consistent data are collected on bird and bat mortality at the site. It considers both human (visual) searching and scent-dog (smell) searching.

The final method utilised for turbine strike monitoring will be informed by the monitoring required under condition 6(a) of the EPBC Act Approval and will consider matters including the availability of a trained dog to support carcass searches at this site for the length of the required monitoring period.

As set out in condition 10 of the EPBC Act Approval, this BBMP is required to be revised at the conclusion of the pre-operational monitoring required under condition 6(a) – it is in this revision that a final determination on the method to be adopted for turbine strike monitoring will be confirmed. Until this time, both methods are described.

Several factors, such as carcass scavenging and carcass detectability, can affect mortality rate estimates and must be measured and included in any estimate of overall mortality rates for the site. The statistical advice that has informed the design of the carcass search program is provided in Appendix 1.

A scavenged carcass could increase the variability in mortality rate estimates and thus carcasses will be assessed for possible scavenging (i.e. evidence of animal disturbance to the carcass) and rates will be estimated from experimental trials (Section 3.2.6).

Human (or canine) detectability of carcasses is also a potential confounding variable and protocols have been developed to control this factor in the final mortality estimates. Section 3.2.7 provides more detail on this issue. Please refer to section 3.2.3 for further information on searching with dogs.

The practical considerations that have informed the design of the carcass search program for this program and associated scavenger trials are listed below:

- Very few carcasses are found under turbines in Australia compared with Northern Hemisphere wind farms (on average, less than half the number in the Northern Hemisphere based on Nature Advisory data across ten wind farms in Australia);
- Carcasses of a suitable range of sizes for scavenger and detectability trials are difficult to source and usually involve a combination of carcasses found under operating turbines and those found along roads and other legal sources. Note that it is illegal to source un-cleaned carcasses from poultry producers;
- For statistical reasons, it is likely to be very difficult to determine more than the grossest of differences in scavenging rate or detectability between seasons within a year and there is no evidence in the literature for significant differences between seasons in scavenger activity. Therefore, annual scavenger and detectability correction factors will be generated and applied; and
- It is known that detectability will be easier in short grass at the dry time of the year compared with in longer grass at the wet time of the year, and detectability trials will be scheduled accordingly (see Section 3.2.7).

After the 24 months of contiguous turbine strike monitoring, required by condition 6(c) of the EPBC Act Approval, a detailed report will be prepared for the Approval Holder detailing a reviewing the mortality detection program and providing recommendations for the future in response to any revised or newly identified risks at the site, including impacts on EPBC Act listed threatened species or EPBC Act listed migratory species (see Section 3.5 for reporting requirements). In accordance with condition 10 of the EPBC Act Approval, the BBMP will be updated revised by a suitably qualified ecologist upon the completion of the turbine strike monitoring required by condition 6(c) of the Approval.

The following Sections outline:

- Turbine selection for survey (Section 3.2.1): how the turbines will be selected for the search.
- Search protocol (Section 3.2.2): the size of area beneath turbines to be searched and how this area will be systematically searched and results recorded.

- Carcass detection protocol for turbine strike monitoring (Section 3.2.4)
- Incidental carcass protocol (Section 3.2.5): outlining the procedure to be adopted in the event of an incidental carcass or feather spot find by Construction or Operation personnel outside the formal turbine strike monitoring.
- Scavenger rates and trials (Section 3.2.6): definition of scavenging and how experimental trials will be conducted.
- Detectability (observer) trials (Section 3.2.7): definition of detectability and the experimental trial methodology.
- Analysis and mortality estimation (Section 3.2.8): general outline of how the data will be analysed to gain estimates of bird and bat mortality.

3.2.1. Turbine selection (stratified sampling)

As supported by the EPBC Act Approval, DREP comprises 43 turbines. It is proposed that a minimum of 33% of the turbines will be searched monthly as part of the operational turbine strike monitoring program required to be undertaken under condition 6(c) of the EPBC Act Approval. For the purposes of DREP, a total of 15 turbines will be adopted and selected at random prior to the commencement of the first turbine strike monitoring search. The same 15 turbines will then be specifically searched for the first 24 months of the survey to maximise the accuracy and precision of the bird and bat mortality rate estimates. The total number of turbines subject to turbine strike monitoring will be confirmed by a suitably qualified ecologist once the pre-operational monitoring required by condition 6(a) of the EPBC Act Approval is completed, with the final number to be reflected in the revision of the BBMP required under condition 10(a) of the EPBC Act Approval. Based on pre-operational monitoring results to date (Nature Advisory, 2020 and 2021), this figure of 33% is not expected to change.

In addition to the 15 randomly selected turbines, if any turbine is assigned as a high risk turbine in accordance with the criteria described in Part C of the EPBC Act Approval, then the high risk turbine will be added to the list of turbines to be searched each month. Monitoring of high risk turbines as part of turbine strike monitoring will be undertaken as long as the high risk turbine remains high risk and will cease after the turbine is no longer a high risk turbine. When the turbine risk is re-assigned to a low risk turbine it will not be required to be searched each month if not previously included in the 15 pre-selected turbines. If it was already included in the 15 pre-selected turbines for carcass searches then no other change is required.

Note that the results of any turbine searches other than the core 15 randomly selected fixed turbines will not be used in the mortality estimates as these depart from the rigorous statistically derived sampling design and would render any estimate invalid.

3.2.2. Search protocol

All turbine strike monitoring carcass searches will be undertaken by a suitably qualified ecologist as defined in the EPBC Act Approval or suitably qualified person. Where a suitably qualified person is utilised, the person will be regularly assessed by the supervising suitably qualified ecologist to ensure they implement the required monitoring methods effectively and consistently, and are able to identify any carcasses (or evidence of collision, such as feather spots) found under wind turbines.

The search area beneath each turbine has been determined as the area to find bats and medium to large bird carcasses with turbines of this size (Hull & Muir 2010). Based on the Hull and Muir model (2010) 95% of bat carcasses are expected to be found within 74m of the turbine, and carcasses of medium to large birds are expected to be reasonably evenly distributed out to 122m. Carcasses of

very large birds (WTE) are found a little further out, but 95% are expected to be within 130m of the turbine.

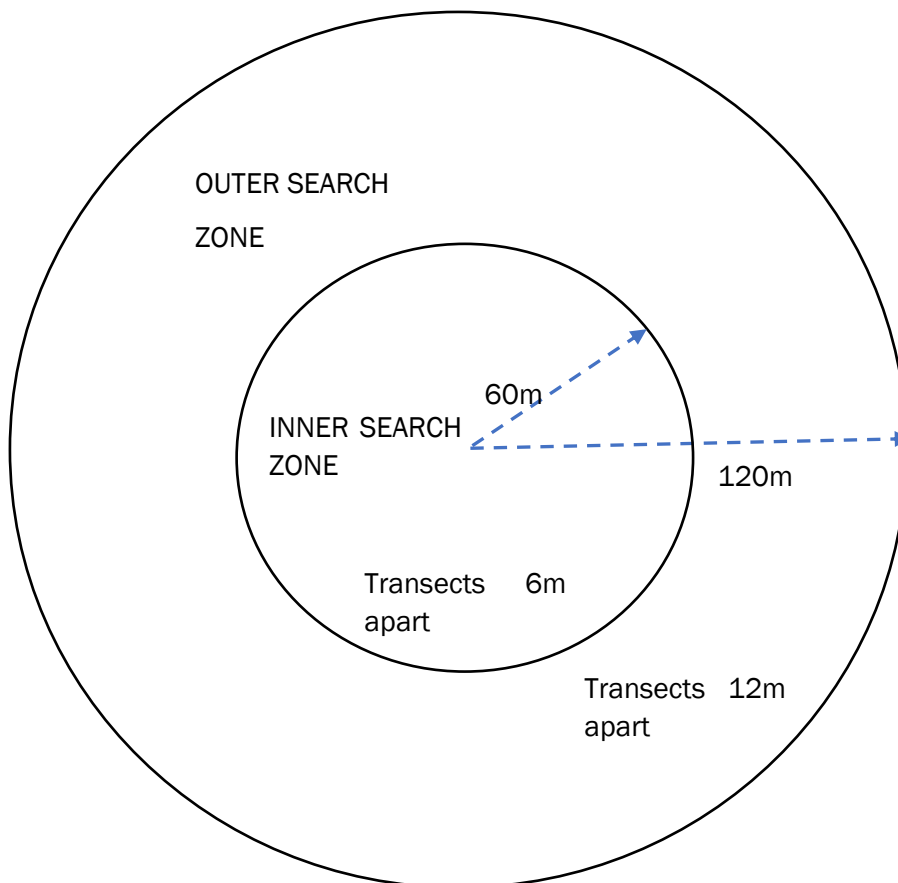
Given this evidence, inner and outer circular search zones have been designated. The inner zone targets the detection of carcasses of bats and small to medium and large sized birds. In the inner zone, a circle is formed with a 60m radius from the turbine and transects are spaced every 6m (Figure 3) as smaller carcasses are more readily found at a closer distance from the observer. The outer zone will comprise the zone between the 60m and 120m radius circles. Although recorded in the inner zone, the outer zone will ensure the adequate detection of carcasses of medium to larger sized birds, which can fall further away from turbines. Search transects in the outer zone are spaced at 12m and carried out from the edge of the inner zone out to the edge of the outer zone given the greater visibility of larger carcasses.

Given that the defined transect spacing and total search area are based on experience and evidence from previous studies e.g. Arnett *et al.* 2005, Hull and Muir 2010 they are considered to be ample to detect bat and the bird carcasses.

Areas under turbines can be located on steep hills and with difficult to access terrain. Search areas in the vicinity of some turbines are densely treed. For these reasons, turbine searches within 120m will only cover hardstands and sections of access tracks and roads within treed and/or steep areas that cannot be accessed safely. The results will be adjusted in this approach to take account of this variable. The likelihood of this applying to the formal turbine strike monitoring will be subject to the final random selection of turbines which will be determined prior to the commencement of post operational BUS.

All selected turbines required for turbine strike monitoring will be searched out to 120m once per month in accordance with condition 6(c) of the EPBC Act Approval. The order of turbines searched will be randomised between searches.

All carcasses found will be recorded using the form provided in Appendix 2.

Figure 3: Inner and outer carcass search zones underneath the turbines

3.2.3. Searching with dogs

Trained dogs could also be used to undertake the carcass searches. However, this will depend upon the availability of trained dogs and dog handlers familiar with the territory and with the appropriate skills to undertake the searches. The suitability of using trained dogs will be determined by the suitably qualified ecologist responsible for overseeing the implementation of this BBMP. A decision on the use of dogs for carcass searches will be informed by the pre-operational monitoring required under condition 6(a) of the EPBC Act Approval. The decision will consider the availability of trained dogs for the full 24 months of contiguous turbine strike monitoring required under condition 6(c). Once a human or canine option is chosen, the method selected will be retained for the duration of the monitoring period.

Although trained dogs can have a better rate of detection, this factor can be corrected for in the searcher efficiency trials outlined below (Section 3.2.7). The landowners may also prefer that dogs not be used at certain times of the year, depending on land use.

If dogs are used for the searches, this will generally involve the dogs working on a transect line from downwind to upwind. The methodology will be detailed in an updated BBMP, should dogs be proposed for use. The method will be based on that described below, adapted as required in response to landholder requirements.

Scent dogs can be trained to locate a variety of targets. The same search area will be targeted out to 120 metres. The dog does not 'look' for carcasses but finds them via scent. Therefore, it does not need to cover as much ground as if it were looking with its eyes. It only needs to cover enough ground to encounter all possible 'scent cones' within the search radius.

The scent cone is the area downwind of the target, in this case a carcass, in which the scent will drift with the wind. So, if the wind is strong; the scent will drift further but in a narrower scent cone, and if the wind is light, the scent cone will be wider but will not drift as far. In the case of strong wind, then transects will need to be narrow to ensure scent cone areas are encountered. Whereas transects of approximately 30 metres wide will be adequate to cover an area in moderate wind conditions, this will be reduced to 10 or 20 metres in conditions with no wind or strong wind.

The handler will start down wind of the turbine and walk across the direction of the wind allowing the dog to freely zig zag across the searcher's transects, using whistle commands to control how far the dog moves to each side of the transect (i.e. 30 metres). This will ensure all scent cone areas will be encountered (Figure 4). As represented in the Figure 4 the search pattern walking across the wind any carcasses scent cone will be encountered several times, or for a long duration, allowing the dog to easily detect and track down the carcass.

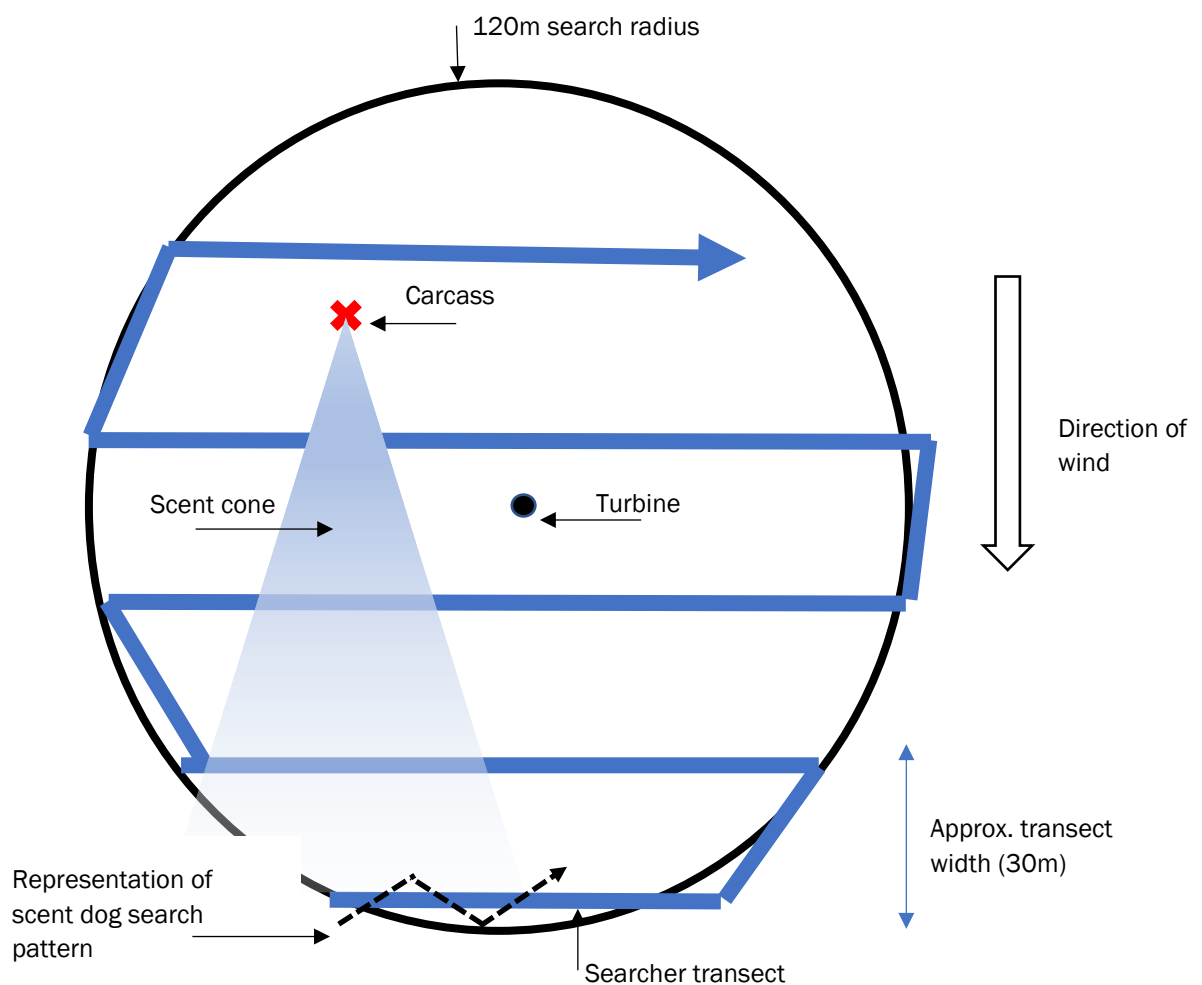


Figure 4: Search pattern for scent dog – across the wind turbine search radius

A GPS collar will be fitted to the dog which will allow the handler to track movements in real time and allow the handler to ensure the entire search area has been effectively covered by the dog. Search areas will be loaded onto GPS prior to commencing searches to allow the handler to see the exact borders of the area and the dog's movements within it. GPS data will be made available to regulators on request.

3.2.4. *Carcass detection protocol for turbine strike monitoring (operation phase)*

If a carcass is detected (a 'find') the following variables will be recorded in the Carcass Search Data Sheet (see Appendix 2):

- Position of carcass in relation to the turbine i.e. distance in metres and compass bearing of the carcass from the base of the turbine;
- Substrate and vegetation, particularly if it was found on a track or hard-stand area without vegetation as this potentially assists in quantifying the number of carcasses not found in areas where ground cover makes carcasses less visible;
- Species, age, number, sex (if possible), signs of injury and estimated date of strike. Where the state of remains does not permit species identification, DNA testing will be undertaken, overseen by a suitably qualified ecologist;
- Weather (including recent extreme weather events, if any), visibility, maintenance of the turbine and any other factors that affect carcass discovery; and
- If the species is not able to be immediately identified (e.g. an incidental find, and there is not a suitably qualified ecologist on site), photographs must be provided to the qualified ecologist within 2 business days of the find, for identification purposes. The suitably qualified ecologist must reply within 2 business days, for the possible reporting of an impact, as outlined in Section 5.

The carcass will be handled according to standard procedures, as follows:

- The carcass will be removed from the turbine site to avoid re-counting;
- The carcass will be handled by personnel wearing rubber gloves, packed into a plastic bag, wrapped in a sheet of newspaper then placed in a second plastic bag;
- The carcass will be clearly labelled by including a copy of its completed Carcass Search Data Sheet in the second plastic bag to ensure that its origin can be traced at a later date, if required; and
- The double-bagged and wrapped carcass will be transferred to an on-site freezer (at DREP site office) for storage. The carcass will be available for a second opinion on the species identity, if necessary, and for use in scavenger and detectability trials (See Section 3.2.7). The freezer will only be used for holding carcasses and not for other uses.

The monitoring program will need to obtain under a NC Act an authority (Scientific Purposes Permit) for keeping remains of native wildlife. This authority will also detail the most appropriate disposal methods.

It will be assumed that any intact dead bird or bat, or bird feather spot (defined as a clump of five feathers or more), detected beneath an operating turbine (refer to Section 3.2.2) has died as a result of collision or interaction with turbine blades. Feather spots will be assumed to be remains of a bird carcass after scavenging and the scavenger correction factor will not be applied to them (refer to Section 3.2.6).

3.2.5. *Incidental carcass protocol*

Personnel working at DREP site will from time to time find carcasses within DREP site during construction, commissioning, day-to-day operations and maintenance activities. In this case, the carcass will be handled according to the Carcass Detection Protocol outlined in Section 3.2.4. All

Construction and Operation personnel will be made aware of this carcass handling protocol as part of their Site training and induction.

Ongoing incidental monitoring of mortality from blade strike by wind farm personnel at operating wind farms typically serves to:

- provide data that can inform adaptive management of the collision risk i.e. patterns of mortality related to seasonal changes or local conditions, and
- detect mortality of threatened and non-threatened bird and bat species, which can be used to understand actual bird and bat impacts.

A Carcass Search Data Sheet (Appendix 2) will be completed for each incidental carcass found (whether removed or not).

This Incidental Carcass Protocol is valid for the operational life of DREP.

3.2.6. Scavenger rates and trials

It will be important to ascertain the rate at which carcasses are removed by scavengers. This can be used to develop a 'correction factor' that informs the estimate of DREP's impacts on birds and bats (mortality rate). Scavengers can include ground-based animals, such as foxes, wild dogs, and rats (more likely to detect carcasses by scent), as well as aerial scavengers such as birds of prey and ravens (more likely to detect them visually). The scavenger trials described below are designed to ascertain the scavenging rate, usually expressed as the average carcass duration in the field.

An intact carcass will be defined as a carcass that does not appear to have been scavenged by a vertebrate scavenger. A partially eaten carcass will be any skeletal or flesh remains found. Feather spots for birds and fur spots for bats will be defined by their presence and the absence of any other remains (a feather spot being a cluster of five or more feathers). Intact or partial carcasses and feather/fur spots will all be recorded as a 'find'. However, the scavenger correction factor will not be applied to fur and feather spots as these are most likely to represent the remains of carcasses after they have been scavenged.

Scavenger trials will be undertaken twice during the first year of operational monitoring required by condition 6 of the EPBC Act Approval. The objective of having two trials is to account for different vegetation conditions, so one will be held when the grass is long and one when the grass is short. The two periods for scavenger trials are shown in Table 4, below.

Table 4: Timing for scavenger trials

Vegetation condition	Likely time period
Short grass	Dry season (October)
Long grass	Wet season (March)

Each scavenger trial will be undertaken by a suitably qualified person (see Section 3.3) as defined in the EPBC Act Approval to determine the rate of carcass loss by scavengers. The search area for scavenger trials will be limited to 60m from the base of the turbine (the inner search zone – Figure 3) and will be located at the previously randomly selected operating turbines that are searched on a regular basis.

To identify potentially different scavenging rates, three categories of carcass will be used (Table 5). Based on current mortality estimation requirements, every endeavour will be made to find all

carcasses of required for each category. Improvements on this described method would require an impractical and unlikely availability of required carcass numbers, and do not lead to a commensurate improvement in the statistical power of estimates (see Appendix 1).

Table 5: Number of replicates for each scavenger trial

Micro-bat	Medium sized birds	Large birds (large raptor size)
10	5	Up to 5

For each scavenger trial, twenty carcasses in total will be randomly placed under different turbines. The carcasses will be checked daily for the first five days, then every two days for the following four days, and then every three days until day 18, followed by every four days until they disappear or at the end of thirty days trial period (see Table 6). On-site personnel will be required to continue this trial beyond the first five to seven days once the trail has been established by the suitably qualified ecologist. Agreement will be reached with the Owner and Operator of DREP on the process for monitoring carcasses during the scavenger trial period. Any on-site personnel utilised to assist with the trials will be provided necessary training from the suitably qualified ecologist prior to assuming responsibility.

Table 6: Scavenger trials search timetable

Day
Day 1
Day 2
Day 3
Day 4
Day 5
Day 7
Day 9
Day 12
Day 15
Day 18
Day 22
Day 26
Day 30

In addition, a second methodology will be trialled at DREP. This will involve the installation of infrared motion detector cameras within 1-2 metres of the carcass at the selected turbine locations. The infrared camera will remain in the field for 5 days when it will be first checked by the suitably qualified ecologist. If the carcass still remains, cameras will then be retrieved by day 30. The images will be downloaded and analysed. A potential limitation of this method includes disturbance associated with installation of the camera including disturbance by livestock and creation of perches for birds from the poles holding the camera in place. Thus, this will be a trial and results will be included in the final report at the conclusion of the 2-year monitoring period.

Additional information on scavenger trials is provided below:

- The timing of searches is based on experience and regulatory approval at several other wind farms;
- A mix of carcass sizes (if available) will be obtained for use in the scavenger trials. Where carcasses of a species of concern cannot be found, a similar-sized and coloured

substitute (e.g. responsibly sourced pest carcasses) will be used to reduce bias by visual predators;

- Latex gloves will always be worn while handling carcasses to minimise contact with human scent, which may alter predator responses around carrion and to minimise disease risk to the handler;
- At each trial site, one carcass (or more) will be placed randomly within the 60m search area. Carcasses will be thrown in the air and allowed to land on the ground to simulate at least some of the fall and allow for ruffling of fur or feathers;
- Carcasses used in the trials will have their coordinates recorded to ensure that they are not confused with an actual fatality found under a turbine during the trial searches;
- Notes will be taken on evidence remaining at sites where carcasses have been scavenged e.g. scavenger scats, bones, feathers, animal parts and type of scavenging if visible, such as tearing, pecking, complete removal of carcass, partial removal of carcass, bird or mammal predator evidence; and
- Notes will be taken on the state of remaining carcasses in each search.

Conducting two scavenger trials at seasonally different times is designed to account for occasional seasonal changes in carrion use by some scavenger species. Previous studies have found that Red Foxes are reliant on rabbits and carrion in agricultural and forested areas e.g. Brunner *et al.* 1975, Catling 1988, Molsher *et al.* 2000. Feral cats show uniform use of carrion throughout the year, whereas fox prey type is dependent on availability (Catling 1988). Catling (1988) found that foxes ate more carrion in winter/spring compared with summer/autumn, when they fed on adult rabbits. However, Molsher *et al.* (2000) found that there was no overall significant difference between seasons for carrion use by foxes. Seasonal differences only occurred in other prey types (not carrion), such as lambs, invertebrates and reptiles, as these are only available at certain times of the year.

Scavenger trials for large raptors will only be conducted once due to lack of availability of suitable carcasses for a technically sound trial. Experience from other wind farms indicates a low level of scavenging of these carcasses and a high level of detectability that is consistent across the year.

The final scavenger trial design (as described) is a necessary compromise between high numbers of trials and practicality whilst ensuring a statistically-valid trial design (see Appendix 1) without altering either the behaviour of scavengers or the number of birds that collide with turbine blades.

3.2.7. Detectability (searcher efficiency) trials

The most efficient use of time is to conduct the detectability (searcher efficiency) trials concurrently with the scavenger trials during the first day of placing the carcasses (to avoid the potential for incidental scavenging by predators). The purpose of the detectability trials is to assess the searcher's ability to detect carcasses in the context of DREP site. As humans are reliant on visual cues to determine carcass location, the two seasonal visibility categories of low and high grass cover will be compared. This approach will also be used if dogs are used (refer to Section 3.2.3). To account for searcher variability in detecting carcasses, only personnel or dogs who have carried out monthly searches at DREP site will be involved in the detectability (searcher efficiency) trials. Detection efficiency (percentage of carcasses detected) will then be incorporated into later analyses that derive mortality estimates for the purposes of assessing the potential impact of DREP. The assessment will be captured in the monitoring report collated at the conclusion of the 24 month monitoring period. The number of carcasses to be employed in each trial is detailed in Table 7 and explained below.

By way of methodology, a carcass controller (a person not involved in monthly carcass searches) will throw each carcass into the air and allow it to land on the ground to simulate at least some of the fall and the potential ruffling of fur and feathers that could result from a collision. The searcher involved will not be aware of timing of the trial and the trial will be undertaken at the same time as the formal monthly searches conducted at the 15 turbines randomly selected for the 24 month monitoring period. The carcass controller will note the placement of carcasses (via GPS) and is free to decide where and how many are deployed under each turbine. However, all carcasses will be located within the inner 60m search zone. The efficiency of the searcher will be determined on the basis of the number of successful finds they make against those carcasses deployed by the carcass controller. This process will be tightly managed to avoid the duplicated counting of carcasses for the purposes of reporting.

Table 7: Number of replicates per season for detectability trials, given two factors of size and visibility

Season	Micro-bat	Medium sized birds	Large birds (large raptor size)
Wet season - Long grass / vegetated	10	5	5
Dry season - Short grass	10	5	5

Sampling will be undertaken during the two periods that represent the greatest change in vegetation cover (therefore potential carcass visibility), using a number of carcasses that is logistically manageable and aligned with the number and timing of scavenger trials. Statistical confidence analysis indicates that this will result in a reasonably precise detectability estimate after one year, and optimal precision after two, although a second year of trials is not currently planned.

Any substitute carcasses for these trials will be of both similar size, colour and form to the species being represented or species of concern (e.g. brown mice rather than birds should be substituted for bats as birds do not have the same body shape, colour and appearance).

After the planned detectability trials during the two-year formal monitoring period, the need and frequency of further detectability trials will be reviewed by the suitably qualified ecologist in consultation with the Approval Holder.

3.2.8. Analysis of results and mortality estimation

The results of the formal carcass searches will be analysed to provide information on:

- The species, number, age and sex (if possible) of birds and bats being struck by the turbine blades;
- Results of scavenger and detectability trials;
- Separate estimated annual mortality rates for all birds and all bats (and for particular species, if required) including an estimate of the number of carcasses per turbine per year; and
- Any detected spatial or temporal variation in the number of bird and bat strikes.

The search results will be detailed in a short annual report to the Approval Holder, to support the preparation of a compliance report under condition 27 of the EPBC Act Approval. The short annual report will include any additional recommendations relevant to the second year of monitoring. In addition to cumulative search results, the analysis and mortality estimates will be detailed in the final monitoring report completed at the conclusion of the 24 month monitoring period required under

condition 6 of the EPBC Act Approval. The latter will also identify if further investigations or mitigation measures are required beyond this initial 24 month monitoring period and will set forth recommendations relevant to the revision of the BBMP as set out in condition 10 of the EPBC Act Approval. The identification of additional monitoring will reflect the risk profile for DREP site (including the identification of any specific turbines) as informed by the formal period of monitoring. Incidental carcass identification monitoring by operational personnel will be ongoing for the operational life of DREP.

Statistically robust projections of bird and bat mortality for the entire Project site will be presented in the second-year report based on the results of carcass searches completed during the formal monitoring period. It is acknowledged that this is a current and dynamic aspect of research and that the outcomes from such programs may be equally dynamic. The proposed program is designed to provide an acceptably accurate and precise estimate of Project related bird and bat mortality over the first two years of operation. Examples of current best practice statistical analysis are outlined in Huso et al. (2017) and Huso et al. (2016).

All data will be analysed to provide the average estimated mortality of birds and bats, their standard error (variability) and ranges for DREP. The mortality rate of each species (if estimates for individual species are possible) and size class detected will be calculated. If possible, the standard error and range of these estimates will be reported. Note that it may not be practically possible to provide a detailed statistical analysis due to the likely low number of carcasses detected at this Project site and should this occur it will be reported as a finding.

The estimated mortality rate for DREP will be generated by modelling the scavenger losses and results of the detectability (searcher efficiency) trials and using sampling inference to account for the periods between turbine searches and unsearched turbines. The data from the scavenger and detectability trials will be analysed using relevant techniques based on Generalised Linear Modelling (GLM) and (censored) Survival Analysis. Censored measurements are only partially known, such as the exact time of mortality or the exact time to scavenge loss e.g. Kaplan & Meier (1958). In addition to providing mortality estimates, this analysis will evaluate if any of the factors e.g. size class or habitat stratification of turbine sites are significant.

Once data is available from bird utilisation surveys, monthly species-specific monitoring and turbine strike monitoring, whether a significant impact has occurred to any EPBC Act listed threatened species and EPBC Act listed migratory species will be determined and any requirement for an offset determined in consultation with DAWE in accordance with the EPBC Act Environmental Offsets Policy.

3.3. Personnel involved

This Section outlines the personnel involved in implementing the BBMP and any training required for the field work and report writing. All personnel working on the requirements of the BBMP will be familiar with the Plan, relevant site policies and procedures, and other administrative matters, e.g. H&S and technical and field methods. The Approval Holder will be responsible for ensuring that suitably qualified and trained people, as defined in the State Development Approval and EPBC Act Approval, are engaged to supervise and implement the formal monitoring program. Beyond the formal period of monitoring, The Approval Holder will be additionally responsible for ensuring ongoing reporting of incidental finds and the engagement of relevant specialists where triggered by this BBMP.

Any suitably qualified person undertaking formal searches will be trained and supervised by a suitably qualified ecologist. Any suitably qualified person engaged as a searcher will receive training from the supervising suitably qualified ecologist in the following areas:

- Turbine searches, including transect spacing in inner and outer zones, number and location of turbines to search and transect search methods;
- Equipment usage, such as GPS;
- Data recording;
- Carcass storage; and
- Species identification.

Where a scent-dog is used to search for carcasses, as described in Section 3.2.3, this will be undertaken by a single dog and their handler fully trained in this method. The same dog and handler will be reasonably required to undertake all carcass searches for the duration of this program to ensure consistency.

The suitably qualified ecologist will supervise the initial carcass search to ensure that field methods are being undertaken correctly and undertake an audit after the first three months to ensure that methods are being implemented correctly. The suitably qualified ecologist will also be responsible for identifying any recorded carcasses from photographs or from specimens transferred to the on-site freezer after searches.

The first searcher efficiency trial will be initiated and set up by the supervising suitably qualified ecologist, who will, if required train a separate person (the 'carcass controller') to run follow-up searcher efficiency trials. This training will include:

- Correct preparation and handling of trial carcasses;
- Correct methods for the random placement of trial carcasses within a randomly selected sub-set of the search areas; and
- The need to place trial carcasses without the searcher knowing they are being placed.

If for some reason a searcher is unable to undertake the monthly searches as planned (due to illness etc.) a back-up suitably qualified person will be identified in advance. If a back-up person is required to undertake searches, they will also be trained and supervised and will additionally participate in searcher efficiency trials to validate any formal searches conducted by this individual.

The scavenger trials will be set up by the supervising suitably qualified ecologist, with searches being undertaken by a trained suitably qualified person engaged as a searcher.

Analysis of mortality data will be undertaken by the supervising ecologist with support from a statistician.

Annual reports and all investigations resulting from an impact trigger (see Section 5) will be prepared by the suitably qualified ecologist.

Training in the handling and management of incidental discoveries by Operational personnel will be undertaken with site staff at the commencement of operations and as reasonably required thereafter during the operational life of DREP. This training will be provided by the supervising suitably qualified ecologist, or a suitably qualified delegate.

3.4. Injured & deceased bird and bat handling protocol

All on-site staff and monitoring personnel will be advised of the correct procedure for assisting injured wildlife. Construction and Operations personnel who find injured wildlife will be required to report the find to DREP's Responsible Officer, who will organise recovery of, and treatment for the animal. If safe

to do so, place the animal immediately into a dark place e.g. box or cloth bag for transfer to the nearest wildlife carer or veterinarian.

All persons who handle injured or dead animals must wear gloves and understand the applicable WH&S requirements. Special care¹ should be taken to avoid bat borne viruses (i.e. Australian Bat Lyssavirus and Hendra Virus), including that only people with appropriate vaccinations should handle living bats. Vets or wildlife welfare officers should be called to deal with injured bats.

Contact details of local veterinary staff and wildlife carers are provided below to ensure that if injured wildlife is found and cannot readily be released back to the wild, they are treated accordingly and in a timely manner.

Table 8: Vet and wildlife carer details for the local region

Name	Phone	Location/Address	Bats (Y/N?)
RSPCA	1300 ANIMAL (1300 264 625)		Yes
Maranoa Wildlife Caring & Education Centre	0458 624 760	CO/- PO Box 924 15 Quintin St Roma, QLD 4455	Yes (check)
Roma Veterinary Clinic	07 4622 1015	148 Northern Rd, Roma QLD 4455	Yes
Maranoa Veterinary Surgery	07 4622 4477 A/H : 0407 717 375	32 Quintin Street, Roma	

3.5. Reporting

Reports will be completed on an annual basis for the first two years of Bird Utilisation Surveys required under condition 6(a) and condition 6(b) of the EPBC Act Approval (respectively), and the turbine strike monitoring required by condition 6(c) of the EPBC Act Approval.

Monthly summary reports of carcass searches undertaken as part of turbine strike monitoring to be provided to the Approval Holder. Further reporting will be recommended to the Approval Holder (if relevant) as part of each annual report. Where required additional monitoring will be agreed with the applicable regulator, for example, in the unlikely event that impact triggers are met or are at reasonable risk of being met as supported by the results of the formal 24 month operational monitoring period.

The short annual reports will be prepared for the Approval Holder within 60 business days of the completion of the first year of monitoring required under condition 6(a), condition 6(b) and condition 6(c) of the EPBC Act Approval. These short annual reports will focus on presenting the results of the bird and bat utilisation surveys and, for the operational monitoring period, will include mortality searches including any impacts to the 'of concern' bird and bat species identified in section 3.1. The short report for Year 1 of operational monitoring will additionally include any additional threatened species identified during the first year of operational monitoring, any mitigation measures implemented (e.g. stock, feral and native animal carcass removal), and recommended refinements to monitoring activities or amendments to the species list assessed in the 'of concern' species list in

¹ Queensland Government (2017) Bats and Human Health
<http://conditions.health.qld.gov.au/HealthCondition/condition/14/217/14/Bats-human-health>, accessed 28/06/18

section 3.1 (if required). The Approval Holder will include content specific to this annual report within the annual compliance report required by condition 27 of the EPBC Act Approval.

The second annual pre-operational monitoring report will include an analysis of the pre-operational survey data and will be utilised to inform the revision to the BBMP required by condition 10 of the EPBC Act Approval. The report will additionally set out the risk allocation to the respective onsite wind turbines as required by condition 9(a) of the EPBC Act Approval. The detailed report will provide an evaluation of proposed mitigation measures and will make recommendations for any additional site specific mitigation measures that could be beneficially adopted in the revision of the BBMP ahead of the first full operation of the wind farm.

The second annual operational monitoring report will present the first full analysis of operational data collected and will be presented to the Approval Holder within 60 business days of the end of the second year of monitoring. This second- year report is particularly important for adaptive management and the process to revise the BBMP in accordance with condition 10 of the EPBC Act Approval. This detailed report will enable the key species affected as a direct result of the operation of the wind farm to be confirmed and, if warranted, provide direction to re-focus monitoring and mitigation measures on species confirmed to be at higher risk. It will also evaluate the effectiveness of any implemented mitigation measures and support the identification of revised controls to minimise potential long term impact on affected species.

Matters to be addressed in the second annual operational phase monitoring report includes, but will not be limited to:

- A brief description of the management measures implemented, and identification of any modifications made to the original mitigation measures described in the BBMP;
- The survey methods (including list of observers, dates and times of observations);
- Results of the bird and bat utilisation surveys, turbine strike monitoring carcass searches, incidental carcass observations, flight behaviour monitoring, and outcomes of eagle nest monitoring as described in this BBMP;
- Estimates of bird and bat mortality rates (per turbine per year) based on statistical analysis (see below and Appendix 1);
- Seasonal and annual variation in the number and composition of bird and bat strikes, where detectable;
- Any other mortality recorded on site but not during designated carcass searches i.e. incidental records by site personnel;
- Identification of any impact triggers, and application of the decision-making framework and relevant adaptive mitigation measures;
- A summary of stock, feral and native animal carcass removal for the purposes of predator reduction;
- Details of any landowner feral animal control programs and their timing; and
- A discussion of the results, including:
 - Bird risk reduction measures (e.g. landowner feral animal control);
 - Any further recommendations for reducing mortality (if necessary);

- Whether the level of mortality was unacceptable (in terms of population risk) for impacted listed species of birds or bats of concern captured in Table 2 (including any additional listed species identified during monitoring);
- Usage of DREP area by species of concern where flight behaviour was observed to present a mortality risk, and factors influencing this i.e. climatic, geographical and infrastructure;
- Analysis of the effectiveness of the decision-making framework captured within this BBMP; and
- Recommendations to the Approval Holder about further monitoring to address targeted or specific species risk (if required),

When adequate monitoring (including any intensification of monitoring in response to a White-throated Needletail or other EPBC Act-listed listed species fatality as a result of the Project) has demonstrated that turbines are low risk turbines, as defined in Part C of the EPBC Act Approval, then monitoring will be amended, reduced or ceased.

3.5.1. Statistical Methods for estimating mortality

The following extract from Appendix 1 describes how mortality rates will be estimated.

Standard approach to estimation

To assess measurability, we need to establish the metric the data will feed. Mortalities at turbine i during search j $\hat{M}_{ij}$ are estimated by (Huso, Dalthorp, and Korner-Nievergelt (2015) and references therein)

$$\hat{M}_{ij} \cong \frac{C_{ij}}{\hat{g}_{ij}} \quad (1)$$

where

- C_{ij} is the number of carcasses found
- $\hat{g}_{ij}$ is the estimate of the detection probability for that search and turbine

For a given turbine, $\hat{g}_{ij}$ is a function of

$$\hat{g}_{ij} \cong a_i p_{ij} s_{ij} \quad (2)$$

- a_i is the fraction of total carcasses within the searched area
- p_{ij} is the probability that an existing carcass will be detected by the searcher
- s_{ij} is the fraction of the carcasses that arrived at turbine i but have not been lost to scavenge or decay before search j . It is a function of the rate of decay and the search interval, relative to the expected time to scavenge (Huso 2011)

Through field surveys we can estimate $\hat{a}$, $\hat{s}$ and $\hat{p}$. C is given by the field observation data.

These components estimate $\hat{M}$ (and confidence bounds) for the site and time period.

4. Mitigation measures to reduce risk

Mitigation involves the prevention, avoidance and/or reduction of the risk of an impact trigger occurring or continuing to occur. An impact trigger is defined in Section 5 as a threshold of impact on birds or bats that triggers an investigation and/or management response. The following section outlines mitigation measures relevant to the reduction and avoidance of risk.

The overall objective of mitigation measures is to ensure that the operation of DREP does not lead to significant impacts on threatened or protected birds and bats. Any future novel or new mitigation measures that are identified to be of potential benefit for birds and bats at DREP site would be assessed for incorporation into this project specific BBMP as part of an adaptive management approach, including as part of the BBMP revisions required by condition 10 of the EPBC Act Approval. Major revisions to the BBMP shall be communicated to the Department of State Development, Infrastructure, Local Government and Planning (DSDILGP) in accordance with condition 9 of the State Development Approval. Where the changes are likely to result in a new or increased impact to any EPBC listed species (i.e. beyond minor variations or updates to the BBMP), the BBMP needs to be referred the Minister in accordance with Section 143A of the EPBC Act.

4.1. Carrion removal program and stock forage control

Land-use and stock management below and around turbines can influence the presence and behaviour of native birds on site. Examples that could elevate bird collision rates include:

- Grain feeding can attract parrots and cockatoos; and
- Carrion can attract raptors including Wedge-tailed Eagles.

This Section proposes possible mitigation measures to address these matters.

The Wedge-tailed Eagle and other raptors forage for carrion (the fresh or decaying flesh of a dead animal) and also on small mammals and rabbits. In order to reduce the risk of raptors colliding with turbine blades, a regular carrion monitoring and removal (where identified) program will be implemented during the commissioning and operation of DREP. This removal program will be adopted to reduce the attractiveness of DREP site to raptors and therefore reduce the potential for fatal collisions by this group of birds. This program will focus on an area of a minimum of 350m radius around turbines, where safe, feasible and practical. The procedures below will be adopted for DREP.

- A designated suitable person will be appointed (e.g. project HSE representative or a project supervisor) to perform the function of 'Carrion Removal Coordinator'. This person will be responsible for ensuring activities described below are carried out:
 - Educate project staff and landowners to report any stock, introduced or native mammal and bird carcasses within 200m of any turbine (to be recorded as incidental finds) that attract raptors e.g. kangaroos, cattle, pigs, goats, foxes, rabbits.
 - Support opportunistic observations by Construction and Operations personnel during routine work assignment on the site to identify and report carcasses of stock, feral or native animals so that timely collection can be undertaken to remove them;
 - Consult with DREP's Responsible Officer in relation to the appropriate disposal of collected carrion, including confirmation of a suitable waste management option;
 - Make suitable arrangements for any carcasses and/or remains found that are within 350m of turbines to be safely collected and disposed of as soon as possible, in a

manner that will avoid attracting raptors close to turbines. Ensure landowners are appropriately engaged where the response is in relation to their stock;

- Ensuring the timely recording carcass occurrence and removal in dedicated carcass removal register maintained by DREP's Responsible Officer.
- Working with landowners, ensure that the practice of grain feeding of stock within 350m of turbines should be avoided to avoid creating a collision risk for parrots and cockatoos.
- Again, working with landowners, any feral animal control on DREP site is required to be implemented in accordance with the Vegetation and Fauna Management Plan developed in accordance with condition 5 of the EPBC Act Approval and is to involve the timely removal and appropriate disposal of resulting carcasses where these are within 350m of a turbine.
- If a large and active pest animal presence is incidentally observed during monitoring surveys that explains impacts (e.g. increases in hare/rabbit numbers corresponding with increased raptor numbers and mortality), an integrated control program will be conducted to reduce the presence of these species to reduce the attractiveness of the site as a hunting ground for WTE and other raptor species. Any control program will require cooperation and agreement from the landowners.
- An annual summary of carcass removal based on DREP's 'dedicated carcass removal register'.

The need for continuation of a more formalised carcass removal program and effort required will be assessed by the suitable qualified ecologist in consultation with the Approval Holder, after one year of operation. In general, the criteria for continuation will be based on the frequency of carcass finds where a link to fatalities is determined. Ongoing incidental non-avifauna carcass discoveries by Operation personnel will continue for the operational life of DREP and these carcasses removed to reduce the potential risk to WTE and other raptors.

4.2. Lighting on turbines and buildings

It has long been known that sources of artificial light attract birds, as evidenced by night-migrating birds in North America and Europe. Lighting is probably the most important factor under human control that affects mortality rates of birds and bats colliding with all structures (Longcore, et al. 2008). Most bird mortality at communication towers in the Northern Hemisphere for example, occurs in poor weather with low cloud in autumn and spring, i.e. during migration periods (Longcore, et al. 2008).

It is postulated that bright lights may temporarily blind birds, particularly those accustomed to flying at night or in low light conditions causing them to fly toward the light source and collide with the lit structure (Gauthreaux and Belser 2006). Bats may also be attracted to the increased numbers of insects that may congregate near bright light sources.

Measures to reduce the impact of lighting include using low pressure sodium or mercury lamps with UV filters to reduce brightness. The colour of lighting may also be important. Some studies have found that red lights resulted in a lower mortality than white lights (Longcore *et al.* 2008), but more recent research on oil rigs at sea suggests that blue or green lights may result in lower mortality than red or white lights (American Bird Conservancy 2014).

DREP will have the following white or yellow lighting:

- A small external light above the entrance door to each wind turbine to be used infrequently to support access to turbines during periods of low light;
- external lighting at the site compound, including the site warehouse, office building, and the substation, baffled to ensure no light-spill;
- portable and temporary lighting as otherwise required to ensure the safety of workers during the construction and operation of the wind farm; and.
- Vehicle headlight usage when vehicles are active during low light and night time periods during construction and operational activities.

Onsite lighting will be managed to ensure that the lighting is directed to targeted areas and so as not to create a light pollution source in a rural environment, such as pointing skyward or laterally beyond the target area. Lighting will be utilised only where practically required for the safety workers and the security of the DREP site.

The Project does not require specific aviation lighting measures. No requirement for turbine aviation lighting was identified by the Civil Aviation Safety Authority or by the Department of Defence in response to their assessment of the location of the Project site. The absence of a requirement for aviation lighting was confirmed by the Aviation Impact Assessment (Aviation Projects, 2018) prepared in support of the application, and remains the continued requirement for the Project site. An updated Aviation Impact Assessment undertaken by Aviation Projects in 2020 reaffirmed the findings of this original assessment.

5. Impact triggers and adaptive management framework

This section identifies the circumstances that will result in Regulatory notification, further investigation and additional mitigation for both threatened and non-threatened birds and bats (impact trigger). The following section gives effect to condition 9(a)(iii) and (vi) of the State Development Approval and conditions 12, 13 & 14 of the EPBC Act Approval and provides an adaptive management framework. The framework will sit within a detailed collective environmental management system for DREP. This environmental management system will consist of management plans (including this BBMP), systems and processes from both the wind farm Approval Holder and from the Operations and Maintenance (O&M) Contractor. The implementation of the Environmental Management System and meeting project compliance obligations will be overseen by the Approval Holder's nominated 'Responsible Officer' who will work closely with all stakeholders holding responsibility for the delivery of environmental compliance, including external technical specialists (e.g. suitably qualified ecologist(s)). In the anticipated structure for the operational DREP, the Approval Holder's Asset Manager will be the 'Responsible Officer' for DREP.

The broader project environmental management arrangements for this project will be consistent with ISO 14000 and will satisfy the broad requirements of the Commonwealth Guidelines for Environmental Management Plans (DoE 2014) in relation to responsibilities, reporting, training, emergency procedures, auditing and review.

This section of the BBMP provides bird- and bat impact monitoring and response procedures and standards that will sit within the broader environmental management system, together with specific monitoring, investigation, reporting and consultation requirements. These implement an over-arching adaptive management framework to ensure the best possible mitigation response to an impact trigger, based on information specific to the site, project and species, as well as the impact event or events.

If an impact trigger occurs, there must be an investigation of the cause of the impact, and whether the event is concluded to be a one-off occurrence or likely to occur regularly. The impact trigger can be considered an unacceptable impact in itself (e.g. for a critically endangered threatened species) or lead to an unacceptable impact if it continues (e.g. for a less threatened species).

Should a White-throated Needletail be found under a turbine, carcass searching will immediately be intensified from the impact monitoring described in Section 3.2 to include all turbines fortnightly until the end of their season in Australia. This will enable ongoing impact to be determined with greater precision due to the higher sampling frequency and turbine numbers as explained in Appendix 1.

Note that the approach developed in this section is based on approaches approved for numerous bird and bat monitoring programs for wind farms in Queensland, New South Wales and Victoria, including by DAWE, and up to date feedback from regulators on the implementation of approved plans (see Section 1.4 for details). This approach has been adopted for consistency with these other regulatory jurisdictions and is required to limit impact on bird and bat species of concern. In its adoption, specific consideration has been given to the site, including habitat quality and likelihood of impact.

Ultimately, the wind farm Approval Holder will be responsible for ensuring implementation of this BBMP and the management of the decision-making required under this Plan. The decision-making process will be undertaken with relevant technical support provided by a suitably qualified ecologist.

It will also, where indicated, involve consultation with the relevant regulators (Queensland and Commonwealth).

5.1. Threatened species

5.1.1. Definition of impact trigger

For this BBMP an *Impact Trigger* for Threatened Species means:

- One (1) identified EPBC Act listed threatened species or EPBC Act listed migratory species (or recognisable parts thereof) evidently killed by a turbine strike within the study area; or
- One (1) identified NC Act listed species (or recognisable parts thereof) evidently killed or injured by a turbine strike within the area used for turbine strike monitoring searches (refer to Section 3.2).

5.1.2. Decision making framework and reporting

If a threatened species impact trigger occurs the decision-making framework outlined below and in Figure 5 will be followed. This framework has been developed with regard to condition 28 and 29 of the EPBC Act Approval.

- Immediate reporting of a carcass or injured bird find to the Approval Holder's Responsible Officer who will be responsible for engaging with a suitably qualified ecologist to determine the species (where not identified directly by a suitably qualified person or suitably qualified ecologist during mortality searches).
- Where an impact trigger is confirmed by the suitably qualified ecologist, DREP Responsible Officer is required to report the trigger within two business days of the species being identified to the relevant statutory planner at the Queensland Department of Environment and Science (DES) and / and or DAWE (pending species identification).
- Immediate investigation (to be completed within ten business days) by a suitably qualified ecologist to determine, if possible, the circumstances that lead to the death or injury. If the cause of death is due to turbine blade collision, an investigation will be undertaken to identify any particular risk behaviours that could have led to the collision. The likelihood of further occurrences will then be evaluated by a suitably qualified ecologist.
- If following this investigation by the suitably qualified ecologist, the fatality is deemed to be a one-off occurrence, or an ongoing impact is unlikely to be significant at a population scale, further action is not considered necessary. The outcomes of the investigation will be shared with DES and DAWE.
- Where an impact is considered not likely to be a one-off occurrence then carcass searching effort will be increased for six weeks to fortnightly frequency to test the postulated ongoing impact potential at the turbine.
- The suitably qualified ecologist will assess potential mitigation measures specific to the circumstance with a view to addressing the risk profile created by the turbine(s). The mitigation measures will be developed in consultation with the Approval Holder (allowing technical/operating constraints to be considered) and measures to ensure that the mitigation is implemented as soon as feasible will be adopted. The investigation will aim to provide a clear understanding of the cause of the impact, where required, informed by on-site investigations of the occurrence of the species on

DREP site. Where applicable, consultation with DES and the DAWE will be adopted in order to inform the final form of the mitigation strategy adopted. This BBMP will be updated (as required) to reflect any additional monitoring or controls required to appropriately respond to the trigger.

- If the cause of the impact trigger is not clear from the initial investigation, further monitoring and investigation by suitably qualified ecologist of risk behaviours and evaluation of likely re-occurrence will be required over the following weeks in consultation with DES and/or DAWE to identify effective mitigation measures(s).
- If these investigations suggest that the impact trigger was a one-off event, or the ongoing risk is unlikely to be significant at a population scale, no further action would be necessary beyond monitoring of the turbine as a high risk turbine in accordance with condition 9(b) of the EPBC Act Approval and in accordance with the process and timeframes described within this BBMP. In this case the decision will be determined in consultation with DES and/or DAWE, based on available evidence.
- If the on-site investigation concludes that the impact trigger represents circumstances leading to a significant impact (with reference to the EPBC Act Significant Impact Guidelines 1.1), species-specific monitoring would be initiated. During species-specific monitoring, periodic reports will be provided by DREP to DES and DAWE.
- Responsive mitigation measures (see Section 5.6) will be developed and implemented in a timely manner to allow for a response to an immediately identified population-based risk. Initial mitigation measures would change in response to the outcomes of the investigation and a further assessment of the risk profile.

In line with condition 12 of the EPBC Act Approval, if an impact trigger is reached or exceeded, the Approval Holder will provide a report to the Minister on the steps taken and outcomes of implementing the relevant commitments in the adaptive management framework in the first annual compliance report required under condition 27 that follows each instance of reaching or exceedance of an impact trigger and/or the implementation of mitigation measures. Each such compliance report must include details of the mitigation measures that have been or will be implemented and an assessment of their likely effectiveness.

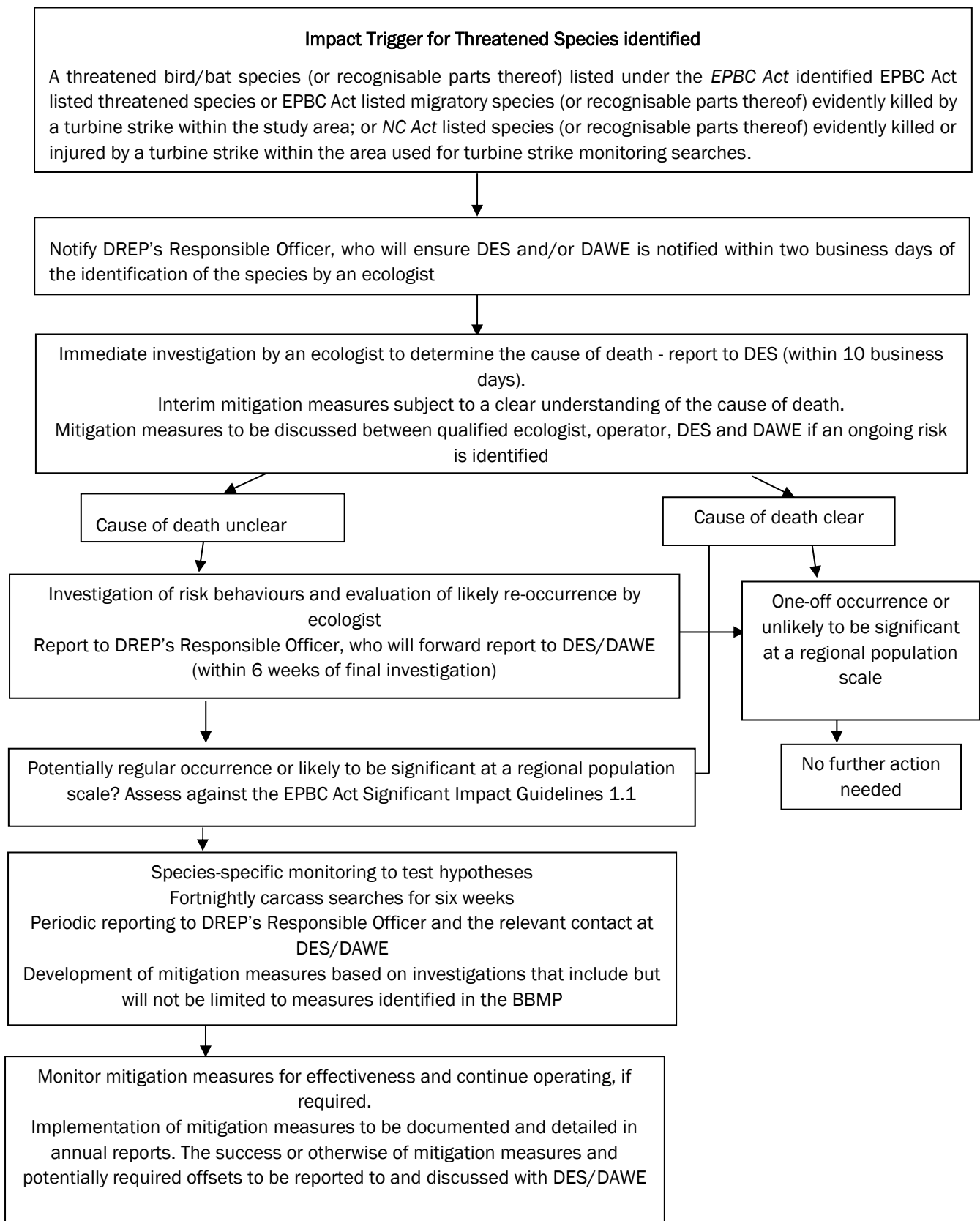
Any evaluation of impacts and decisions regarding mitigation measures and further investigations required will be undertaken in consultation with DES/DAWE (as required). Any required investigation, and recommended management and supplementary mitigation measures identified during the formal 24 month monitoring period will be detailed in the annual reports provided to the Approval Holder to support the Approval Holder in the compilation of the annual compliance report required under condition 27 of the EPBC Act Approval.

In the event offsets are triggered as a result of an impact, offsets will be provided by the Approval Holder in accordance with the EPBC Act *Environmental Offsets Policy* (DSEWPAC 2012). Where direct offsets are not practically available, other compensatory measures will be identified and established in accordance with the Offsets Policy. In the event a direct offset cannot feasibly be established to offset an identified impact, a full explanation/justification will be provided to DAWE and other compensatory measures will be proposed for the impacted species explored. Any offset would be developed in consultation with, and approved by, DAWE.

In accordance with condition 13 of the EPBC Act Approval, if the Minister writes to the Approval Holder stating that the mitigation measures will not prevent further reaching or exceedance of an impact trigger, then the Approval Holder must curtail the operation of any wind turbine that presents an

ongoing risk of reaching or exceeding an impact trigger (within an identified period of risk to the impacted EPBC Act listed threatened species or EPBC Act listed migratory species) until such time as alternate mitigation measures can be identified to support the ongoing operation of the turbine. Where mitigation measures cannot be identified, the DREP must engage a suitably qualified person to develop a species-specific curtailment protocol for the turbine to allow the turbine to be operated for periods outside of identified period of risk to the impacted species.

In accordance with condition 14 of the EPBC Act Approval, any requests to the Minister by DREP to cease or reduce a curtailment must include an evidence-based assessment by a suitably qualified ecologist demonstrating how the ceasing or reducing of the curtailment will not reasonably be expected to result in any subsequent reaching or exceedance of a defined impact trigger.

Figure 5: Decision making framework for identifying and mitigating impact triggers for threatened species

5.2. Non-threatened (protected) species

5.2.1. Definition of Impact Trigger

For the purpose of this BBMP an *Impact Trigger* for Non-threatened Species: A total of four or more non-threatened bird or bat carcasses, or parts thereof, of the same species identified during two successive searches at the same or adjacent turbine(s).

Where population numbers are known and reported by DES or where habitat extent is known, the definition of a significant impact on non-threatened species is any impact that is likely to reduce the viability of the population of the affected species in the bioregion. The assessment of the population will be determined by a suitably qualified ecologist.

5.2.2. Decision making framework

In the event that an impact trigger for non-threatened species is detected the following steps will be followed:

- DES will be notified of the impact trigger within seven days of recording the event;
- An investigation and evaluation of impacts to the non-threatened species' bioregional population will be undertaken by a suitably qualified ecologist; and
- A report on the investigation will be delivered by the Approval Holder's Responsible Officer to the relevant statutory personnel at DES within three weeks of the event (or date agreed with DES).

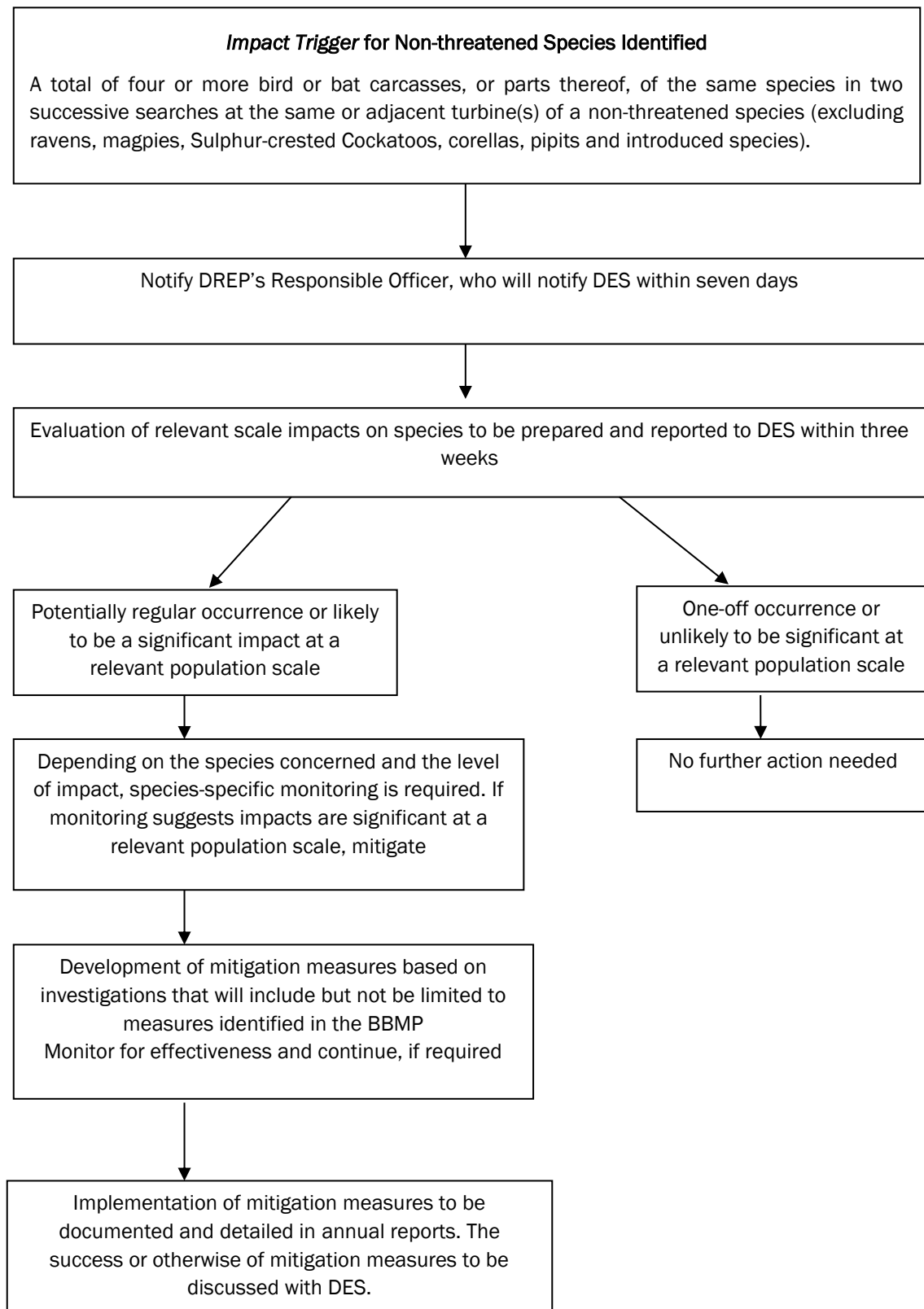
If the evaluation indicates that the event was a one-off occurrence or is unlikely to be a significant impact at a bioregional population scale for the species in question, no further action by the Approval Holder will be necessary (as outlined in Figure 6).

If the event is deemed to be a potentially regular occurrence or likely to lead to a significant impact on the population of the species in question, species-specific monitoring will be required (Figure 5). If further monitoring confirms that impacts are likely to lead to a significant impact on the species, additional mitigation measures will be required. Potential mitigation measures are outlined in Table 9, however, specific mitigation measures will be determined based on the species involved, the outcome of investigations and developed in consultation with the Approval Holder taking into account technical and operational constraints.

Any required investigation, and recommended management and supplementary mitigation measures, will be detailed in annual reports, as described within this BBMP, at the end of year one and year two formal post operational monitoring period.

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Figure 6: Decision making framework for identifying and mitigating *impact triggers* for non-threatened species.



5.3. Supplementary mitigation measures

Supplementary mitigation measures would be implemented in the event that an impact trigger occurs and investigations indicate that additional measures are warranted. These supplementary mitigation measures are additional to the proactive risk reduction mitigations described in Section 4. The purpose of supplementary mitigation measures will be to prevent the impact from continuing to occur at a scale that leads to a significant impact (i.e. at the bioregional population scale) to the species in question. Specific mitigation measures will be implemented depending on the nature, cause and significance of the impact recorded and in response to the results of investigations of the event and of the species concerned on DREP site.

Offsets are appropriate, if a significant residual impact is determined for an EPBC Act listed threatened bird or bat species. Where the need for offsets is identified, offsets will be established in accordance with the EPBC Offsets Policy. Any offset would be developed in consultation with, and approved by, DAWE.

Although it is unknown what supplementary mitigation measures will be required in response to a particular situation, some hypothetical examples are provided in Table 9. These are examples of issues which have been encountered and addressed at other wind farms in Australia. Should these be implemented as a management response for DREP, the response of birds and bats to these measures will be monitored and recorded in the annual report described within the BBMP. These supplementary mitigation measures are additional to the proactive risk reduction mitigation measures described in Section 4.

5.4. Specific management objectives, activities, timing and performance criteria

Table 10 summarises specific management objectives, activities, timing and performance criteria for the implementation of this BBMP. It can be used for monitoring and reporting. It includes commitments to specific objectives, management activities and controls, as well as performance criteria for measures that are known to have worked in Australia on other wind farm projects. Being specific about *all* possible mitigation measures is not possible given they are not reasonably predictable for DREP until investigation of an impact trigger gets underway. Australian experience is limited and any requirement will be triggered by circumstances unique to DREP, site and species concerned. The adaptive management framework approach of this BBMP allows for the development and implementation of a particular set of measures that are relevant, effective and warranted given the reasons for and scale of the impact, and the species concerned.

5.5. Risks to plan implementation

Implementation of this BBMP can be affected by risk factors that are hard to anticipate. Possible reasons why work to gather information and respond to impact triggers could not proceed include:

- One-off operational health and safety issues that limit access, such as turbine malfunction (likely to be very rare);
- Bushfire;
- Flooding or weather-related impact on safe access; and
- Biosecurity emergency, including a pandemic.

In the event that these arise, contingency plans will be developed to ensure that required monitoring is scheduled as soon as safely and practicably possible after the scheduled event to ensure as closely as possible compliance with this plan. Should these events create limitations to

the analysis of monitoring results then these will be described in reporting and the implications clearly described.

Apart from the risk arising from a pandemic, other risks last no more than days whereas the implementation of this plan operates on a monthly cycle. Therefore, the risk that these issues will prevent the effective implementation of the plan are considered low.

Experience implementing these plans during a recent pandemic, even under Level 4 movement restrictions indicate that energy infrastructure and its environmental compliance is an essential work activity for which a Permitted Work Permit applies. This results in no disruption to environmental compliance obligations. Pandemic conditions therefore do not represent a significant risk to the implementation of this plan.

5.6. Response to significant impact

A significant impact on the White-throated Needletail would be if the wind farm consistently, over two or more years, affected 0.1% of the estimated needletail population of 10,000 (i.e. ten or more birds per year). This threshold is based on the definition of an important population of a migratory species as defined by the DoE (2014). This definition was established before the needletail was listed as 'vulnerable' under the EPBC Act and in the absence of other guidance has been adopted. A review of this significant impact threshold will be made under this adaptive management framework where further information on the needletail and the potential impact from wind farms becomes available in Australia and/or as part of the second-year annual report for DREP should significant White-throated Needletail impact be identified.

As the White-throated Needletail is fast and far-ranging, using a wide range of habitats across a vast area, offsetting a significant impact associated with the operation of the wind farm is likely to be challenging within the terms of the EPBC Act Environmental Offsets Policy. It is expected that direct offsets until this Policy will be impractical for White Throated Needletail and this was discussed with DAWE in detail during the EPBC Act approvals process. Where an offset obligation is identified to address an ongoing risk to this species, other compensatory measures will be identified for discussion with DAWE as part of a revision of the BBMP in accordance with condition 10 of the EPBC Act Approval.

The identification of indirect offsets in accordance with the Offsets Policy would involve the performance of research on this species in the context of the potential impact of the wind farm. Indirect research-based offsets may include:

- Searches of rocky and cliffy country within 200 km of the wind farm for roost sites (if found, later to be protected in cooperation with the landowner/manager); or
- Surveys of the wider region of the occurrence of the needletail to ascertain habitat preferences;

The scope of an indirect research-based offset would be developed in consultation with, and subject to approval, by DAWE. Should an indirect offset be required, additional utilisation data from the wind farm and publicly available data will be utilised to inform the offset identified.

Table 9: Supplementary mitigation measures in the event of an impact trigger occurring – illustrative examples only

Hypothetical cause of impact	Mitigation Measure ²	Likelihood of impact continuing following mitigation	Time to implementation
Foraging source identified that attracts threatened species and 'at risk' species to impact areas	Consider the use of acoustics e.g. bird deterrent devices / irregular noise to discourage birds from foraging in this location where such noise would not impact sensitive receptors	Low	Implement at appropriate times
	Encourage species into alternative areas outside of DREP boundary, where available, through the use of social attraction techniques off-site (decoys and audio playback systems)		Implement according to agreed plan
	Remove the foraging resource proximate to turbines (in accordance with any necessary approvals)	Low	Implement according to agreed plan
Farming practice attracts threatened species to risky areas e.g. grain feeding of stock within 350m of turbines	Investigate whether farming practice is a contributing factor and if so, liaise with the landowner to relocate the issue farming practice further from turbines to reduce risk	Low	Immediately
Wind/rain/fog causing low visibility	If low visibility at DREP site is identified as contributing to the repeated mortality of threatened species from turbine strike, carcass searches may be repeated during periods of low visibility to measure mortality rates and to validate this hypothesis. If validated, further mitigation measures such as temporary turbine curtailment of those turbines found to cause the problem will be evaluated and, if deemed likely to be effective, implemented during periods of extreme low visibility. This measure is to be implemented only in the event that threatened species are experiencing or are likely to experience significant impacts and other available mitigation measures are ineffective in reducing confirmed ongoing impact to it to an acceptable level.	Low	During specific low visibility conditions identified as the cause of significant impacts on threatened species.
Attraction to lights on DREP site	Avoid high intensity lighting within DREP site e.g. consider use of light hoods or switch off lighting temporarily while species is on or near DREP site. Alternative measures include: ▪ Synchronise any flashing lights; ▪ Use red rather than white or yellow lights; ▪ Remove aviation lights, where practicable and supported by aviation authorities; and/or ▪ All building lights switched off except when needed for service work.	Low	If lights can be switched off, this should occur immediately. Alternative measures should be implemented as soon as practicable after recording the <i>impact trigger</i> .
Attraction to small dams on site	Subject to Landowner agreement, fill in dam and provide alternative stock watering arrangements (e.g. establish replacement dam further from turbines). In this semi-arid location mitigation methods to avoid having to remove dams will be adopted as an initial preference where this action will have an impact on the landowner's agricultural activities.	Low	Implement as soon as possible after recording the <i>impact trigger</i> if the dam is identified as the cause of the problem.
Nest site close to turbine	Discourage nesting close to turbines	Low	Prior to breeding season.
Perching/foraging close to turbines	Minimise perching opportunities near turbines	Low	Implement according to agreed plan
Ongoing impacts on listed threatened birds and bats	Explore, and, where considered effective for the particular circumstances, implement innovative measure for reducing impacts on these species, including, but not limited to bird and bat deterrent methods and/or a well-researched turbine curtailment protocol.	Low	Implement in accordance with the adaptive management framework set out in Figure 4, in close consultation with DAWE.

² Note that the mitigation measures in this table are potential measures. Ultimately, the chosen mitigation measures will be identified as part of the impact-trigger investigations shown in Figures 4 and 5, and may not include any of these examples if they are not evaluated as effective.

Table 10: Specific management objectives, activities, timing and performance criteria

Management objectives	Management activities and controls	Timing	Performance criteria for measuring success of methods	Responsibility	Completed (yes/no)
Pre-operational surveys	Obtaining pre-operational baseline bird and bat utilisation data	Pre-operations ▪ Bird survey ▪ Bat survey	▪ Bird utilisation surveys (point count and transect surveys) undertaken as summarised in this BBMP - see Section 2.1 and 2.2 ▪ Bat utilisation surveys undertaken as summarised in this BBMP- see Section 2.1 and 2.2	Ecologist	Yes
Operational BUS survey	Obtain operational baseline bird and bat utilisation data with a focus on species at risk	Operational ▪ Bird and bat surveys – year 1 and year 2	▪ Bird utilisation surveys (point count and transect surveys) undertaken as summarised in this BBMP - see Section 2.1, 2.2 and 3.1	Ecologist	No
Mortality monitoring	Incidental carcass searches and records	Commissioning and operational phases – ongoing	▪ All incidental carcass finds of birds and bats recorded	Operational staff of wind farm	No
	Up to 15 turbines to be surveyed each month to 120m radius, in accordance with the inner and outer zone search protocol. The same turbines will be searched each month for a period of two years. A pulse search will also be completed of each turbine.	Operational phase (once commissioning completed) monthly until end of two years in total	▪ Operational phase mortality surveys undertaken monthly at 19 turbines, for at least two years, with a review after the first year to determine if a change in methodology is required	Ecologist	No
	Calculating annual mortality of birds and bats per turbine, based on monitoring activities. Mortality estimates should include correction factors from scavenger and detector efficiency trials. The need for further surveys will be reviewed based on the results of the first two years of monitoring	Commissioning and Operational phases, at the end of each year of mortality monitoring	▪ Scavenger and detector efficiency trials (2 of each) undertaken within the first year of monitoring	Ecologist	No
Annual Reports	Preparation of Annual BBMP Reports	Operational phases – within three months of the completion of carcass searches in years one and two, and each following year of operations	▪ Annual reports for the first two years delivered within three months of completion of yearly monitoring. ▪ Annual reports to include (but not be limited to) results of monitoring surveys for that year, any <i>impact triggers</i> or significant impacts identified, mitigation measures implemented, application of the decision-making framework and recommendations for the following year ▪ Estimates of mortality for birds and bats made after 2 full years of monitoring and reported in 2nd annual report (See section 3.5)	Approval Holder's Responsible Officer + Ecologist	No
Mitigation measures to reduce risk	Carrion removal program – subject to Landowner agreement, stock and kangaroo carcasses should be removed from within 350m of turbines on a monthly basis and disposed of appropriately	During commissioning and operational phases	▪ Carcasses removed ▪ Activity recorded in dedicated register ▪ Increase frequency of stock and kangaroo carcass removal and disposal if required	Project's Responsible Officer	No No
	Subject to Landowner agreement, stock should not be fed grain within 350m of a turbine		▪ No increase in bird mortality due to grain feeding		No

Management objectives	Management activities and controls	Timing	Performance criteria for measuring success of methods	Responsibility	Completed (yes/no)
	Pest control program – Implement rabbit or other pest control if the carrion removal program suggests such pests are an issue, (subject to Landowner consultation)		Monitor effectiveness of rabbit or other pest control, and where bird mortality is clearly related to their numbers, increase the effectiveness of control		No
Mitigation measures to reduce risk	Minimising external lighting, when required. There should only be low levels of lighting on DREP site during operation, where allowed.	During commissioning and operational phases	If mortality at turbines near light sources significantly exceeds that of activity at unlit turbines, type and duration of lighting will need to be reviewed, subject to security and OH&S limitations	Project's Responsible Officer	No
	Avoid or minimise permanent lighting on the turbine entrance, buildings and sub-stations to avoid light spillage and visibility from above				No
	Baffle security lighting to avoid light spillage and visibility from above				No

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Appendix 1: Statistical Report



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making your data work harder

To: Bernard O'Callaghan
Nature Advisory
Via email

Ref #: BLADULA20200325

Date: 23 June 2021

CC: Brett Lane

Re: Review of mortality study design at Dulacca Wind Farm

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To whom it may concern:

Thank you for requesting our review of the proposed carcass detection and mortality estimate methods at Dulacca Wind Farm, QLD. This letter outlines the scope of the review and our appraisal of the study and final comments.

Scope of works

We were engaged by Nature Advisory, on behalf of RES Australia Pty Ltd, to carry out the following tasks:

- Review the proposed design of the mortality study design (including carcass searches, scavenger loss and searcher efficiency trials) for the wind farm component of the Dulacca Renewable Energy Project (DREP), QLD
- Review existing review comments from the Department of Agriculture, Water and the Environment (AWE) on same
- Prepare a letter of advice regarding the efficacy of the proposed design, referencing statistical adequacy

In reviewing the documentation, we refer specifically to the following documents

- Nature Advisory (2020) *Dulacca Renewable Energy Project Bird and Bat Management Plan*. Report No. 19103 (2.4). Prepared for RES Australia Pty Ltd (Hereafter **BBAMP**)
- We specifically refer to
 - Section 4.2 *Carcass searches* and subsections
 - other sections only as relevant to the sections under review.

About the reviewers

Symbolix is an Australian business specialising in data science and statistical analysis services. We have provided these services to the Australian Wind Energy Industry from 2004. We have provided statistical methods, models and advice throughout all stages of the wind farm lifecycle; from pre-approvals, BBAMP plan design and operational monitoring.

Our wind farm research work has been published in the Australasian Journal of Environmental Management, New Zealand Journal of Zoology, and Wildlife Society Bulletin. Our research has also been presented at industry and research conferences in Australia, New Zealand and Europe.

Our principle reviewer for this work is Dr Elizabeth Stark.

Elizabeth is a co-founder of Symbolix. She has over a decade's experience supporting environmental practice through data and analytics. She is a current Board member of the Environment Institute of Australia & NZ (the professional body for environmental professionals) and a member of the American Ecological Association. Elizabeth has delivered a number of projects for

environmental management and is currently leading a project for DEWLP (Vic) to deliver a state-wide analysis of wind farm post-construction data from multiple sites in Victoria.

Appraisal of the Mortality study program

What determines a statistically valid monitoring program

A good statistical sampling design must balance four broad considerations ([Kish 1995](#)):

- **Goal orientation:** The design must reflect the goal; e.g. to determine the mortality rate across the whole site we should sample randomly from the whole site (rather than bias to certain areas).
- **Measurability:** The design must support statistical inference/estimation, including the ability to determine measures of statistical variability (e.g. standard errors). In this project, we want to ensure the design will support the application of a Horvitz-Thompson style estimator (analytical or algorithmic) for mortality estimation.
- **Practicality:** The design must be practical. For example, assuring 95%+ detection probability is not practical within the bounds of OH&S requirements using dogs or humans (e.g. see [Moloney and Smales \(2019\)](#) for modelling of detection probabilities). However, collecting robust data to enable a Horvitz-Thompson style estimate of mortality (see next section) is practical and feasible.
- **Economy:** This is economy in the broad sense of not oversampling beyond the point required by our objectives. For instance, we will obtain a more precise estimate of the time to scavenger loss with 200 carcass trials than 20, but there is a point of diminishing returns where the extra information gathered is not justified by the effort (when such effort could potentially be used on actual conservation outcomes).

What are the required goal for the Mortality Study?

From the state conditions of approval for DREP, the BBAMP is required to identify 'at-risk' species of bird and bat, implement mitigation measures and a monitoring program (including management triggers).

In the BBAMP the response to this requirement is to propose:

- A survey program designed to estimate the total mortality of birds and bats (and species/size groups if sufficient carcasses found).
- To report on the un-expanded count of carcasses found (incidental and during formal surveys) to allow for management throughout the year.

In addition, we note the review of the previous BBAMP version by the AWE requests confirmation

"The methodology in the monitoring program [must] demonstrate that birds and bats are not colliding with turbines."

It is not likely that the wind farm will result in no collisions at all in the first two years; therefore we argue that demonstrating the above is not informative. Rather, the proposed survey program aims to produce an unbiased estimate of the overall numbers of collisions. We detail the statistical underpinnings of this program in the following letter.

Note the main goal is to estimate mortality. This letter will assess the design based on **current understanding of best practice for estimating mortality from carcass search programs**. For clarity, we outline that approach first.

Standard approach to estimation

To assess measurability, we need to establish the metric the data will feed. Mortalities at turbine i during search j $\hat{M}_{ij}$ are estimated by (Huso, Dalthorp, and Korner-Nievergelt (2015) and references therein)

$$\hat{M}_{ij} \cong \frac{C_{ij}}{\hat{g}_{ij}} \quad (1)$$

where

- C_{ij} is the number of carcasses found
- $\hat{g}_{ij}$ is the estimate of the detection probability for that search and turbine

For a given turbine, $\hat{g}_{ij}$ is a function of

$$\hat{g}_{ij} \cong a_i p_{ij} s_{ij} \quad (2)$$

- a_i is the fraction of total carcasses within the searched area
- p_{ij} is the probability that an existing carcass will be detected by the searcher
- s_{ij} is the fraction of the carcasses that arrived at turbine i but have not been lost to scavenge or decay before search j . it is a function of the rate of decay and the search interval, relative to the expected time to scavenge (Huso 2011)

Through field surveys we can estimate $\hat{a}$, $\hat{s}$ and $\hat{p}$. C is given by the field observation data.

These components estimate $\hat{M}$ (and confidence bounds) for the site and time period.

Now that we have outlined the framework, we assess the suitability of each component of the proposed design against that framework.

What is the proposed design?

The carcass survey program consists of carcass searches and adjunct surveys testing the efficiency of searchers and scavengers.

The data will be used to estimate the total mortality of birds and bats (and individual species/groups where feasible).

Carcass loss due to scavenger

Scavenger trials are proposed in two seasons of the year, corresponding to the wet season, and the dry season of the Western Downs Region of Queensland. This is with the aim of covering the range of vegetation conditions onsite (Table 8 Section 4.2.6).

Both tranches of data collection propose 10 bat replicates and 10 bird replicates (split 50:50 between medium and large/raptor sized).

Raptor carcass trials will be held in one data collection tranche, due to difficulty sourcing carcasses.

The carcasses will be distributed among different turbines. Field officers will check the continuity of carcasses at a sliding scale from daily to 4 day intervals as the age increases. In addition, there will be a camera trial used to obtain as accurate as possible a loss time. (See table 10, pp.36)

Searcher efficiency

Searcher efficiency trials will also be held in these seasons (corresponding to high and low biomass cover, See Section 4.2.7, and referencing Section 6, for coverage of different vegetation levels).

Carcasses will be distributed among turbines and the searcher being tested will carry out the standard carcass search protocol.

Carcass searches

- Minimum of 33% of the 43 turbines will be chosen at random for monitoring
- Searches using human or dog
- Inner search zone (out to 60m) with 6m transects.
- Outer search zone (from 60-120m) with 12m transects.
- The inner+outer zones will be searched once per month.

Appraisal of the design

Sampling stratification

All three component surveys are based on a single geographical site stratum.

The habitat quality for birds and bats is considered to be low in the largely cleared parts of the site, and moderate to high in most woodland areas of the site. (*Section 1.5 BBAMP*). All turbines are located in cleared agricultural land, varying distances from wooded areas.

The choice of a single stratum is reasonable in this case.

Selecting turbines at random for the carcass search sample will ensure a non-biased sample of the site geography. This is required to achieve a non-biased estimate of site mortality.

Selected turbines are maintained within the pool, and consistently revisited. This helps to reduce variance in any estimates.

The searcher efficiency and scavenger rate trials will be timed to occur at times of the year that represent low vegetation load versus high vegetation load. This is a reasonable compromise between running multiple trial throughout the year but still sampling the range of conditions that impact detection and scavenger activity.

Statistical adequacy - searcher efficiency

The number of replicates (20 per year per species type) proposed is statistically reasonable for the searcher efficiency.

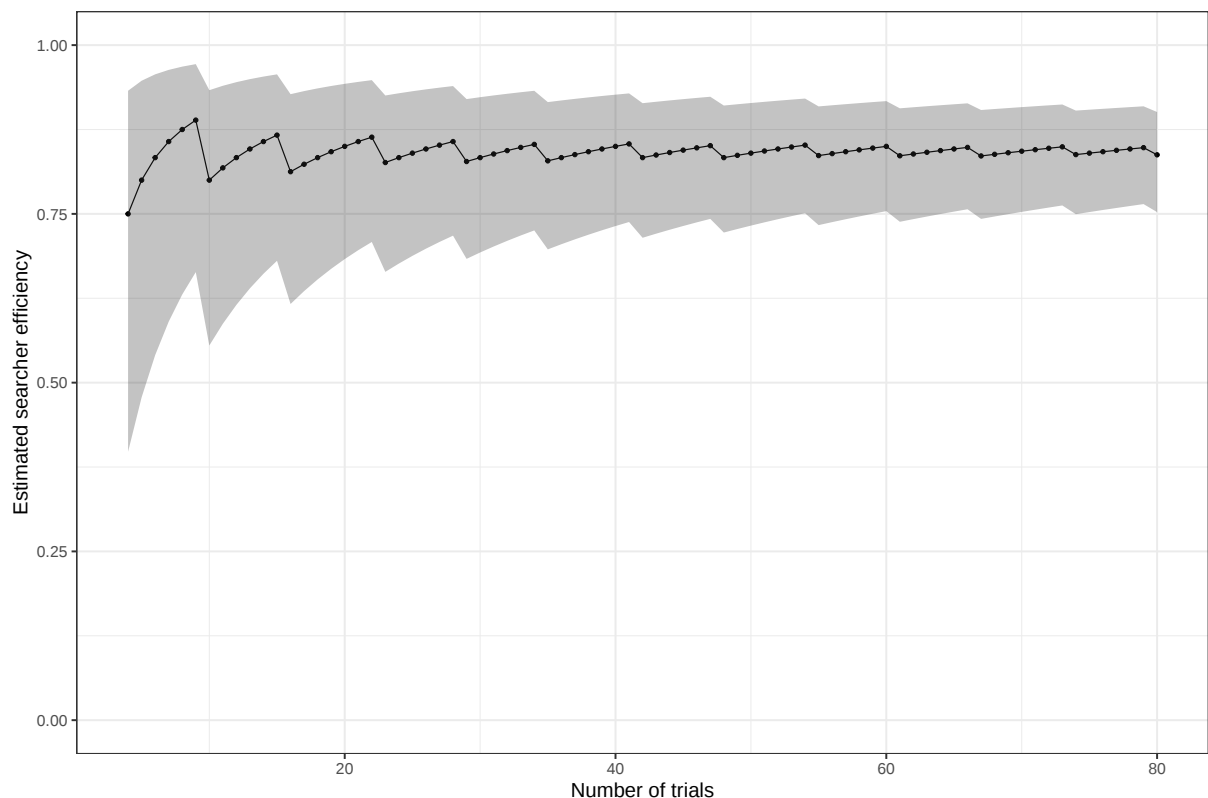


Figure 1: Estimated searcher efficiency (proportion of carcasses found) with 95% confidence bound for a given number of trials. Assumes the overall efficiency of 84.3%

The above chart (Figure 1) has been calculated (Clopper 1934) as a scenario to highlight the issues with detectability trials. We have assumed that the “true” observer efficiency is 84.3%.

The coarse black line shows us the estimated efficiency, given a field trial of known sample size, and some number of detections. The 95% confidence window is shown by the grey shaded area. The jaggedness of all curves is a known effect, due to the nature of a dichotomous variable (i.e. “I found it/I did not find it”).

There is little precision gain for adding more than 15-20 replicates for a given species class. Although the mechanism for generating time to scavenge is different to searcher efficiency, a similar result holds in that case also.

Statistical adequacy - scavenger rate trials

How precisely can we measure time to (scavenger) loss?

Estimating this parameter requires on-ground trials and analysis. Analysis should use standard survival study methods to account for the uncertainty in measuring time of loss ([Kaplan and Meier \(1958\)](#), [Terry M. Therneau and Patricia M. Grambsch \(2000\)](#)). Although cameras will be trialled, we still support survival methods to account for any unknown loss times (e.g. carcasses still in place at end of trial).

If we assume an exponential loss function for carcasses, the relative standard error is a simple function of the number of carcasses lost - $RSE = 1/\sqrt{(n)}$. As Figure 2 shows, the precision is not vastly improved by increasing the numbers of trials.

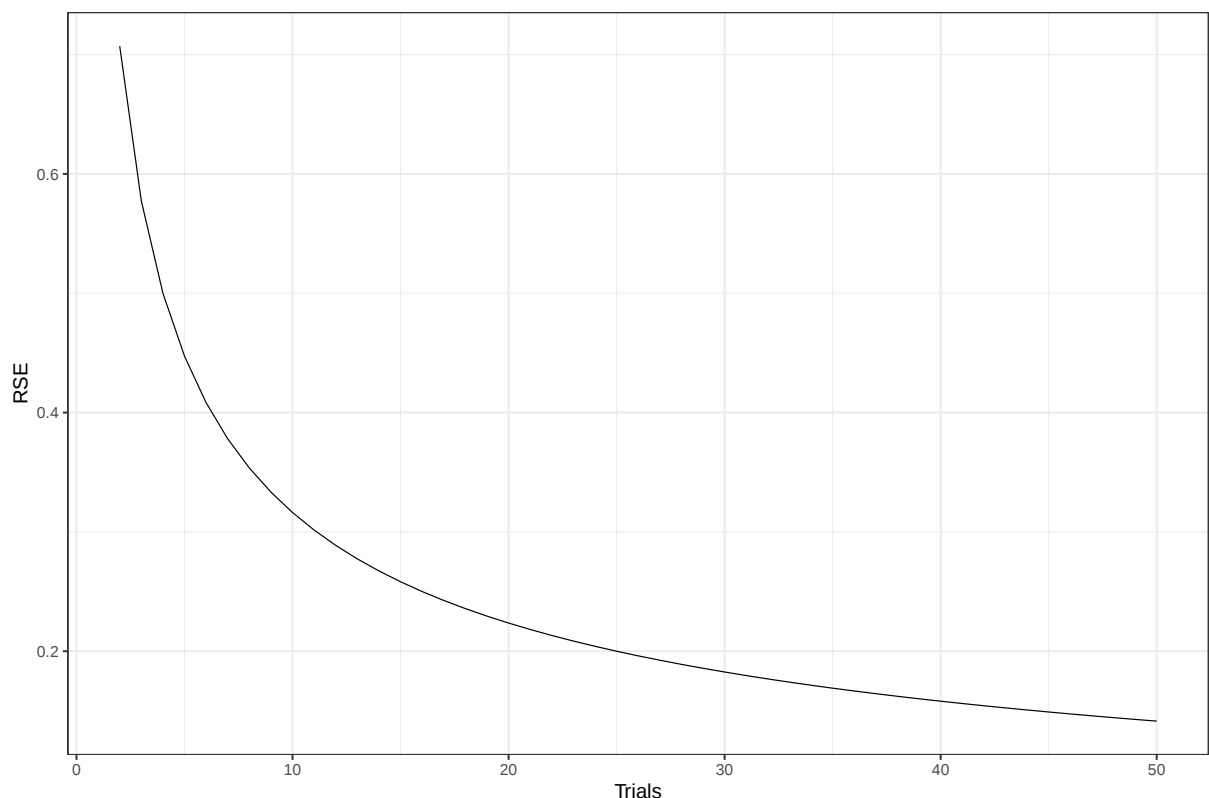


Figure 2: Relative standard error of scavenger rate as a function of carcasses lost

We would recommend 10 replicates as a minimum. The survey design proposed balances the precision requirements with the operational difficulty of sourcing carcasses.

Statistical adequacy - carcass searches

Turbine selection

The proposed carcass surveys will sample 33% of turbines (minimum). There is no strict statistical rule for the right number of turbines sampled (except there must be more than two per stratum to capture statistical variation).

It is more important to ensure the turbines are selected at random (assuming all turbines are accessible). This is the only way to enable an un-biased estimate of mortality.

We also recommend the same turbines are searched each month. Having a consistent minimum time between searches minimises the variability in estimating the chance a carcass has been lost to scavengers since the last survey.

The survey (as proposed in the BBAMP) complies with these suggestions.

Survey timing

The BBAMP specifies monthly carcass searches. This will provide an unbiased estimate of mortality if the data is analysed using a method that is aligned with the method outlined above. Monthly surveys are sufficient to provide overall estimates of birds and bats, but the variance is likely to be too large to support estimates of individual species.

This is not uncommon and why we recommend that the overall mortality estimates are combined with management triggers based on the number of carcasses found. The BBAMP complies with this advice, with impact triggers not requiring statistical estimation but based on finding the carcass of a species of concern.

Survey program duration

Regarding the adequacy of a two-year survey period (or if longer is needed), there is little published data discussing trends in post construction monitoring, but Symbolix have provided analysis of around a dozen Australian post-construction monitoring programs. In our experience there is little gained in extending the survey program (unless this is part of an agreed action following the results of the initial years). The first two years are usually sufficient to understand the magnitude of the mortality onsite (generally speaking).

Final remarks

The survey program represents standard statistical practice for estimating mortality at a wind farm. It is consistent with other sites in Queensland, NSW and Victoria, which enables future combined analysis.

Regards,



Dr Elizabeth Stark

Managing Director - Symbolix Pty Ltd;

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References

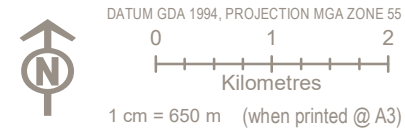
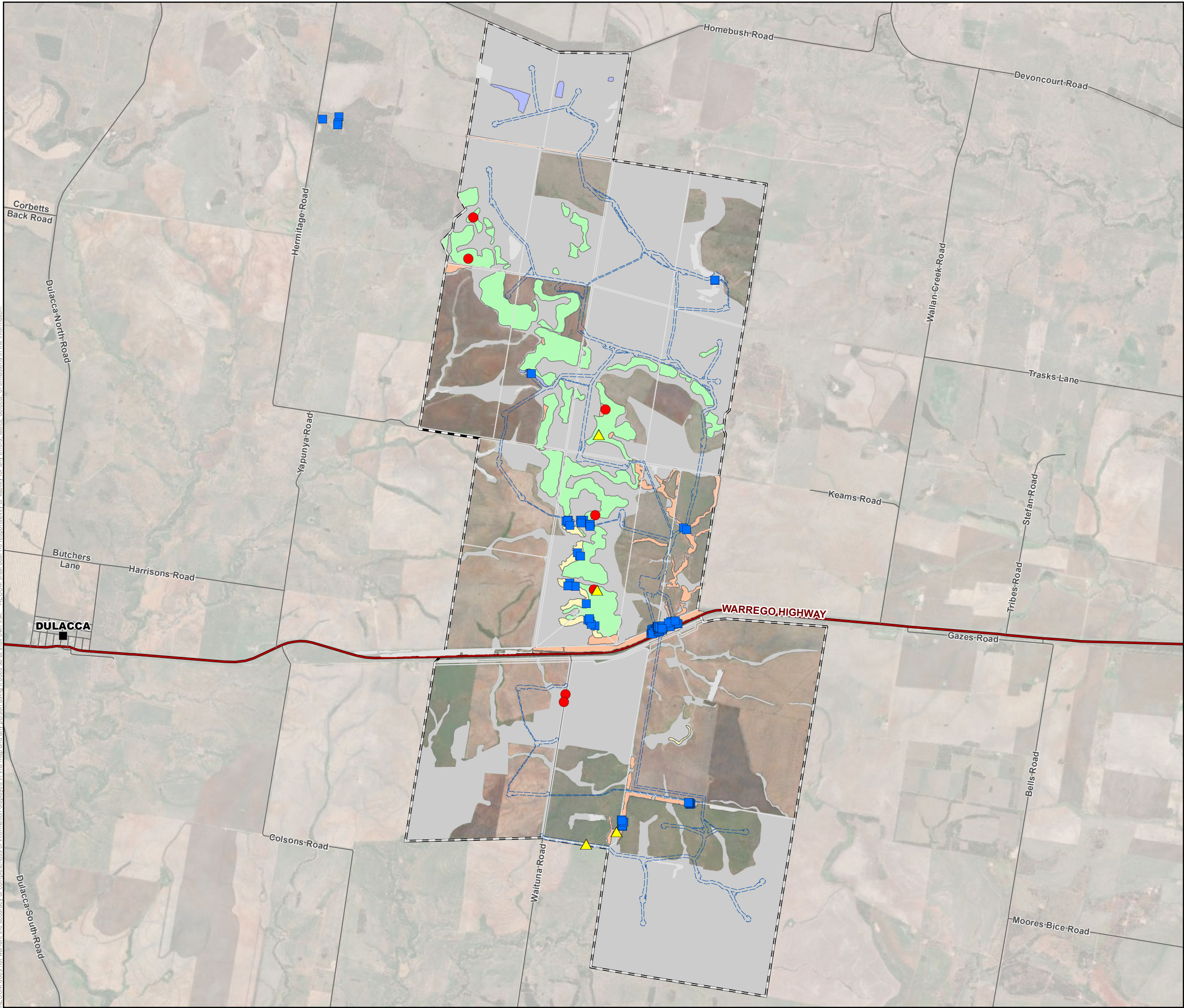
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Appendix 2: Carcass data sheet

Dulacca Renewable Energy Facility - CARCASS DATA-SHEET*				
Please fill out all details above the heavy line for each site searched All details below the line are required if a carcass is found Refer to Section 3.2.4 Carcass Detection / Turbine Strike Monitoring Protocol Do not move a carcass until the details below have been completed				
Reference number				
Date:				
Start Time:				
Finish Time:				
Turbine Number:				
Wind direction and strength in preceding 24 hours:				
Any unusual weather conditions in last 48 hours?				
Distance of Carcass from Tower (m):				
Bearing of Carcass from Tower (magnetic deg):				
Preliminary Species Identification:				
Photo Taken**	Yes / No			
Signs of injury:				
How old is carcass estimated to be (tick category):	<24 hrs	1-3 days	> 3 days	Other
Other Notes (i.e. sex/age of bird) and substrate:				
Post Find Actions: 1. Place carcass in sealable plastic bag then wrap it in newspaper and into another plastic bag (with copy of this sheet within) and take to freezer at site office. 2. Contact project ecologist to confirm identification of carcass				
* One form should be completed for each carcass found				
** Please attach photos to this form				

Appendix 3: Fauna habitats of the DREP site (source: AECOM 2019)

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Legend

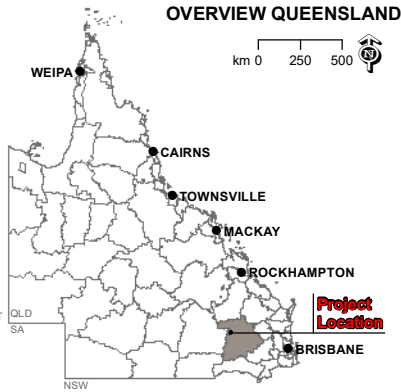
- Study Area (8,177 ha)
- Disturbance Footprint
- Highway
- Other roads

Conservation Significant Species

- Echidna
- Fork-tailed swift
- Dulacca Woodland Snail

Fauna Habitat Type

1. *Eucalyptus crebra* open woodland on laterite
2. *Acacia harpophylla* and *Casuarina cristata* open forest on fine-grained sedimentary rocks
3. *Acacia harpophylla* and *Eucalyptus* species woodland
4. Non remnant vegetation, including creek lines and dams
5. Semi-evergreen vine thicket



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2. Local Government Areas © State of Queensland (Department of Natural Resources and Mines) 2017
3. Place names gazetteer - Queensland © State of Queensland (Department of Natural Resources and Mines) 2017
4. Baseline roads and tracks Queensland © State of Queensland (Department of Natural Resources and Mines) 2017
5. Rail network - Queensland © State of Queensland (Department of Natural Resources and Mines) 2017
6. Electrical Network - Ergon Energy 2018
7. World Topographic Base Map © Esri, HERE, DeLorme, Intermap, Incormet P Corp., GEBCO, USGS, FAO, NPS, NRCAN, Geobase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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DULACCA RENEWABLE ENERGY PROJECT

FAUNA HABITAT TYPES AND
CONSERVATION SIGNIFICANT FAUNA SPECIES

PROJECT #: 60567855
CREATED BY: AS
LAST MODIFIED: 16/10/2020
VERSION: 2

Figure
2