Palmer Wind Farm

Bird and Bat Management Plan

Final

April 2026

umwelt

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Prepared by
Umwelt (Australia) Pty Limited

On behalf of
Palmer Wind Farm Pty Ltd as trustee for Palmer Wind Farm Project Trust

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt acknowledges the Traditional Owners of Country throughout Australia and their continuing values, culture and connection to the land, waters and sky.

We pay our respects to Elders past and present.

The below image is from the artwork *Yapung Maryiyang* (Pathway Forward) by Saretta Fielding.

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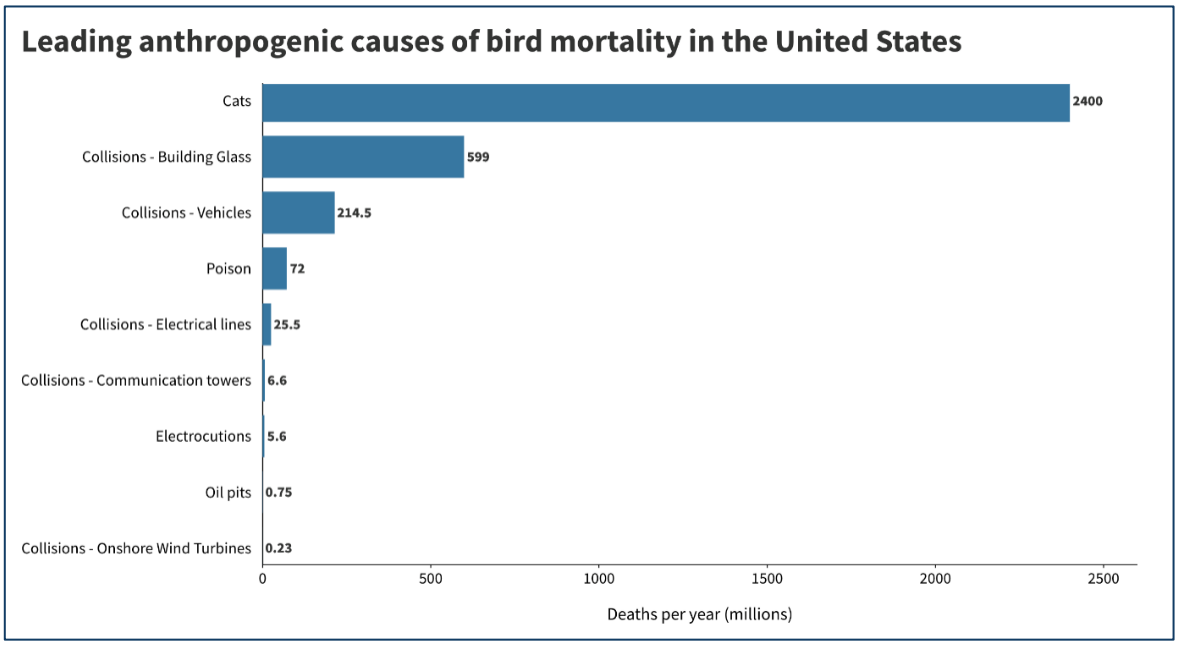
Preface

The operation of wind energy developments results in mortality of birds and bats, primarily through collision with turbine blades and barotrauma associated with rapid air-pressure changes near operating turbines. These impacts are measurable and site-specific, varying with turbine design, placement, local species composition, and operational practices (Marques, et al., 2014). Certain taxa—such as micro-bats and some large soaring raptors are more susceptible than others.

When evaluated in the broader context of anthropogenic mortality, however, wind energy contributes a relatively small proportion of total human-caused bird and bat deaths. Studies conducted in the United States estimate that wind farms likely account for less than 0.01% of total bird deaths annually (US Fish & Wildlife Service, 2017). Other more significant sources of avian mortality include domestic and feral cats, collisions with buildings and windows, vehicles, power lines, and communication towers, as well as habitat loss and degradation driven by urbanisation, agriculture, and resource extraction.



Importantly, climate change—driven largely by fossil fuel combustion—is increasingly recognised as a significant long-term threat to both birds and bats through altered habitats, shifting prey availability, extreme weather events, and changes in migration patterns (Jenouvrier, 2013). In this context, wind energy can be viewed as both a source of localised wildlife impacts and a tool for mitigating broader, systemic risks associated with greenhouse gas emissions.

Overall, while wind farms do pose risks to birds and bats, these impacts are generally smaller in magnitude than those from many other anthropogenic sources and can often be reduced through careful site selection, design and consideration of emerging technological improvements. As such, assessments of wind energy impacts are most appropriately framed within a comparative, cumulative-risk perspective that accounts for both direct wildlife effects that are addressed by this Bird and Bat Management Plan and the broader environmental benefits of renewable energy deployment.

Abbreviations

Abbreviation	Definition
BBMP	Bird and Bat Management Plan
BBUS	Bird and Bat Utilisation Survey
COEMP	Construction and Operational Environment Management Plan
Commission / Commissioning	All activities, including turning of turbines, after the components of the first complete wind turbine are installed. The date on which commission/commissioning commences is the first date on which the blades of the first completed wind turbine start rotating.
Developer	Palmer Wind Farm Pty Ltd as trustee for Palmer Wind Farm Project Trust
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEM	Department of Energy and Mines
DEW	Department for Environment and Water (SA)
EBS Ecology	Environmental and Biodiversity Services Pty Ltd – trading a EBS Ecology (which is now Umwelt)
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Detection Act 1999*
Feather-spot	A collection of five or more feathers found grouped together in a manner that suggests a dead bird was once at the location.
Feather-spot (Scavenger Trial)	A collection of feathers remaining after a carcass used in a scavenger trial has been scavenged.
HRE Act	*Hydrogen and Renewable Energy Act 2023*
kV	Kilovolt
MLR	Mount Lofty Ranges
MMC	Mid Murray Council
MW	Megawatt
NPW Act	*National Parks and Wildlife Act 1972*
The Development	The Palmer Wind Farm Project
Project Area	The area (or boundary) in which the Development will be located
REIL	Renewable Energy Infrastructure Licence
RSA	Rotor-swept Area
SA	South Australia
SCAP	State Commission Assessment Panel
SPC	State Planning Commission
Symbolix	Symbolix Pty Ltd
Umwelt	Umwelt (Australia) Pty Ltd
WTG(s)	Wind Turbine Generator(s)

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1.0 Introduction

1.1 Background

The Palmer Wind Farm Project (the Development) is located approximately 50 km east of Adelaide, near the townships of Palmer and Tungkillo (**Figure 1.1**) and wholly contained within the Mid Murray Council (MMC) Local Government Area. Palmer Wind Farm Pty Ltd as trustee for Palmer Wind Farm Project Trust (the Developer), is proposing to construct and operate up to 40 wind turbine generators, totalling approximately 288 megawatts (MW) of installed generation capacity as part of the Project, with associated wind farm infrastructure. The Project will connect to the national electricity grid via the existing Tungkillo Switchyard, owned and operated by ElectraNet.

The State Commission Assessment Panel (SCAP) (of the Government of South Australia) resolved that the Development is not considered at variance with the relevant Desired Outcomes and Performance Outcomes of the Planning and Design Code pursuant to section 107(2)(c) of the *Planning, Development and Infrastructure Act 2016*. The Development was granted Planning Consent subject to Reserved Matter 10 (**Table 1.1**), which is relevant to this Bird and Bat Management Plan (BBMP):

> *A Bird and Bat Monitoring Plan which sets out the monitoring and reporting requirements in relation to bird and bat strikes and fatalities, the monitoring timeframes, and proposed response processes, shall be prepared in consultation with the Department for Environment and Water and submitted to the satisfaction of the State Planning Commission [SPC].*

This BBMP specifically addresses the requirements of Reserved Matter 10. The Development will be carried out generally in accordance with the Construction and Operational Environmental Management Plan (COEMP) during the construction and operation of the Palmer Wind Farm.

Construction of the Development is planned to commence in mid-2026, with the operation of the Development scheduled to commence from late 2028.

1.2 Purpose and Objective of the BBMP

This BBMP presents a strategy to monitor and mitigate impacts including to birds and bats attributable to the operation[1] of the Development. Suitable design considerations (e.g. setback to raptor nests) and construction controls will be implemented through the other phases of the Development to manage potential impacts to bird and bat species.

The overall objective of this BBMP is:

> ***To ensure the Development does not result in a significant impact on birds and bats by retaining viable local populations of threatened species.***

[1] Commencement of wind farm operation is defined as the date when all of the following have occurred: All turbines are commissioned and tested (including testing dependent on wind conditions); All turbines have been handed over from the Supply and Installation Contractor to the Developer; and Australian Energy Market Operator testing is complete (grid compliance testing).

An assessment of the likelihood and consequence of direct impacts such as blade strike was conducted for 11 bird species that are listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the *National Parks and Wildlife Act 1972* (NPW Act) and 15 non-listed species (refer to **Section 4.0**). Eight species, namely Wedge-tailed Eagle (*Aquila audax*), Brown Falcon (*Falco berigora*), Australian Kestrel (*Falco cenchroides),* Peregrine Falcon (*Falco peregrinus*), Rainbow Bee-eater (*Merops ornatus*), Elegant Parrot (*Neophema elegans*), Australian Pelican (*Pelecanus occidentalis*) and Diamond Firetail (*Stagonopleura guttata*), and were identified as being of 'medium' risk.

An assessment of the likelihood and consequence of direct impacts such as blade strike was conducted for two bat species that are listed under the EPBC Act and/or the NPW Act and 10 non-listed species (refer to **Section 4.0**), the latter of which are listed below:

- Chocolate Wattled Bat (*Chalinolobus morio*).
- Inland Freetail Bat (*Mormopterus species 3)*.
- Southern Freetail-Bat (*Mormopterus species* 4)
- Lesser Long-eared Bat (*Nyctophilus geoffroyi*).
- Inland Broad-nosed Bat (*Scotorepens balstoni*).
- White-striped Freetail-Bat (*Tadarida australis*).
- Large Forest Bat (*Vespadelus darlingtonia*).
- Southern Forest Bat (*Vespadelus regulus*).
- Small Forest Bat (*Vespadelus vulturnus*).

All 10 non-listed species were identified as being of 'medium' risk. The Bird and Bat Risk Assessment for the Palmer Wind Farm (EBS Ecology 2024a) can be referred to in **Appendix A.**

This environmental objectives of this BBMP, including a table of commitments to achieve these objects, are outlined in **Section 2.0**. Details of the Developer's regulatory requirements and commitments in relation to operational bird and bat management are summarised in **Table 1.1**, including where these requirements have been addressed in this BBMP.

Table 1.1 Bird and Bat Management Plan Requirements

Reference	Requirement / Commitment	Where addressed in this BBMP
Planning Consent (Development Application No: 24005571)		
Reserved Matter 10	A Bird and Bat Monitoring Plan which sets out the monitoring and reporting requirements in relation to bird and bat strikes and fatalities, the monitoring timeframes, and proposed response processes, shall be prepared in consultation with the Department for Environment and Water and submitted to the satisfaction of the State Planning Commission.	This Plan
	- *Bird and bat strikes and fatalities*	**Section 5.0**
	- *Monitoring timeframes*	**Section 5.0** **Section 6.0** **Section 7.0**
	- *Response processes*	**Section 5.0**

Reference	Requirement / Commitment	Where addressed in this BBMP
		Section 6.0 **Section 7.0**
Native Vegetation Clearance Approval (Decision Plan: 2025/3236/711)		
Condition 12	A monitoring program to be developed to include twice-yearly monitoring of bird-strike to occur over a minimum of 5 years (minimum 100m radius) a sample of wind turbines using established scientific methods, to be undertaken by an appropriately qualified scientist and to include identification of all carcasses located. Monitoring to commence within one year of wind farm construction.	**Section 5.4**
Condition 13	Results of the monitoring in Condition 12 to be reported in writing to the Native Vegetation Council each year for a minimum of 5 years.	**Section 1.2**
Statement of Commitments (Development Variation Application)		
4.5/3	Within one year after construction of turbines in a turbine area, the operator will implement a bird monitoring program in respect of the turbine area that provides for annual monitoring, for a minimum of five years, of all nest sites of Wedge-tailed Eagles and Peregrine Falcons recorded in the turbine area in the EBS Ecology Report "Flora and Fauna Impact Assessment" dated 16 February 2024. Monitoring is to be undertaken in accordance with established scientific methods and at a minimum must identify whether each nest is active and whether young have successfully fledged from the nest. The operator will provide a report of the results of the monitoring to the Mid Murray Council each year for a minimum of five years.	**Section 3.2 and Section 5.2.2**
4.5/4	Following construction of turbines in a turbine area, the operator will maintain a register of bird mortalities in respect of the turbine area for a minimum period of 5 years. The register will record the location of any bird carcasses that are found by the operator's employees or contractors within the turbine area that are reasonably attributable to birdstrike, the date that the carcass is found, and identification of the species of the bird to the extent that the operator can make an identification using reasonable endeavours. The operator will provide a copy of the register to the Mid Murray Council each year for a minimum of five years.	**Section 5.4**

1.3 Site Description

The Development is located approximately 50 km east of Adelaide near the centre of the Mount Lofty Ranges (MLR), South Australia (SA) (**Figure 1.1**). Land use within the area is predominantly agricultural (e.g. grazing for sheep and cattle). Native vegetation in the area has been extensively cleared historically, with most of the footprint containing grassland with large outcrops of rock and boulders. Remaining native vegetation is typically located on private land. Woodland vegetation is generally restricted within small patches and within creeklines (EBS Ecology 2024b). It is situated within the Murraylands and Riverland Landscape Management Region.

Fourteen broad vegetation associations are mapped across the Project Area (EBS Ecology 2024b). *Austrostipa* sp. grasslands with high incursions of introduced herbs and grasses are widespread across the Development. Very open *Eucalyptus* spp. woodlands are more common in the south as well as pockets of *Eucalyptus* spp. woodlands which are limited to small areas, often where isolated landscape features, such as drainage lines and steep hills, occur.

Vegetation condition varies from poor to excellent, with poor condition vegetation observed in the grasslands. Higher quality vegetation occurs in the gorge areas, which generally do not experience sheep grazing due to the steep terrain. In total, grasslands make up 77.07 % of the Project Area, woodlands make up 15.28 %, shrublands make up 1.27 % and sedgelands make up 0.19 % of the Development. The remaining 6.19 % of the Project Area is mapped as amenity or cropping with scattered trees.

The assemblage of bird and bat species that occur within the Project Area is typical of areas containing native grasslands mixed in with woodland and shrubland, set within an agricultural landscape of the eastern MLR.

1.4 Overview of the Development

The Development will consist of WTGs with associated infrastructure including substations, access tracks, transmission lines and underground cabling. The main components include:

- Forty (40) WTGs distributed approximately 13 km from north to south along the flank of the eastern MLR.
- The WTGs are three-bladed, variable speed, pitch regulated machines with a rotor and nacelle mounted on a cylindrical steel tower.
- WTGs distributed in two clusters:
    - Area B (central) – 19 WTGs.
    - Area C (southern) – 21 WTGs.
- Maximum overall height of the WTGs (to blade tip) of 212 m, with a blade length of 86 m and the distance of the tip of the blade to the ground being 40 m. Further detail is provided in **Section 1.4.1** (**Table 1.2**).
- Overall electricity generation capacity of approximately 288 Megawatt (MW).
- Each WTG sited within a hardstand area of approximately 80 m x 40 m.
- A network of internal access tracks of up to 10 m carriageway width, linking wind farm infrastructure and to provide access to and from public roads.
- Underground 33 kilovolt (kV) transmission cables and fibre optic cabling.
- Overhead 33 kV transmission lines comprised of up to 2 circuits (6 conductors) on a single pole with steel poles of up to 30 m in height and spaced approximately 250-300 m apart.
- Overhead 275 kV transmission line approximately 12 km in length, comprised of lattice towers and steel monopoles up to 55 m high and spaced approximately 300-600 m apart.
- Substation, operations, and maintenance facilities occupying a total site area of approximately 5.5 ha and consisting of:
    - Two permanent 33 kV / 275 kV substations, each approximately 150 m x 150 m
    - Operations and Maintenance Facility of approximately 100 m x 100 m and including buildings, car park, and workshop.
- Three permanent and three temporary meteorological masts of 130 m height.

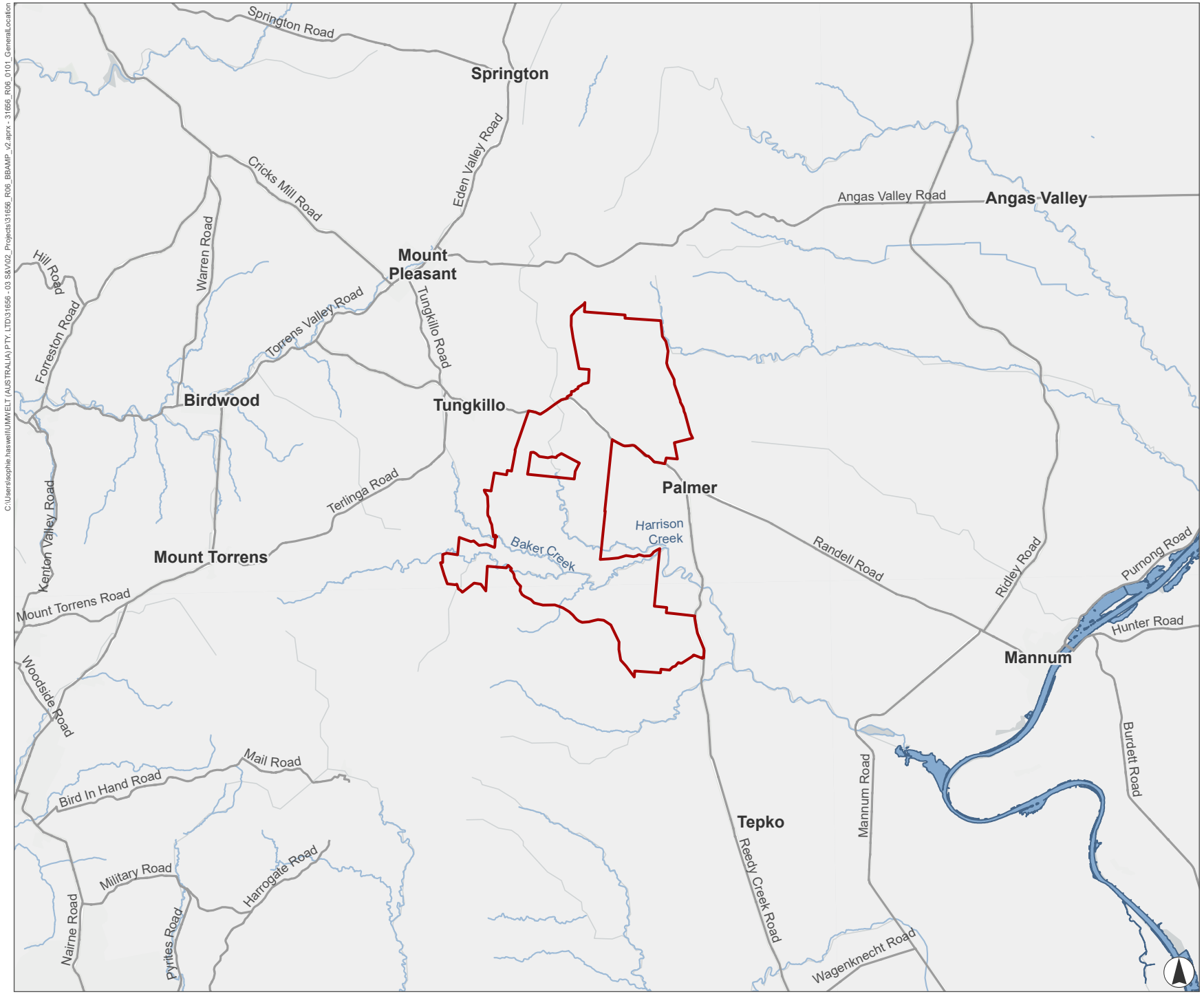
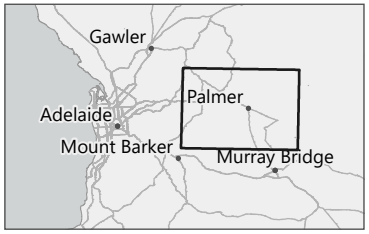


FIGURE 1.1
Development Location

Legend

- Project Area
- River Murray
- Watercourse
- Main road



0 2 4

Kilometres

Scale 1:200,000 at A4
GDA2020 MGA Zone 54

Image Source: ESRI Basemap (2025) | **Data Source:** Umwelt, Tilt, DIT, DEW (2025)

1.4.1 Wind Turbine Generators

The selected wind turbines for the Development are a three-bladed design with a maximum rotor diameter of 172 m, a 212 m tip height, resulting in a 40 m ground clearance (**Table 1.2**). A comparison of the approved wind turbine specifications and the final selected wind turbine are provided in **Table 1.2**. The rotor diameter is the width of the circle swept by the rotating blades (**Figure 1.2**). The circle the blades rotate through is known as the rotor-swept zone or rotor-swept area (RSA).

Table 1.2 Summary of WTG Specifications – Approved and Telected Turbine

WTG specifications	Approved Parameters	Selected Wind Turbine (V172)
Maximum WTG height (at blade tip)	220 m	212 m
Maximum blade length	90 m	86 m
Maximum rotor diameter	180 m	172 m
Rotor-swept area (RSA) (height above ground)	40 – 220 m	40 – 212 m
Number of turbines	40	40
Total RSA per turbine	25,447 m^2	23,235 m^2
Total RSA	1,017,876 m^2	929,400 m^2

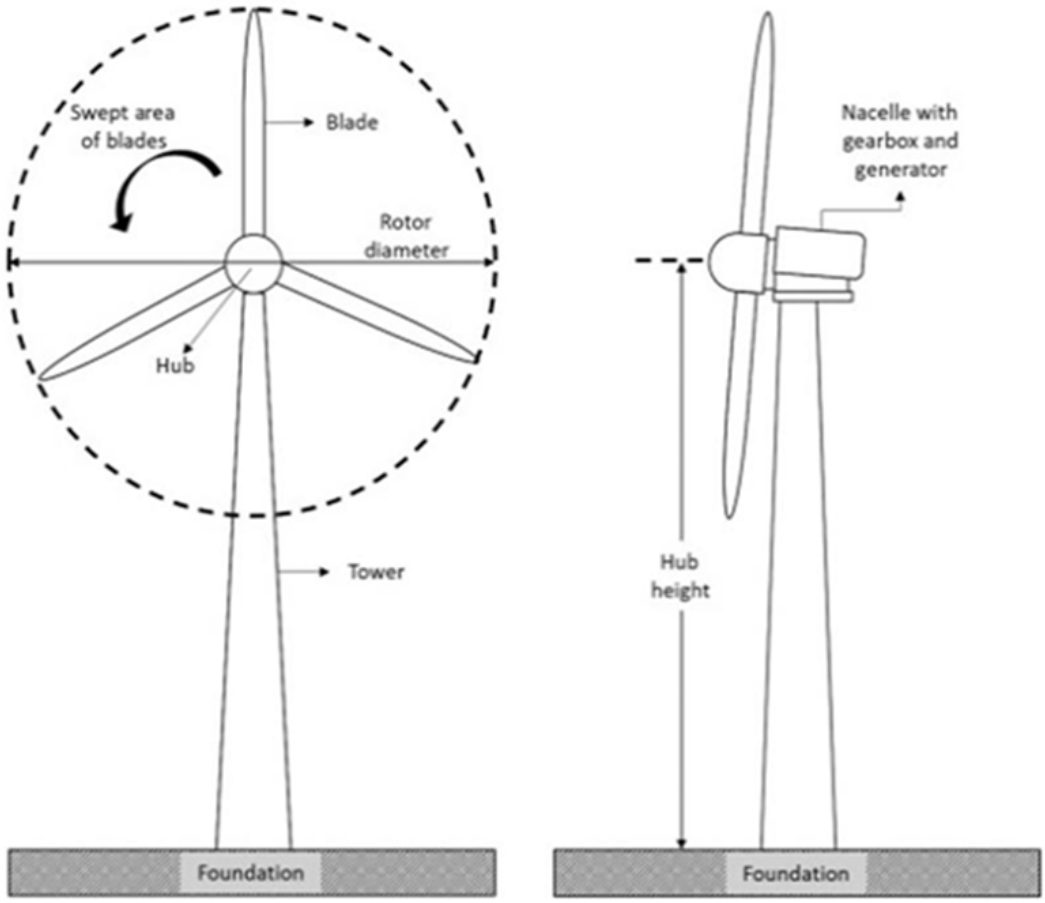


Figure 1.2 Schematic Diagram of Turbine Elements of a Three-bladed Turbine

(source: https://www.sciencedirect.com/topics/engineering/horizontal-axis-wind-turbine)

1.5 Legislation and Other Environmental Management Requirements

Legislation and guidelines relevant to this BBMP includes:

- *National Parks and Wildlife Act 1972*.
- *Planning, Development and Infrastructure Act 2016*.
- *Hydrogen and Renewable Energy Act 2023*.

The Development was referred to the Minister for Environment and Water for consideration of whether it constituted a controlled action, requiring assessment and approval under the EPBC Act (EPBC 2024/09884). On 25 July 2024, the Minister determined that the Development does not require assessment or approval under the EPBC Act and therefore the BBMP has been prepared to address matters relevant to State legislation.

The contents of this BBMP will be submitted to the SPC for approval in line with the conditions of the Development Approval. The Development is required to transition to the *Hydrogen and Renewable Energy Act 2023* (HRE Act) and a Renewable Energy Infrastructure Licence (REIL) prior to the commencement of operations. On transition to the HRE Act regime, references to SPC and/or Department for Housing and Urban Development will be replaced by the Department of Energy and Mines (DEM).

1.6 Consultation

This Plan will be prepared in consultation with Department of Environment and Water (DEW), with a review already completed by Symbolix Pty Ltd. Symbolix are an Australian data science consultancy who provide advice, analysis-as-a-service and custom solutions for data-driven management. As outlined in **Appendix B**, Symbolix have provided technical advice on the following:

- The proposed survey frequency and proportion of turbines.
- The frequency and design of carcass persistence and searcher efficiency trials.
- The selection of the turbines to be surveyed and the allocation of turbines across Areas B and C.
- The effect of the survey frequency, radius and proportion of turbines on survey effort.

2.0 Environmental Objectives

2.1 Environmental Objectives and Commitments

This BBMP has been developed to align with contemporary bird and bat management plans for onshore wind developments. The environmental objectives (**Table 2.1**) and commitments (**Table 2.2**) within the BBMP seek to align with both the requirements of the regulatory approvals (refer to **Table 1.1**), and ensure that quantification of impacts is achievable. This would allow for proposed mitigation or further avoidance measures to be based on scientifically robust evidence.

Table 2.1 Environmental Objectives of the BBMP

Environmental Objectives	
Operational Phase Monitoring	• To detail survey methods to monitor any changes or trends in bird and bat occurrence or behaviour during the operational phase to enable assessment of whether any such changes may be influenced by the operation of the Development. • To detail a carcass detection program to monitor and record the number of incidences of blade/infrastructure strike or barotrauma resulting in bird or bat mortality to facilitate assessment of the significance of any findings. • To detail carcass persistence and detectability trials to inform estimation of mortality rates.
Bird and Bat Risk Assessment	• To estimate relative levels of collision or barotrauma risk for certain 'at-risk' species allowing for a focus on key species of consequence.
Impact Triggers	• To identify unacceptable impacts on bird and bat species considered to be at highest risk of significant impacts.
Mitigation Strategy and Notification	• To provide a summary of the process to select management actions required if an impact trigger is met. • To provide details on mitigation measures to manage bird and bat strike or barotrauma at the Project.
Reporting Requirements and BBMP Review	• To detail reporting requirements relating to bird and bat surveys, carcass search surveys and impact triggers. • To provide details of the review of this BBMP.

Table 2.2 Commitments to Achieving the Environmental Objectives of this BBMP

Environmental Objectives	Commitments	Where addressed in this BBMP
Operational Phase Monitoring	• The Developer will undertake surveys by suitably qualified and trained ecologists to monitor any changes or trends in bird and bat occurrence, abundance, or behaviour during pre-construction and operational phases to enable assessment of whether any such changes may be influenced by the operation of the Development. The Developer will undertake these surveys, using conservations dogs and/or suitably qualified and trained ecologists, as detailed in **Section 5.0** of this BBMP. • The Developer will undertake a detailed program to monitor and record the number of incidences of blade / infrastructure strike or barotrauma resulting in bird or bat mortality to facilitate assessment of the significance of any findings. The Developer will undertake this program as detailed in **Section 6.0** of this BBMP. • The Developer will undertake carcass persistence and detectability trials by detection dogs (or by suitably qualified and trained ecologists) to inform estimation of mortality rates. The Developer will undertake this program as detailed in **Section 5.5** and **Section 5.6** of this BBMP.	**Section 5.0**
Bird and Bat Risk Assessment	• Umwelt (on behalf of the Developer) has undertaken a bird and bat risk assessment that has estimated the relative levels of collision or barotrauma risk for perceived 'at risk' species (EBS Ecology 2024a) (**Appendix A**).	**Section 5.0**
Impact Triggers	• Eight bird species and 11 bat species were identified as being a 'medium' risk (**Section 1.2**), of mortality. The Developer will follow the impact trigger and response procedures for both threatened species and raptor species as detailed in **Section 6.0** of this BBMP.	**Section 6.0**
Mitigation Measures and Reporting	• The Developer has provided a summary of management actions required in the event that an impact trigger is met. The Developer will follow these management actions in the event that an impact trigger is met as detailed in **Section 6.2.** • The Developer has provided details on mitigation measures to manage bird and bat mortality associated with the Development. The Developer will consider these mitigation measures to manage bird and bat strike or barotrauma as detailed in **Section 6.2**.	**Section 6.2**
Reporting Requirements and BBMP Review	• The Developer has provided detailed reporting requirements relating to bird and bat surveys, carcass search surveys and impact triggers. The Developer will undertake these reporting requirements as detailed in **Section 8.0**. • The Developer has provided details of the review of this BBMP. The Developer will undertake review of this BBMP as detailed in **Section 8.2**.	**Section 8.0**

2.2 Risks to Achieving the Environmental Objectives

A summary of potential risks that could inhibit the BBMP achieving its environmental objectives in accordance with the regulatory requirements (refer to **Table 1.1**), are provided below:

- Equipment failure, including but not limited to vehicles and microbat recording devices, could potentially result in reduced survey data for a particular survey program.
- Use of detection dogs poses its own risks (e.g. injury or sickness of the animal during detection work due to environmental or other conditions).
- Environmental conditions, including wet weather, bushfires, excessively hot temperatures (>40 degrees Celsius) and other extreme weather events, could present operational safety limitation posing a risk to survey scheduling.
- Potential landholder access issues (e.g. lambing occurring at particular times of the year, and sheep disease present at some properties in the northern section of Area B).
- Operational and maintenance work proposed to wind turbines or other infrastructure could pose a risk through access prevention.

There are no identified risks considered to have the potential to compromise the BBMPs ability to implement the mitigation strategy or reporting requirements or successfully report on the methods and results of the BBMP or outcome of future reviews of the BBMP.

As described above, most potential risks of the BBMP not achieving the environmental objectives relate to the operation phase of the monitoring, specifically being survey scheduling and resourcing. The risk is often identified prior to it occurring and the necessary responsive action can be identified in a timely manner. For example, a survey can be readily rescheduled, or an alternative ecologist resource can be mobilised without compromising the integrity of the monitoring survey program or subsequent statistical analysis.

3.0 Pre-construction Bird and Bat Surveys

The Development has a long timeline of ecological surveys through its development phase, with avian surveys of the Project Area initially commencing in February 2013. Formal Bird and Bat Utilisation Surveys (BBUS), aligning with the requirements of the Onshore Wind Farm Guidance (DCCEEW 2024), were initiated in November 2022 and seven BBUS were undertaken until May 2024. The presence, species use and abundance are well understood through both the historical and contemporary avian surveys of the Development.

3.1 Bird Surveys

Initial bird surveys were undertaken at the site during the summer and winter of 2013 and are described in the Flora and Fauna Assessment Report (EBS Ecology 2014). The point count survey sites selected during the previous survey work, provided the basis for the BBUS monitoring that was undertaken from spring 2022 to winter 2024.

Fourteen (14) survey sites were established across a range of different vegetation associations in the Project Area. A total of 6,447 individuals from 91 bird species were observed at BBUS sites and 226 individuals from 35 bird species observed opportunistically. A total of 6,673 individuals were recorded across the seven survey periods in the Project Area. A total of five threatened species listed under the EPBC Act and/or the NPW Act were observed across the seven survey periods as detailed in **Table 3.1**.

Table 3.1 Bird species Listed under the EPBC Act and/or NPW Act Recorded Within the Project Area

Scientific Name	Common Name	EPBC Act	NPW Act
Aphelocephala leucopsis	Southern Whiteface	VU	-
Falco peregrinus macropus	Peregrine Falcon	-	R
Falco subniger	Black Falcon	-	R
Neophema elegans	Elegant Parrot	-	R
Stagonopleura guttata	Diamond Firetail	VU	-

Conservation codes: VU: Vulnerable. R: Rare.

3.2 Raptor nests

Ecological desktop and field surveys have been undertaken for the Development from 2012 to 2025, including surveys and reports prepared for earlier iterations of the Development. A high-level summary of all raptor nest surveys conducted for the Development are summarised in **Table 3.2.**

Table 3.2 Summary of Surveys Relevant to Raptor Nest Identification and Monitoring (2012-2025)

Survey	Dates
Bird and bat surveys	18-20 February 2013
Bird and raptor nest inspections	21-23 August 2013

Survey	Dates
Bird and bat analyses	29 October – 2 November 2013
Assessments of bird species in gorges and additional bird surveys	25-27 November 2013
WTE nest assessment	9-10 March 2022
WTE and Peregrine Falcon nest assessment	17-21 October 2022
Bird utilisation survey (spring 2022) Bird utilisation survey (summer 2023) Peregrine Falcon habitat assessment and Bird utilisation survey (autumn 2023)	7-11 November 2022 23 – 25 January 2023 26 – 28 April 2023
Bird utilisation survey (winter 2023) Bird utilisation survey (spring 2023)	10 – 13 July 2023 16 – 18 October 2023
Bird utilisation survey (summer 2024) Bird utilisation survey (autumn 2024)	5-7 February 2024 20-22 May 2024
WTE nest and Peregrine nest assessment	21 May 2024 2 October 2024

Surveys conducted in 2013 identified the locations of 10 WTE nests and 4 Peregrine Falcon nests both within and surrounding the Project Area.

During the October 2022 surveys, WTE and Peregrine Falcon nest locations were revisited to determine the breeding success (if any) of individual birds present, including all WTE and Peregrine Falcon nests within the Project Area and those outside the Project Area where access was granted from landowners. The location, dimensions and signs of activity were recorded for each nest (Umwelt 2025a).

For WTE, sightings and behaviours were recorded during all survey periods. Photographs of each of the nesting sites were taken and the occupancy of a nest site was assessed as well as its status, particularly through the spring breeding period. The presence of a chick, fledgling or adult WTE, in or near the nest, was determined. Any eagles flying from the area upon arrival were also recorded. Other parameters were also used as an indication of nest occupancy such as fresh whitewash (bird excrement), prey remains on the ground beneath or within the nest and the presence of green leaves in the nest bowl (when views were available) (Umwelt 2025a).

For Peregrine Falcons, one nest was observed in use within the Project Area during the October 2022 surveys. In February 2023, suitable nesting habitat for Peregrine Falcons was initially defined via aerial imagery, after which field assessments were undertaken to ground truth the extent of suitable Peregrine Falcon nesting habitat based on known nesting preferences.

As part of the commitments summarised in **Table 1.1**, the operator will:

> *Implement a bird monitoring program in respect of the turbine area that provides for annual monitoring, for a minimum of five years, of all nest sites of Wedge-tailed Eagles and Peregrine Falcons recorded in the turbine area in the EBS Ecology Report "Flora and Fauna Impact Assessment" dated 16 February 2024.*

3.3 Microbat Surveys

Anabat recorders have previously been used to detect and record high frequency contact and hunting calls of micro-bat species flying over the Project Area at night. The location of Anabat recorders were previously chosen according to their suitability as flyways or roosting habitat.

This included areas such as drainage lines in woodlands that provide clear flight paths and are surrounded by tree hollows and larger trees suitable for roosting.

Eight common bat species were recorded in the Project Area across four of the seven survey periods. No bat species listed as threatened under either the EPBC or NPW Act were recorded.

As part of this BBMP, the Anabat recorders have been relocated for the following reasons:

- To coincide with the turbines that have been selected for carcass searches.
- To be located at turbines to record possible presence of bat species, as well as any correlation with potential bat strike, if any carcass and/or injured bat was to be detected at that turbine location.

The Anabat recorders will be placed at B46, B55, C04 and C34 (**Figure 5.1**).

4.0 Bird and Bat Risk Assessment

A risk assessment was conducted on the potential impact of the Development to birds and bats (**Appendix A**). This was previously written as part of the Palmer Wind Farm Variation Application – Bird and Bat Risk Assessment (Umwelt 2025b). Updated guidelines by DCCEEW were produced in 2025 on the *Impacts on birds and bats from onshore wind farms in Australia* (Reid & Baker 2025) which were considered when undertaking the risk assessment on birds and bats at the Palmer Wind Farm.

A risk assessment matrix was used to qualitatively define the risk of the proposed Project on threatened bird species observed in the Project Area and threatened bird species defined as "possibly" or "likely" to occur within the Project Area based on database searches. Other bird species identified as having performed at-risk-movements within the Project Area (such as raptors) were also assessed. A risk assessment matrix was also used to define the risk to all bat species identified within the Project Area during, and other species including threatened bat species determined as "likely" to occur in the Project Area based on database searches.

The assessment of the risk of threatened or migratory bird collisions with WTG, identified three species as being at 'medium' risk: Diamond Firetail, Elegant Parrot, and Rainbow Bee-eater. The assessment of the risk of other bird collisions with WTG, identified five species as being at 'medium' risk, being: Wedge-tailed Eagle, Brown Falcon, Nankeen Kestrel, Peregrine Falcon and Australian Pelican. The likelihood of collision causing mortality was determined as likely for all bat species (11 out of 12), apart from the EPBC listed South-eastern Long-eared Bat (*Nyctophilus corbeni*), which was unlikely because it is unlikely to occur. As such, the overall level of risk for the 11 bat species, was determined as 'medium'.

It is noted that the risk assessment relevant to this BBMP is directly applicable to collision or barotrauma risk with the operational wind turbines constructed as part of the Development. Other relevant risks (and therefore potential impacts) to the population of a species (e.g. fire, waste and feral pests) will be addressed in other management plans relevant to the Development.

4.1 Overview of Risk Assessment Approach

The risk assessment follows the approach typically used for estimating risk to birds and bats at wind farms whereby qualitative estimates designed to provide indicative levels of risk are determined using a risk matrix which considers likelihood and consequence of blade strike or indirect impacts (e.g. barotrauma).

Likelihood was defined as how likely mortality from collision is to occur, and consequence was defined as significance of associated impact on species viability (**Table 4.1**):

- Categories A to E were used to define likelihood, ranging from chronic (the event is expected to occur in most circumstances) to rarely (where the event may occur only in exceptional circumstances).
- Categories 1-5 were used to define consequence, where one equated to nil/insignificant (individuals may be affected, but viability of local population was not impacted) and five equated to catastrophic disaster (potential to lead to collapse of a species).

Criteria used to describe consequences of risk, were summarised across four levels: low, medium, high and extreme (**Table 4.2**). If the level of risk was categorised as medium, then all efforts should be made to mitigate against potential impact on the species.

Table 4.1 Criteria Used to Ascribe Likelihood and Consequence

Likelihood (how likely is mortality from collision to occur)		Consequence (significance of associated impact on species viability)	
Rating	**Definition**	**Rating**	**Definition**
Chronic	The event is expected to occur in most circumstances.	**Catastrophic/ Disaster**	Potential to lead to collapse of species.
Frequent	The event probably will occur in most circumstances (e.g., weekly to monthly).	**Major**	Critical event, very likely to have significant impact on species.
Likely	The event should occur at some time (i.e., occasionally).	**Moderate**	Likely to have impact on population, potential to impact on long-term viability under some scenarios.
Unlikely	The event could occur at some time.	**Minor**	May have impact on local population, no impact on species.
Rarely	The event may occur only in exceptional circumstances.	**Insignificant**	Individuals may be affected, but viability of local population not impacted.

Table 4.2 Criteria Used to Ascribe Consequence of Risk

Likelihood	Consequences				
	Insignificant (1)	**Minor (2)**	**Moderate (3)**	**Major (4)**	**Catastrophic (5)**
A (Chronic)	High	High	Extreme	Extreme	Extreme
B (Frequent)	Medium	High	High	Extreme	Extreme
C (Likely)	Low	Medium	High	Extreme	Extreme
D (Unlikely)	Low	Low	Medium	High	Extreme
E (Rarely)	Low	Low	Medium	High	High

4.2 Summary of Risk Assessment Results

Of the 30 bird species assessed, 11 are a 'medium' risk and 19 are a 'low' risk of being impacted by the Development (**Table 4.3**). Seven out of the 11 species were raptors due to their flight behaviour (particularly while foraging) and the fact they were frequently recorded flying at heights within the rotor swept area. Raptors such as the Wedge-tailed Eagle and the Peregrine Falcon generally reside and nest in permanent home ranges, therefore, when they intersect with wind farms, there is likely to be a higher risk of collision.

In general, the potential effects of a wind farm on woodland bird species are related to (1) possible loss of habitat and (2) disturbance from turbines if situated close to woodlands. Direct interaction with turbine blades was considered unlikely for woodland specific bird species, as the rotor-swept area is higher than typical flight heights observed for woodland birds in the Project Area.

Of the 12 bat species assessed, 11 are a 'medium' risk and 1 is a 'low' risk of being impacted by the Development (**Table 4.3**). No flight heights were recorded for bat species observed at the Project Area, however, for the risk assessment it was assumed that a risk of collision may occur due to bats flying into the rotor swept area as they leave their roosting sites and traverse between areas and through wooded habitats, in search of food.

Due to the findings of this risk assessment, the bird and bat monitoring program and the mitigation and adaptive management strategy described in this BBMP will have a particular emphasis on effectively monitoring and managing risk of collision of the 11 species assessed as 'medium' risk of being impacted by the Development.

Table 4.3 Risk Assessment Results Summary

Latin Name	Common Name	EPBC Act	NPW Act	Likelihood	Consequence	Risk Rating
Bird species						
Accipiter cirrocephalus cirrocephalus	Collared Sparrowhawk	-	-	Unlikely	Insignificant	Low
Accipiter fasciatus fasciatus	Brown Goshawk	-	-	Likely	Minor	Medium
Aphelocephala leucopsis	Southern Whiteface	VU	-	Rarely	Minor	Low
Aquila audax	Wedge-tailed Eagle	-	-	Likely	Minor	Medium
Cacatua sanguinea	Little Corella	-	-	Likely	Insignificant	Low
Circus assimilis	Spotted Harrier	-	-	Unlikely	Insignificant	Low
Corvus mellori	Little Raven	-	-	Likely	Insignificant	Low
Elanus axillaris	Black-shouldered Kite	-	-	Unlikely	Insignificant	Low
Eolophus roseicapilla	Galah	-	-	Likely	Insignificant	Low
Falco berigora	Brown Falcon	-	-	Likely	Minor	Medium
Falco cenchroides	Nankeen Kestrel	-	-	Likely	Minor	Medium
Falco longipennis	Australian Hobby	-	-	Likely	Minor	Medium
Falco peregrinus	Peregrine Falcon	-	R	Likely	Minor	Medium
Falco subniger	Black Falcon	-	R	Likely	Minor	Medium
Gymnorhina tibicen	Australian Magpie	-	-	Likely	Insignificant	Low
Milvus migrans	Black Kite	-	-	Unlikely	Insignificant	Low
Hieraaetus morphnoides	Little Eagle	-	V	Unlikely	Minor	Low
Hirundo neoxena	Welcome Swallow	-	-	Likely	Insignificant	Low
Coracina papuensis	White-bellied Cuckoo-shrike	-	R	Unlikely	Insignificant	Low
Corcorax melanorhamphos	White-winged Chough	-	R	Unlikely	Minor	Low
Melanodryas cucullata cucullata	Hooded Robin	EN	R	Unlikely	Minor	Low
Merops ornatus	Rainbow Bee-eater	Ma	-	Likely	Minor	Medium

Latin Name	Common Name	EPBC Act	NPW Act	Likelihood	Consequence	Risk Rating
Microeca fascinans fascinans	Jacky Winter	-	R	Rarely	Minor	Low
Myiagra inquieta	Restless Flycatcher	-	R	Rarely	Minor	Low
Neophema chrysostoma	Blue-winged Parrot	-	V	Unlikely	Minor	Low
Neophema elegans	Elegant Parrot	-	R	Likely	Minor	Medium
Pelecanus occidentalis	Australian Pelican	-	-	Likely	Minor	Medium
Petrochelidon ariel	Fairy Martin	-	-	Likely	Insignificant	Low
Platycercus elegans	Crimson Rosella	-	-	Likely	Insignificant	Low
Stagonopleura guttata	Diamond Firetail	VU	-	Likely	Minor	Medium
Bat species						
Chalinolobus gouldii	Gould's Wattled Bat	-	-	Likely	Minor	Medium
Chalinolobus morio	Chocolate Wattled Bat	-	-	Likely	Minor	Medium
Mormopterus species 3	Inland Freetail Bat	-	-	Likely	Minor	Medium
Mormopterus species 4	Southern Freetail-bat	-	-	Likely	Minor	Medium
Nyctophilus corbeni	South-eastern Long-eared Bat	V	-	Unlikely	Minor	Low
Nyctophilus geoffroyi	Lesser Long-eared Bat	-	-	Likely	Minor	Medium
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	-	R	Likely	Minor	Medium
Scotorepens balstoni	Inland Broad-nosed Bat	-	-	Likely	Minor	Medium
Tadarida australis	White-striped Freetail-bat	-	-	Likely	Minor	Medium
Vespadelus darlingtoni	Large Forest Bat	-	-	Likely	Minor	Medium
Vespadelus regulus	Southern Forest Bat	-	-	Likely	Minor	Medium
Vespadelus vulturnus	Small Forest Bat	-	-	Likely	Minor	Medium

Conservation Codes: EN: Endangered. VU/V: Vulnerable. R: Rare. Ma: Marine

5.0 Bird and Bat Monitoring Program

5.1 Roles and Responsibilities

Meeting the objectives of this BBMP is ultimately the responsibility of the Developer, with the roles and responsibilities of this BBMP being consistent with the COEMP. Oversight of the implementation of this BBMP will require ongoing liaison between the Developer, DEW and the SPC.

The Developer will engage a suitably qualified ecologist who will be responsible for a number of tasks related to bird and bat monitoring and management. The ecologist may choose to engage a sub-contractor that specialises in the bird and bat survey methodology below, particularly relating to statistical analysis, modelling and carcass searches.

The ecologist will ensure the bird and bat monitoring program is conducted in line with the requirements of the BBMP, and the incidental bird and bat carcass find protocol and injured bird and bat find protocol are adhered to.

The Developer will be responsible for implementation of mitigation measures as discussed in **Section 6.2**. The Developer's reporting requirements are outlined in **Section 8.0**.

The ecologist (or the nominated sub-contractor) will be responsible for organising and undertaking the operational phase bird and bat surveys, the carcass persistence and detectability trials, and implementing the carcass search program.

The ecologist will be responsible for the management and analysis of the data collected during these surveys and reviewing this BBMP and preparing reports relevant to the bird and bat monitoring program (see **Section 8.0**). The Developer will be responsible for submission of any reporting associated with implementation of the BBMP.

5.2 Bird Surveys

Bird surveys are to be conducted seasonally, proposed for February, April, July and November[2] during the first two years of operation from the date that is within three months of commencement of operation of the Development (i.e. surveys will commence in the next identified survey month following that milestone).

Fourteen (14) survey sites have previously been surveyed (Umwelt 2025a) as illustrated in **Figure 5.1**. At each site, a 2-ha area was traversed for 20 minutes, according to the standard Birdlife Australia 2-ha survey method (Birdlife Australia 2024). These 14 survey sites will be revisited during the survey periods specified above, with the objective being to collect data on relative abundance and to a lesser degree, flight behaviour, of bird species across different vegetation types within the Project Area.

[2] These months have been selected as representative of the relevant seasons and may be adjusted by the engaged ecologist depending on climatic conditions to ensure optimal survey coverage.

5.2.1 Vantage point surveys

Vantage points surveys are to be conducted at five sites (two in Area B and three in Area C), during the first two years of operation (to coincide with the bird surveys detailed in **Section 5.2**). Each site will be surveyed for one hour on two occasions per seasonal survey round, once in the late morning (i.e. between 9:30 and 12:00) and once in the early afternoon (i.e. between 12:00 and 15:30). Total vantage point survey effort over the two survey years will be 120 hours.

The objective of these surveys is to collect information on flight activity, height and behaviour from prominent locations both at turbine locations (treatment sites i.e. at the 14 established BBUS sites) and at least 500 m away from turbine locations (control sites).

The nature of vantage point surveys (high vantage, focus on aerial activity) lend themselves to targeting certain threatened and raptor at-risk species, including:

- Black Falcon (year-round).
- Little Eagle (year-round).
- Wedge-tailed Eagle (year-round).
- Elegant Parrot (year-round).
- Rainbow Bee-eater (October to January).

5.2.2 Raptor Nest Monitoring

Targeted surveys undertaken in 2013 and 2022 during the design phase of the Development, identified 14 raptor nests (**Figure 5.1).** Out of these, 5 are located within the Project Area and 9 are located within 2 km of a WTG. Out of 5 located inside the Project Area, 1 is a Wedge-tailed Eagle nest and 4 are Peregrine Falcon nests.

Additional ecological surveys of the Native Vegetation Clearance Significant Environmental Benefit site in October 2025 (post-Variation Approval) recorded 3 additional WTE nests, all of which are within the Project Area (**Figure 5.1**), making the total number of nests to 17 (**Table 5.1**).

The locations of these 17 nest sites are provided in **Table 5.1.** Raptor nest monitoring will be undertaken at each of the 17 nest sites. Monitoring of these nests will be part of pre-construction surveys to coincide with the bird surveys proposed in **Section 5.2**, and be aligned during springtime, when chicks may be present/but not yet fledged.

There will be several methods used to determine whether each nest is considered active, including:

- Dimensions and signs of activity.
- Photograph of each nesting site and occupancy of the nest.
- Presence of a chick, fledgling or adult bird, in or near the nest.
- Any eagles or falcons flying from the area upon arrival.
- Other parameters used as an indication of nest occupancy including fresh whitewash, prey remains on the ground beneath or within the nest, and presence of green leaves in the nest bowl.

Table 5.1 Wedge-tailed Eagle and Peregrine Falcon Nests Located in the Project Area and within 2 km of a WTG (that will be included in the Raptor Nest Monitoring Program)

Nest type/ID	Easting	Northing	Comment
WTE 3	329487	6140952	Cluster of 4 WTE nests all within 2 km buffer
WTE 6	326541	6147179	Falls within the 2km buffer - will depend on landholder access
WTE 7	329180	6141194	Cluster of 4 WTE nests all within 2 km buffer
WTE 8	329569	6140579	Cluster of 4 WTE nests all within 2 km buffer
WTE 9	329221	6140600	Cluster of 4 WTE nests all within 2 km buffer
WTE 10	329561	6139472	Delfabro Property - falls within 2km buffer - to be monitored
WTE 11	329878	6139343	Delfabro Property - falls within 2km buffer - to be monitored
WTE 12	327456	6138479	Falls within the Project Area - to be monitored
WTE 14	328868	6138031	New nest recorded during Bettcher Offset Survey Oct 25 - to be monitored
WTE 15	329091	6138657	New nest recorded during Bettcher Offset Survey Oct 25 - to be monitored
WTE 16	330136	6137804	New nest recorded during Bettcher Offset Survey Oct 25 - to be monitored
PF 2	331725	6146867	Falls within the 2km buffer - Milendella Creek - will depend on landholder access
PF 5	330009	6139122	On boundary of Bettcher SEB Aea - to be monitored
PF 6	330172	6139513	Falls within 2 km buffer - to be monitored
PF 7	330014	6138966	Falls within Bettcher Offset Area - to be monitored
PF 8	329693	6138886	Falls within Bettcher Offset Area - to be monitored
PF 9	329490	6138730	Falls within Bettcher Offset Area - to be monitored

Raptor nest monitoring will coincide with the bird surveys and vantage point surveys described in **Section 5.2** and **Section 5.2.1**. The objective of the annual monitoring program will be to determine the breeding status of WTE and PF at nest locations recorded in the turbine area, as well as a subset of nests located within a 2 km buffer of a wind turbine. This will occur annually from the commencement of operations for 5 years and will occur in spring when birds are most likely to be breeding. The location of the nests to be monitored are described in **Section 3.2**. The monitoring will comply with the condition, which requires:

> *Monitoring to be undertaken in accordance with established scientific methods and at a minimum must identify whether each nest is active and whether young have successfully fledged from the nest*.

It should be noted as part of this BBMP, that monitoring of nests will be subject to permission from landowners adjacent to the Project Area and should access not be achievable, certain nests may not be able to form part of the monitoring program.

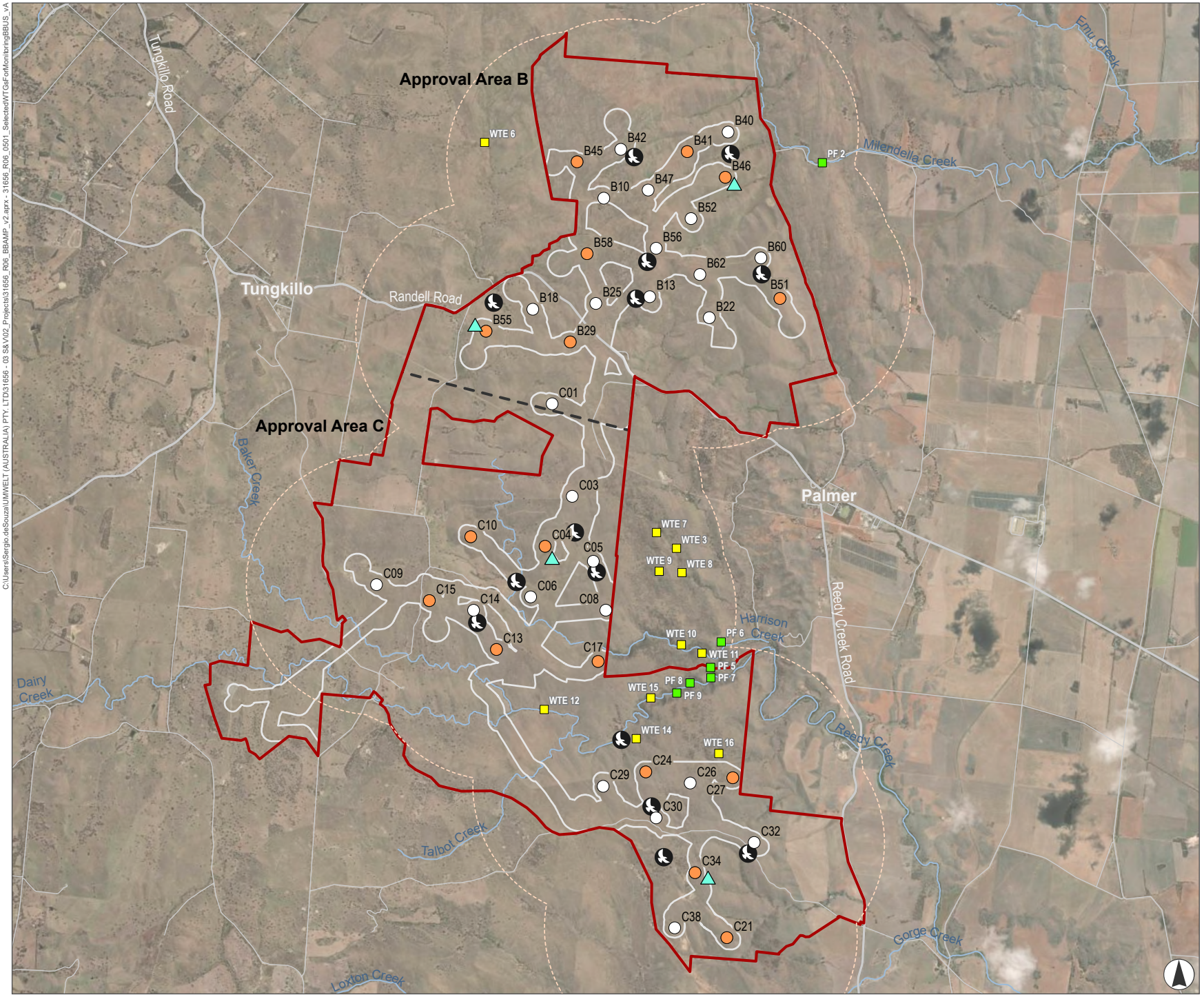


FIGURE 5.1

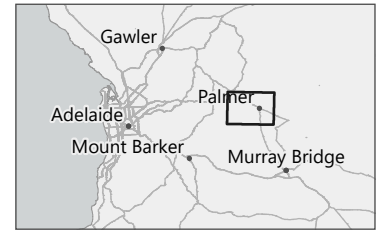
Selected Wind Turbines for Monitoring in Relation to Bird and Bat Sites

Legend

- Project Area
- Approval Areas
- Micrositing Area
- WTG Buffer (2km)
- No carcass searches to be undertaken at turbines
- Carcass searches at turbines to be undertaken
- BUS Site
- Anabat Site
- Main road
- Local road
- Watercourse

Nest Location

- Peregrine Falcon
- WTE



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umwelt

Image Source: ESRI Basemap (2025) | **Data Source:** Umwelt, Tilt, DIT, DEW (2025)

5.3 Bat Surveys

Bat detectors will be deployed at four wind turbine locations (B46, B55, C04 and C34) (**Figure 5.1**) in February, April, July and November[3] during the first two years of wind farm operations, as described above in **Section 5.2**. At height data will be collected on the nacelle of wind turbines in consultation with the Development's operational and maintenance contractor.

The bat surveys will coincide with when bird surveys and vantage point surveys are being carried out. They will be deployed across the same seasonal spread as those of the bird surveys, as well as align with the methods proposed with collecting pre-construction data (**Section 3.3**). The objective of these bat surveys will be to collect data on presence of bat species at these turbine locations, as well as draw on any correlation of these bat species occurring and any bat strikes (if a carcass and/or injured bat were to be found).

5.4 Carcass Search Program

The key objective of the carcass searches is to estimate the frequency of bird and bat mortality due to collision associated with the operation of the Development, from which the total number of collisions can be determined. Reporting requirements relevant to the carcass search program are described in **Section 8.1.**

It is an assumption that as part of the carcass search program, detection dogs will be used (unless determined as not being feasible). The Development is in South Australia, where detection dogs have not yet been trialled, however Umwelt has access to use detection dogs as a resource for carcass search programs. There may be some searcher efficacy or carcass detectability limitations if humans are used to search for carcasses rather than dogs, however, human monitoring is also possible. When the BBMP is approved by SPC, the implementation will require the decision as to whether dogs or humans are used during the carcass search program based on availability of detection dog contractors.

The carcass search program will be reviewed for efficiency after two years. As part of this review, SPC and/or DEW will be consulted to determine whether or not it is appropriate to discontinue the carcass search program based on the findings of the first two years of monitoring activities as detailed in the relevant annual reporting and major review of the BBMP (refer to **Section 8.0**).

A permit will be obtained prior to commencement of the carcass search program from DEW to keep carcasses of native species.

5.4.1 Turbines to be Searched

Searches will be undertaken at 16 turbines (i.e., 40% of the turbines to be constructed – **Figure 5.2**), throughout the carcass search program. Of the 16 WTGs, 7 are in situated in Area B and 9 in Area C. The list of 16 turbines, and their associated habitat types, are summarised in **Table 5.2**.

[3] These months have been selected as representative of the relevant seasons and may be adjusted by the engaged ecologist depending on climatic conditions to ensure optimal survey coverage.

The same turbines will be searched throughout the carcass search program, with the turbines to be searched having been selected with consideration of the following:

- Spatial coverage across the Development.
- Habitat variability and representation of different vegetation types, ensuring good coverage of woodland and shrubland areas as well as open grassland.
- Access to wind turbines selected for monitoring i.e. from existing tracks or linkage of tracks to other WTG.
- Location to features in the landscape e.g. creeklines or ridge.
- Agreeable landholders and other issues e.g. sheep disease (to prevent time consuming requirement to washdown vehicles every time a WTG is monitored).

Table 5.2 Selected Wind Turbines for Monitoring and their Associated Habitat

Wind Turbine	Easting	Northing	Habitat Type
B51	331075	6144785	*Austrostipa* sp. grassland over mixed exotic forbs and grasses
B29	327856	6144118	*Austrostipa* sp. grassland over mixed exotic forbs and grasses
B41	329652	6147038	*Austrostipa* sp. grassland over mixed exotic forbs and grasses
B46	330236	6146644	*Austrostipa* sp. grassland over mixed exotic forbs and grasses
B45	327961	6146882	*Austrostipa* sp. grassland over mixed exotic forbs and grasses
B55	326563	6144283	*Austrostipa* sp. grassland over mixed exotic forbs and grasses
B58	328114	6145472	*Eucalyptus camaldulensis* (River Red Gum) and *Allocasuarina verticillata* (Drooping Sheoak) very open woodland over exotic grasses and forbs
C04	327470	6140983	*Austrostipa* sp. (Spear Grass) grassland
C10	326329	6141130	*Austrostipa* sp. (Spear Grass) grassland
C13	326723	6139400	*Austrostipa* sp. (Spear Grass) grassland
C15	325693	6140150	*Austrostipa* sp. (Spear Grass) grassland
C17	328283	6139216	*Austrostipa* sp. (Spear Grass) grassland
C21	330260	6134979	*Austrostipa* sp. (Spear Grass) grassland
C24	329016	6137522	*Austrostipa* sp. (Spear Grass) grassland
C27	330351	6137432	*Eucalyptus fasciculosa* (Pink Gum) (NPW Act: Rare) open woodland over *Austrostipa* sp. (Spear Grass)
C34	329772	6135976	*Eucalyptus fasciculosa* (Pink Gum) open woodland over *Austrostipa* sp. (Spear Grass)

It is noted that certain wind turbines have been excluded from consideration as part of the carcass search program , including B60, C30 and C32 that have part of the carcass search zones crossing public roads and may pose a safety risk to searchers/detection dogs in undertaking the surveys as well as C08, which has part of the search zone crossing into a neighbouring property outside of the Project Area (i.e. no land access rights).

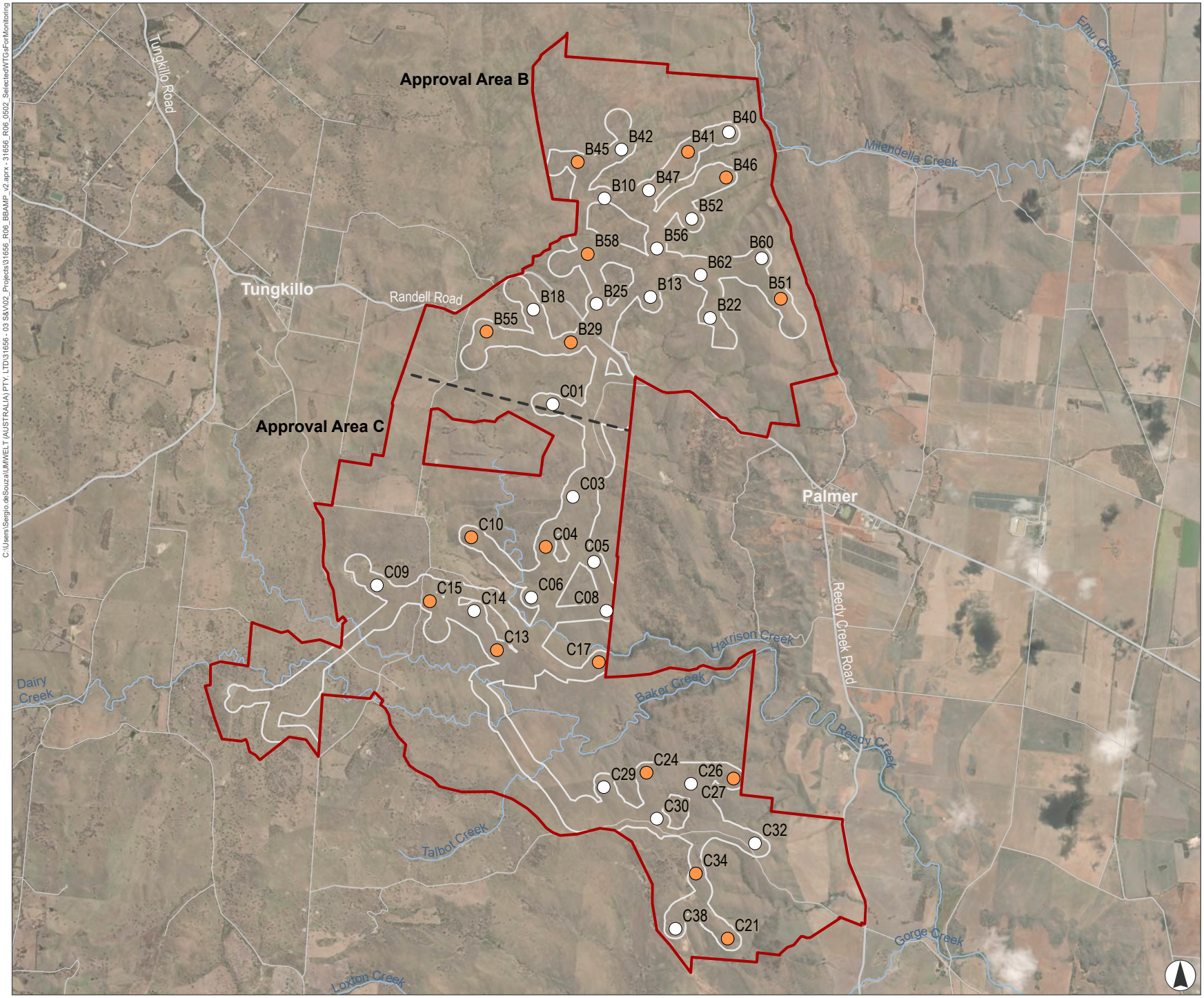

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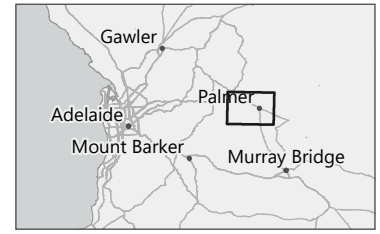
FIGURE 5.2

Selected Wind Turbines for Monitoring

Legend

- Project Area
- Approval Areas
- Micrositing Area
- No carcass searches to be undertaken at turbines
- Carcass searches at turbines to be undertaken
- Main road
- Local road
- Watercourse



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GDA2020 MGA Zone 54

umwelt

Image Source: ESRI Basemap (2025) | **Data Source:** Umwelt, Tilt, DIT, DEW (2025)

5.4.2 Search Area and Survey Frequency

The size of the search area and the method in which carcass searches will be conducted is consistent with current standard practice used at other windfarms (Nature Advisory 2020). The turbine specifications of the Development (**Table 1.2**) and the findings of Hull and Muir (2010), Huso and Dalthorp (2014) and Prakash and Markfort (2020) were considered in the determination of the most appropriate search area. Given the maximum blade tip height (212 m) and the rotor diameter (172 m), an area with a radius of 120 m comprising an inner and outer search area (with radii 60 m and 120 m, respectively) will be surveyed at each of the selected sites. This search area is illustrated in **Figure 5.3.**

Figure 5.3 Illustration of Carcass Search Area

When the BBMP undergoes review following the completion of Year 2 (detailed in **Section 8.2**), a thorough review of current literature will be undertaken to determine if there is any recent research supporting a change to search areas of carcass surveys, whether that be to the inner or outer search zones or increasing the search zone scale. Changes to search areas will be made in consultation with SPC and/or DEW and be reliant on the presence of current and scientifically based research.

Following the commencement of operation of the Development, the carcass search program will be conducted as follows:

- Years 1 and 2: The inner and outer search areas will be surveyed once per month throughout each year.
- Years 3 to 5: The survey frequency will be determined based on the outcome of the review of the BBMP (refer to **Section 8.2**), including consideration of relevant observations, outcomes of the carcass persistence trials and associated statistical analysis.

The frequency of the carcass search program in Years 3 to 5 will not be considered more frequently than quarterly (i.e. 4 surveys within a 12-month period) and consistent with Condition 12 of the Native Vegetation Clearance Approval for the Development must not be less than twice yearly (i.e. 2 surveys within a 12-month period).

The order of wind turbine clusters searched will be randomised between surveys.

5.4.3 Unsearchable Areas

River Redgum and/or Pink Gum open woodland and *Acacia* shrubland may remain within the carcass search area (r = 120 m) following vegetation clearance for the development of the hardstand, roads and other infrastructure. At such, it is possible that there may be some searcher efficacy or carcass detectability (if humans are used to search for carcasses rather than dogs) limitations across the search zones. However, human monitoring will only occur in the event that detection dogs are not available for any given survey (i.e. human monitoring is the backup). Furthermore, unsearchable areas, should they be identified, are likely to be very limited. No areas considered unsearchable for detection dogs or human monitoring, are present in the proposed carcass search areas.

If carcass search areas are deemed unsearchable at any given turbine (and yet still included in the carcass search program), it will be mapped and a corrective function applied to estimate total carcass numbers applied. The method through which to estimate the number of carcasses likely to have fallen in the entire search area (in cases where its entirety is not searched) will be determined in consideration of current peer-reviewed methods.

A corrective function will be applied for monitoring undertaken with trained detection dogs where unsearchable areas are identified. The statistical model can account for the survey effort. This model considers the area that can be realistically surveyed, adjusting the fall zone accordingly to provide an accurate prediction of mortalities (refer to **Section 5.8**).

5.4.4 Search Method

The search method can be defined as using trained detection dogs or trained ecologists on foot, the latter of which has been largely done here in South Australia.

5.4.4.1 Use of Trained Detection Dogs

Trained detection dogs will be used as the default if available and the climatic conditions of the site and the terrain of the search areas are suitable for a dog to conduct searches safely and effectively. Given the location of the Development in the eastern MLR, maximum daily temperatures are typically suitable throughout much of the year for working dogs. Surveys conducted during December to March may need to be scheduled around hot weather and other conditions such as bushfires and wind. The terrain of the search areas is suitable for access by a dog and handlers given the limited areas of rocky terrain and steep slopes in search areas within the Project Area.

During each turbine search a dog and handler would traverse the search area along paths spaced by approximately 20 - 30 m from one another depending on wind speed. The spacing of the paths within this range would be determined by the handler as they see fit during each survey. The dog would be fitted with a GPS unit to provide a measure of coverage completed during each survey. Dog handlers will be trained and experienced in identification of all bird and bat species that may occur within the Project Area and understand the data collection and carcass find protocol detailed in **Section 5.4.5**.

The detectability of carcasses through use of trained dogs would be assessed as specified in **Section 5.6.**

5.4.4.2 Use of Ecologists

If a trained dog is unavailable, carcass searches will be conducted by ecologists experienced in the identification of carcasses of bird and bat species that may occur within the Project Area. At each turbine search area, the observer will walk transects spaced by 6 m within the inner search area and 12 m within the outer search area. The observer will record their movement along transects using a handheld GPS device. The detectability of carcasses by ecologists conducting carcass searches would be assessed as specified in **Section 5.6.**

5.4.5 Data Collection and Carcass Find Protocol

During the carcass search surveys and the carcass persistence trials, data will be collected and recorded on the data sheets provided in **Appendix C**, **Appendix D** and **Appendix E** (namely the Carcass Search Survey Data Sheet, the Dead or Injured Bird/Bat Data Sheet and the Carcass Persistence Trial Data Sheet respectively), or data may be recorded using a digital data collection program such as ESRI's ArcGIS Survey or Survey123 using all fields present in the survey data sheets.

For each turbine search during the carcass search surveys, the Carcass Search Survey Data Sheet must be completed (**Appendix C**). Along with collection of basic survey and weather information, a number of additional factors will require careful estimation and ongoing consideration throughout each individual turbine search, namely, the extent of different ground substrates and the extent of the search area that is accessible/searchable.

In the event that a bird or bat carcass or feather-spot (e.g. a collection of five or more feathers, indicating a dead bird) is detected during a carcass search survey, the carcass or featherspot[4] must be collected, photographed and stored (if a carcass), its location must be recorded on a GPS device and the Deceased or Injured Bird/Bat Datasheet (**Appendix D**) must be completed. Handling and collection of carcasses will be undertaken as follows:

- The carcass must be removed from the site by a person wearing rubber gloves and double bagged in plastic bags.
- The carcass must be photographed in such a way that it can be further identified, i.e., on a white background with an item or measure for scale and adequate lighting.
- A label with the date, turbine number, species name (if known) and a unique specimen code (i.e., GALAH01) must be placed in the second bag to allow cross-reference to the corresponding completed Deceased or Injured Bird/Bat Datasheet.
- The carcass will be transported to a freezer (likely located at the Operations and Maintenance Facility) where it will be retained for the purpose of either a second opinion on its identification, or for use in carcass persistence trials or carcass detectability trials.

In cases where feather-spots or carcasses cannot be identified by the contracted ecologist, the following process will be undertaken:

[4] A featherspot is defined as a collection of five or more feathers closely positioned in a way that suggests a carcass had been present at that precise location.

1. Photos of the feather-spot or carcass will be analysed by the lead ecologist (including any colleagues) to definitively identify the find, including circumstances where the lead ecologist allocated the identification to likely or probable confidence levels.
2. If the lead ecologist is still unable to definitively identify the featherspot or carcass (including likely or probably confidence levels), they will only further attempt to definitively identify the feather-spot or carcass if the find could potentially result in an impact trigger being met (either there is potential it could be a threatened species or would trigger a non-threatened species impact trigger).
3. Methods to further definitively identify the feather-spot or carcass could then involve sending photos of the find and/or the find itself to a species specialist or museum or send for DNA testing.

If used, DNA swabs would be sent to the South Australian Museum for analysis. DNA swabs are not proposed to be used for carcasses or feather-spots unless there is a potential it could be a threatened species.

At the conclusion of the carcass search program any carcasses of interest may be made available to the South Australian Museum or disposed of if deemed appropriate in consultation with SPC and/or DEW.

All data collected during the carcass search program will be entered into a database. Data pertaining to incidental findings (i.e., completed Deceased or Injured Bird/Bat Datasheets for incidental finds by site personnel) must also be kept in this database. A second database will serve as an inventory of carcasses collected. This can be maintained by the Environmental Representative within which records detailing whether carcasses are retained, disposed of or sent off-site will be managed (i.e. to an authority such as the South Australian Museum).

All reporting requirements, including timeframes, are detailed in **Section 6.0** and **Section 8.0**.

5.5 Carcass Persistence Trial

Birds and bats injured or killed through collision with turbines may be removed from search areas by scavengers such as raptors, ravens, and a suite of introduced mammals (i.e. cats and foxes). To estimate persistence rates of different sized carcasses beneath turbines within the Project Area (to aid estimation of mortality rates of birds and bats impacted by turbines) a carcass persistence trial will be undertaken.

A carcass persistence trial will be carried out by ecologists during the Years 1 and 2 spring and autumn carcass survey program. The trial will be conducted over two years to account for interannual variation in species presence. The carcass persistence trial (i.e., both spring and autumn) will be conducted at the 16 turbines. Since carcass persistence trials are intended to assess scavenger efficiency during the main surveys, they will be conducted at the same time as the main surveys. The order in which the 16 turbines will be surveyed, will be randomised. The carcasses (comprising 5 small-medium sized bird carcasses and 5 large carcasses) and 10 bat carcasses will be deployed within 60 m of turbine bases. The 20 carcasses used in the spring trial may not be reused in the autumn trial. Where required, carcasses will need to be substituted based on carcass availability within South Australia.

Surrogate carcasses will be used for carcass persistence trials. Small to medium sized surrogate carcasses should be chosen to be similar in size to the target species of this BBMP (where possible).

Surrogate carcasses must be marked to prevent confusion with carcasses that are not part of the trial. A Carcass Persistence Trial Data Sheet (**Appendix E**) must be completed for each turbine included in the carcass persistence trial.

Remote sensing cameras will be deployed to record persistence of carcasses with each camera being set to record three images when movement is detected or otherwise set to take one image per hour in the case of sites where moving vegetation is likely to cause regular false triggers. Use of remote-sensing cameras as opposed to using human observers has several advantages including lower survey effort and the ability to determine the exact time of carcass removal and potentially the scavenger species involved in the removal.

Each trial will run for up to 30 days during which time the cameras and the carcasses will be checked at 5 days and 15 days (either of these visits may be timed to coincide with a carcass search survey). If a carcass has been removed within the first fortnight it may be replaced by another. Carcasses are deemed to be removed when they no longer occur in the search zones (Inner and Outer) (**Figure 5.3**).

If the inspections on day 5 and/or day 15 find a carcass has been moved outside of the field of view from the remote sensing camera, but remains within the search zones, it is not deemed to be removed. In such a case, the camera will be re-located to the new position of the carcass.

The use of remote sensing cameras may be replaced with another suitably efficient and accurate method if one should become available. Such a change to the carcass persistence trial methodology would be undertaken in consultation with DEW.

Quantifying the mean and confidence interval of the time of removal of carcasses is required for input into calculation of mortality estimates. Carcass persistence would be examined through survival analysis using statistical software to estimate the survival function. The analysis would include:

- Fitting a range of carcass persistence distributions to determine the best fit.
- Testing for the significance of the covariates for carcass size and suite strata.
- Generating an estimate for each significant covariate group.

Reporting requirements relevant to carcass persistence trials are described in **Section 8.0**.

5.6 Carcass Detectability Trial

The detectability of carcasses under turbines can vary depending on a range of factors such as efficacy of the observer, size of the carcass and type of vegetation association and type of ground cover. Given this, carcass detectability trials will be undertaken to determine the efficacy of the dog and handler or the ecologist undertaking searches at finding carcasses within the Project Area. Determining the probability of the selected trained dog or observers detecting a carcass and how it may vary depending on turbine site ground conditions or carcass size is important to ascertain the correction factor needed to accurately estimate total number of collisions.

A carcass detectability trial will be conducted during the Year 1 spring and autumn carcass survey program. These trials can be undertaken concurrently with the carcass persistence trials and/or the carcass search surveys to maximise survey efficiency.

The carcass detectability trial will be conducted at 16 turbines that form part of the carcass search program, and which are to be selected using a random number generator prior to the commencement of the trial.

During each trial (i.e., for both the spring and the autumn trial) approximately 10 bird carcasses (comprising 5 small-medium sized carcasses and 5 large carcasses) and 10 bat carcasses will be randomly distributed onto the ground within the inner search area by a person not involved in searches for carcasses. The same carcasses used in the carcass persistence trial may be used in the carcass detectability trial if the carcass persistence and carcass detectability trials are conducted consecutively rather than concurrently. The carcass detectability trial will however be conducted prior to the carcass persistence trial. The searcher will not be aware of the number or location of carcasses deployed. The number and type of carcasses detected during the trials will be compared with the number and type of carcasses placed in the search areas for such trials.

Reporting requirements relevant to the carcass detectability trial are described in **Section 8.0.**

5.7 Incidental Bird and Bat Carcass Find Protocol

Throughout the operational lifetime of the Development, if a carcass or a feather-spot is discovered incidentally by site personnel the Dead or Injured Bird/Bat Data Sheet must be completed (**Appendix D**) and the find reported to an Environmental Representative. If the impacted species found incidentally meets the relevant reporting thresholds, notification of the impact must adhere to the reporting requirements and timeframes described below in **Section 6.1.2** and **Section 6.1.4**.

The Developer will provide additional training to key personnel, including the Environmental Representative as minimum, to assist with the identification of carcasses and/or feather-spots as well as the carcass find protocol (refer to **Section 5.4.5**).

If a carcass is discovered incidentally at any stage during the operation of the Development, the carcass may be handled and removed in accordance with the carcass find protocol (**Section 5.4.5**). Any injured birds or bats must be handled in accordance with the injured bird and bat protocol (**Section 5.7.1**). Key site personnel will receive training in the process to be followed in the event that injured or deceased birds or bats or featherspots are discovered incidentally. Copies of the Dead or Injured Bird/Bat Datasheet must be available for use by all site personnel.

5.7.1 Injured Bird and Bat Find Protocol

If an injured bird or bat is discovered the Environmental Representative must be notified as soon as possible of the finding (allowing time for ecologists to deal with aspects such as capture, labelling, data capture, reduced phone service, etc.). The Environmental Representative will be responsible for organising the recovery and/or treatment or euthanasia of the animal. Where possible all injured birds should be placed into a ventilated box or cloth bag by a person wearing rubber gloves, to minimise stress and assist with transportation.

If required, local veterinarians, wildlife carers or the contracted ecologist should be contacted by the Environmental Representative to discuss whether release, rehabilitation or euthanasia is the most appropriate action. If it is determined that the animal should not be released on site or euthanised by the Environmental Representative, and instead by a veterinarian or wildlife carer, then this should be arranged. Contact details are provided below; however other appropriately qualified veterinarians and wildlife carers may be used:

- Fauna Rescue SA: 08 8289 0896 or Bat Rescue: 08 8486 1139
- Save our Wildlife Foundation: 08 7120 6610

- Wildlife SA: 0402 734 555
- Vet in the Hills (Veterinary Clinic) (Mannum): 08 8389 7947.

Site staff are prohibited from touching or handling any bats (injured or otherwise). A qualified and appropriately vaccinated ecologist or wildlife carer must be called to handle any bats. Only persons vaccinated against Australian Bat Lyssavirus may handle injured bats.

5.8 Mortality Estimation

All data will be analysed to estimate mortality rates and the annual number of collisions for each bird and bat species. Estimates of the number of carcasses per wind turbine per year will also be determined and 95% confidence intervals around total annual estimates and rates of mortality calculated.

A suitably experienced data science consultancy, Symbolix, has undertaken a review of this BBMP to determine whether the survey program represents standard statistical practice and whether the survey design will provide data suitable for estimating mortality at the Development. This BBMP has considered the suggested amendments made by the consultancy as part of this review. A summary of the statistical analysis that will be undertaken for the mortality estimation is provided below, however the full review by Symbolix is provided in **Appendix B**.

Mortalities at turbine *i* during search *j* are estimated by (Huso, Dalthorp, and Korner-Nievergelt (2015) and references therein):

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

Where:

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

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

$$\hat{g}_{ij} \cong a_i r_{ij} p_{ij}$$

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

Searcher efficiency (p_{ij}) will be reported as a mean and variance measure.

Searcher efficiency will be modelled using logistic regression as this allows binary data to be modelled accounting for covariates such as carcass size and time of year. The probability of success in the carcass detectability trial *i* as $\pi\ (x_i)$ where x_i is a vector of covariates. The relationship between the probability of success and the log odds will be modelled using the logistic model:

$$\text{logit}\ [\pi\ (x_i)] = \beta x_i$$

Where:

- Logit [·] denotes the log-odds function $\text{logit}\ (\rho) = ln\frac{\rho}{1-\rho})$
- β is a vector of regression coefficients.

As $\pi\ (x_i)$ is free to vary with each trial, this allows the mean to be modelled in a flexible manner depending on carcass size and so on. The estimates of regression coefficients β, are obtained via maximum likelihood estimates which is the standard method of estimation in GLMs. Both estimates of the mean, and standard errors of those estimates, are obtained by this technique. This allows significance testing of covariates and reporting of confidence intervals.

5.9 Survey Schedule

An overview of the survey schedule for the different survey components of the bird and bat monitoring program is provided below in **Table 5.3.**

Table 5.3 Proposed Survey Schedule during operation of the Development

Survey	Timing	Duration
Bird surveys (BBUS and vantage point)	Seasonally (February, April, July and November) from the commencement of operation of the Development.	Two years (Year 1 and 2)
Raptor nest monitoring	Annually in Spring (October or November)	Five years
Bat surveys	Seasonally (February, April, July and November) from the commencement of operation of the Development.	Two years (Year 1 and 2)
Carcass search surveys (full program)	Monthly for Years 1 and 2, commencing within three months of commencement of operation of the wind farm, and subsequently for Years 3 to 5, frequency determined following review of BBMP	Five years (Year 1 to 5)[5]
Carcass persistence trial	During the first autumn and spring of the year/s following commencement of operation.	Two years (Year 1 and 2)
Carcass detectability trial	During the first autumn and spring of the year following commencement of operation.	One year (Year 1)
Incidental bird and bat finds	Will be conducted opportunistically through the operational life of the Project.	Operational life of Project

[5] Review of the carcass search program to be undertaken with SPC and/or DEW following two years and varied following review (refer to **Section 5.4**).

6.0 Impact Triggers and Response Procedure

To meet the overall objective of the BBMP, it is necessary to define impact trigger thresholds and appropriate responses to where verified impacts to species indicate that the operation of the Development may significantly impact the viability of local populations of a threatened bird or bat species.

In addition, raptors have been identified by the local community to be important to their sense of place, maintaining biodiversity and ecosystem health as apex predators and are often a significant cultural icon in many Aboriginal cultures. Due to this significance and the regulatory requirements / commitments of the Developer in relation to raptor species (refer to **Table 1.1**), the BBMP also recognises these species with specific impact and response processes.

For the purposes of this BBMP, post-trigger assessment of impacts on nationally threatened and state conservation rated raptor species, is to be conducted with reference to the species' total population and local population. For any non-listed raptor species, assessment of impacts is to be conducted with reference to the species' local population only.

Total population refers to the estimated total Australian population, while a local population would refer to the estimated population in the Project Area. Density is to be estimated using data from the pre-construction surveys (**Section 3.0**) in combination with existing density estimates from primary literature, relevant to the eastern MLR. Local population estimates are to be derived using vegetation mapping for the Project. The local population of a given species is to be estimated by the contracted ecologist if an impact trigger for that species is met taking into consideration population dynamic assumptions such as, but not limited to, seasonal or inter-annual fluctuations in abundance in the Project Area.

No specific impact trigger or response procedures are proposed for other non-threatened species, however consultation will occur with DEW as part of the major BBMP Review to evaluate the impacts to non-threatened species from the initial operation of the Development, in addition to the appropriateness of the impact trigger levels of threatened and raptor species (**Section 8.2**).

Notification of a trigger should occur as early as practicable but will occur within the timeframes set out within this BBMP. The procedure for responding to an impact trigger threshold being met will be adhered to for the operational lifetime of the Development.

6.1 Threatened Species

6.1.1 Threatened Species Impact Triggers

The impact trigger threshold for species listed as threatened under the EPBC and/or the NPW Act is the detection of more than 1 carcass, injured individual or featherspot of the same species under or near a turbine in any 12-month period. This includes finds during any of the surveys and incidental finds by site personnel.

6.1.2 Threatened Species Response and Reporting Requirements

In the event that an impact trigger threshold for a threatened species is met[6], it is the responsibility of the person who discovered the carcass, injured individual or feather-spot to notify the relevant Environmental Representative upon discovery (allowing for identification, if required). At that point, the Developer must then notify DEW of the event within two business days.

Following notification of the initial impact trigger, consultation with DEW will occur within 10 business days of the impact trigger being recorded (pending availability of DEW personnel). Additional online or in-person meetings may be required depending on the nature of the consultation and extent of the impact trigger investigation (refer to **Section 6.2**). The specific timeframe of this additional consultation will be determined in the initial meeting.

The reporting process and decision-making framework depicted in **Figure 6.1** must then be followed. Impact trigger reporting requirements are described in **Section 8.0.**

6.1.3 Raptor Species Impact Trigger

For the purposes of defining raptor species relevant to the Development[7], those species identified as part of the bird and bat risk assessment (**Table 4.3**) and are relevant to the impact triggers of this BBMP include:

- Collared Sparrowhawk.
- Brown Goshawk.
- Wedge-tailed Eagle.
- Spotted Harrier.
- Black-shouldered Kite.
- Brown Falcon.
- Black Kite.
- Little Eagle.

The impact trigger threshold for a raptor species is the detection of two or more carcasses, injured individuals or feather-spots under or near the same or adjacent turbines (i.e. turbines not separated by another) during carcass searches in any two consecutive months (i.e. trigger activated if a total of four or more birds/carcasses or featherspots detected across two consecutive months, with two or more carcasses detected each month). For example, two carcasses detected in May, followed by two carcasses detected in June at the same or adjacent turbines would activate the trigger.

[6] If further identification (including DNA testing) is required to determine the species of a carcass, then the impact trigger will occur from the date the species of the carcass is confirmed as a threatened species.

[7] For the avoidance of doubt, where a raptor species has a formal conservation listing under the NPW Act or EPBC Act, this species is considered a threatened species for the purposes of the relevant impact trigger threshold.

6.1.4 Raptor Response and Reporting Requirements

In the event that an impact trigger threshold for a raptor species is met, it is the responsibility of the person who discovered the carcass, injured individual or feather-spot to notify the relevant Environmental Representative upon discovery. At that point, the Developer must then notify DEW of the event within five business days.

The reporting process and decision-making framework depicted in **Figure 6.1** must then be followed. Impact trigger reporting requirements are described in **Section 8.0.**

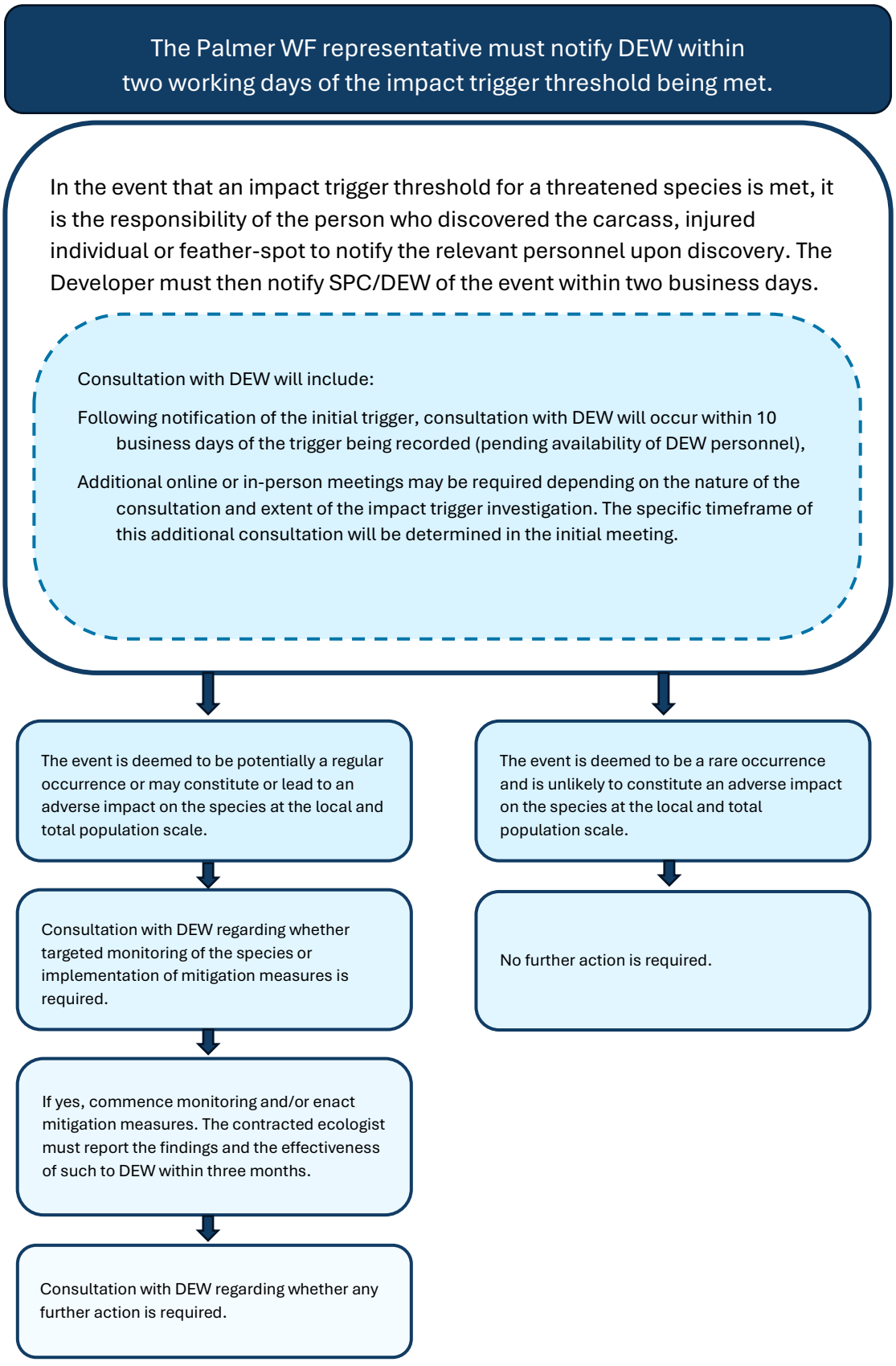

Figure 6.1 Threatened Species Impact Trigger Response Procedure

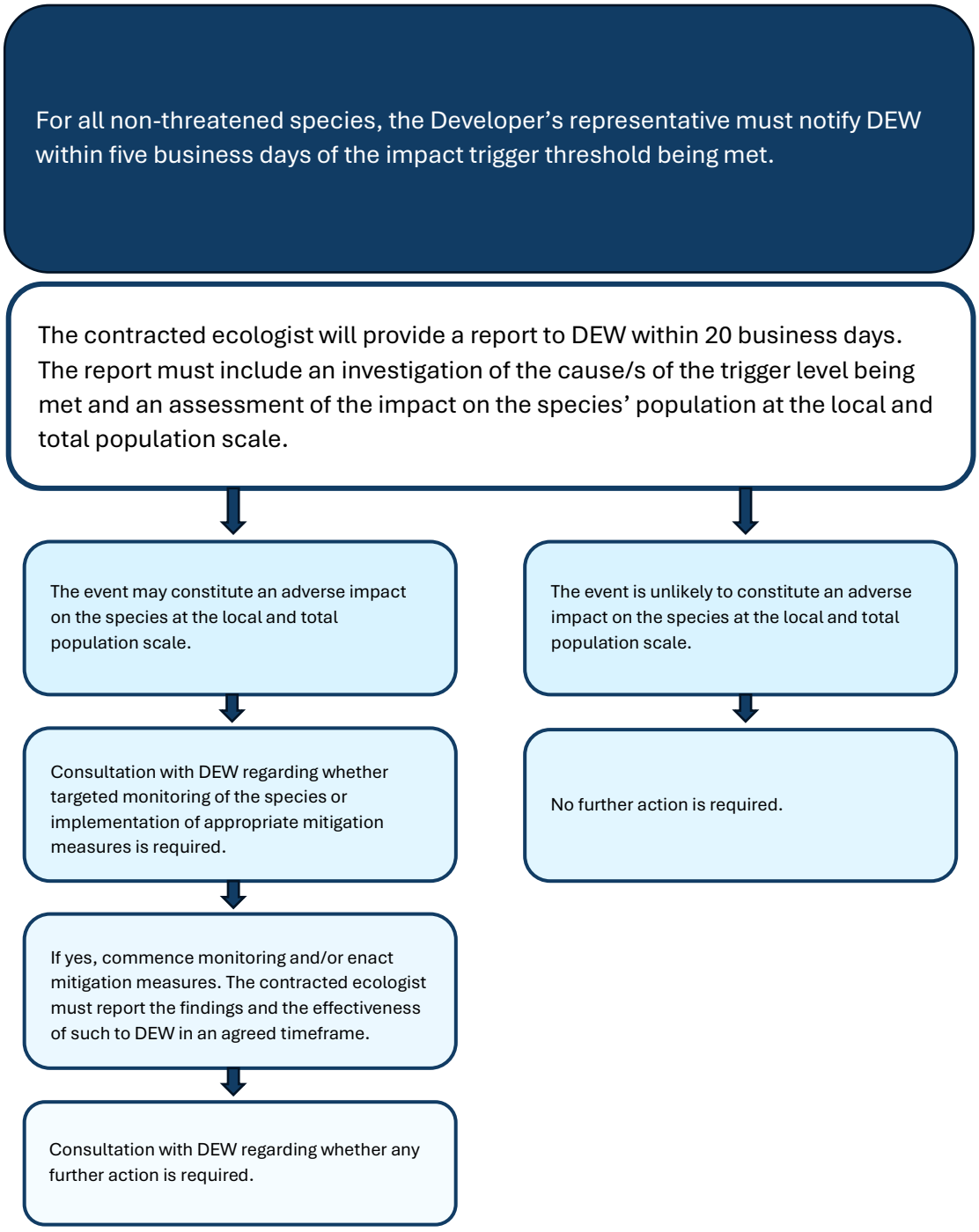

Figure 6.2 Non-threatened Species Impact Trigger Response Procedure

6.2 Impact Trigger Investigations

This BBMP does not currently ascribe numerical values to what should be considered an adverse impact at the total population and/or the local population scale. Rather, this BBMP currently describes an assessment process through which an ecologist first prepares an impact investigation that examines whether the event may be regular or may constitute, or lead to, an adverse impact on the species' local or total population. It is intended that the definition of an adverse impact to a population is further informed by the operational bird and bat monitoring program (**Section 5.0**)

The findings of this impact investigation determine the need for additional monitoring or mitigation action (refer to **Section 7.0**). The minimum requirements of the impact investigation report are detailed below:

- Specify the particular impact trigger level that was recorded including the species and number of individuals.
- Specify the date/s and location/s of recovered carcass(es)/feather-spot(s).
- Discuss any potentially influential ecological factors that may have contributed to the impact trigger such as recent climate, weather, presence of prey species/foraging opportunities or seasonal factors (i.e., migration).
- Verify whether or not the species has been impacted (including number of individuals and frequency) at regional wind farm developments within the range of the species by accessing where publicly available, any other BBMP reports.
- Recommendation of further monitoring above the scope of the BBMP and/or consideration of mitigation actions.

Definitions of adverse impacts for any impacted species will be prepared in consultation with DEW as part of the relevant impact trigger investigation should this milestone occur.

7.0 Mitigation Measures

The purpose of this section is to provide details of mitigation measures to manage risk of the Development leading to a significant adverse impact to a population of bird and bat species. Mitigation considered as part of the BBMP is intended to be targeted and specific to reducing mortality to species that have been identified to reach the relevant impact trigger thresholds.

Mitigation that is proposed under this section of the BBMP is additional to the avoidance and minimisation of impacts that the Developer has considered in the siting and design of the Development, which is considered the primary form of mitigation to reduce impacts to avian species (e.g. position of wind farm in cleared agricultural landscape, implementation of setbacks to known nests, etc.). In addition, the implementation of broader operational environmental controls will lead to ongoing preventative measures to minimise attraction of avian species to the Project Area (e.g. efficient waste management, minimising light spill).

7.1 Mitigation Evaluation

This BBMP is intended to present a decision-making hierarchy that is adaptive reflecting on the uncertainty of the various orders of avian species that may be impacted by the Development and the feasibility of emerging technological mitigation options. It is highly likely that suitable mitigation options considered by the Developer at the commencement of operations will change over the operational period of the Development due to further scientific research and technological advancement of various technologies that are being developed to further minimise impacts to avian species from operating wind farm developments.

Due to this, on reaching an impact trigger threshold, should an impact trigger investigation recommend the consideration of additional environmental controls or mitigation (refer to **Section 6.2**), the Developer and engaged ecologist will complete a detailed contemporary evaluation of available mitigation to reduce impacts to the species of concern.

This review will include consideration of:

- Established and emerging environmental controls and mitigation options currently deployed or under late-stage development.
- Current state of implementation – both in Australia and internationally – including any known constraints and limitations that would affect adoption at the Development.
- Scientific studies and research evaluating the efficacy of mitigation in relation to the target species.
- Viability of technical integration, financial costs and operational capabilities.
- Timeframes and process for implementation (e.g. requirements for variation to Development Authorisation, third-party consents, etc.).

The Developer will in consultation with the engaged ecologist, DEW and other technical advisors (as relevant) make a determination to select and implement additional environmental controls and mitigation. Through this consultation, the timeframe and process for implementation of the agreed measures will be agreed with DEW.

The Developer and DEW will take into account an escalation of complexity and scale of the relevant mitigation to achieve the objectives of this BBMP. This includes timing for deployment, overall cost and minimising the potential reduction of renewable energy production from the Development. Larger scale and complex technological mitigation will take longer to deploy than simpler environmental and land management considerations that may reduce the overall timeframe for reducing ongoing adverse impacts to a species. Consideration will also be given to deployment of trials of emerging technologies to better understand its efficacy for reducing mortality to avian species from wind developments.

7.2 Mitigation Options

Without limiting the scope of the mitigation evaluation (**Section 7.1**), to allow for a transparent assessment of the renewable energy industry's capacity to implement suitable mitigation to minimise impacts to avian species, a list of current or emerging environmental controls and mitigation measures the Developer may currently consider as part of the Development, are identified in **Table 7.1**.

The mitigation measures provided in **Table 7.1** are subject to change during the life of the BBMP as monitoring results are realised, technological advances occur across the industry, and new or alternative mitigation measures become available and scientifically validated. Other novel measures may be developed or considered in response to specific requirements and based on the current technologies at the time of the impact.

Curtailment of wind turbines is not considered the default or first mitigation option. Other environmental controls and mitigations may significantly reduce the potential impacts to a species. Considering disincentives of reducing renewable energy generation (and climate mitigation benefits) the Operator will consider curtailment as one of a suite of mitigation options if an impact trigger threshold relevant to threatened species.

Whilst it is considered unlikely that mitigations are ineffective and cannot meet the objective of this BBMP (being the Development does not result in a significant impact on threatened avian species), the Developer may consider offsetting as a last resort such impacts with a view of the Development having a net-zero impact.

Table 7.1 Potential Mitigation Measures for Consideration through SPC and/or DEW Consultation

Potential Mitigation Measure	Description	Likely timing for implementation	Relevant Species
Environmental controls			
Altered land management practices	Modification of existing land management practices within the Project Area and adjacent land to reduce attraction of species to the Project Area. Consideration to be given to land management in close proximity to wind turbines such as locations of lambing ewes, reduction of grain stock feeding and relocation of farm dams.	Within 3 months of the agreed mitigation approach and agreement of the landowner	Wedge-tailed Eagle Little Eagle Black Falcon Other raptors
Carrion removal program	Removal of carrion around turbines mitigates the risk of carrion feeders such as Wedge-tailed Eagle colliding with turbines.	Within 1 month of the agreed mitigation approach	Wedge-tailed Eagle Little Eagle Black Falcon Other raptors
Enhancement or propagation of impacted species habitat and their local population	Additional installation of artificial nest boxes specific for bird species being impacted, with inclusion of post installation monitoring. Installation of artificial bat boxes specific for bat species being impacted, with inclusion of post-installation monitoring.	Within 6 months of the agreed mitigation approach	Nankeen Kestrel Little Eagle Black-shouldered Kite Welcome Swallow Little Corella Australian Ringneck Australian Wood Duck Fairy Martin Inland Free-tailed Bat White-striped Freetail Bat
Supporting conservation programs	Funding and facilitation of revegetation programs in the local area to facilitate regeneration of suitable habitat for bird species being impacted. Funding contribution to published recovery programs for threatened species of bird and bat species impacted.	Within 3 months of the agreed mitigation approach	All

Potential Mitigation Measure	Description	Likely timing for implementation	Relevant Species
	Funding contribution to breeding and/or monitoring programs for bird and bat species being impacted. Funding and facilitation of research programs with local universities for bird and bat species being impacted.		
Technological mitigation			
Acoustic deterrents	The implementation of acoustic and/or ultrasonic deterrent devices targeted at particular wind turbines where impact triggers have been recorded, not Project wide, unless it is deemed impacts are Project wide.	Within 6-12 months of the agreed mitigation approach	Threatened birds and bats
Camera and radar detection systems	Prepare a testing and monitoring program for the implementation of radar systems (IdentiFlight or similar) to detect and monitor bird flight for particular species. Installation may be wind turbine specific, clusters of wind turbines or Project wide; but would be guided by the impact triggers recorded. Radars would be used to control wind turbine speeds and even shut-down wind turbines if collision is deemed likely.	Within 12-18 months of the agreed mitigation approach	Wedge-tailed Eagle Little Eagle Black Falcon Other raptors
Blade painting	Painting one of the wind turbine blades black/red (or in stripes) to minimise motion smear and reduce avian collision risk.	Within 12-18 months of the agreed mitigation approach	All (particularly raptors)
Wind turbine curtailment	Altering Cut-in Speeds: Involves increasing the wind speed at which turbines begin generating electricity. This adjustment reduces the risk of collisions for bats and birds during low-wind periods when they are most active. Temporary Shutdowns (Curtailment): Temporarily halting turbine operations during critical high-risk periods, such as during bird and bat migration seasons, at specific times of day (e.g., sunset and sunrise), or in the absence of heavy rainfall.	Within 1 month of the agreed mitigation approach	All (particularly raptors and migratory species)

8.0 Reporting and Review

8.1 Reporting

The reporting requirements of this BBMP are identified in **Table 8.1** and which aim to align with the specific regulatory requirements and Developer's commitments (refer to **Table 1.1**). The reporting identified in this section of the BBMP is in addition to any incident or non-compliance notifications required by the broader environmental management framework for the Development.

Table 8.1 Reporting Requirements

Report	Description	Timing	Performance Criteria	Responsible Person
Impact Trigger Reporting	DEW will be notified when impact triggers are met (**Section 6.0**), depending on whether or not the species impacted is threatened or raptor species. The report compiled by the contracted ecologist must then be submitted to the SPC and/or DEW within 10 business days for threatened species or 20 business days for raptor species of the incident being reported detailing: • The impact trigger level that was reached. • The species and number of individuals involved in the impact trigger. • The date/s and location/s of recovered carcasses/featherspot. • Any identified ecological factors contributing to the impact trigger such as recent climate, weather, presence of prey species/foraging opportunities or seasonal factors (i.e., migration). • Whether the event may constitute an adverse impact on the species at the local or total population scale. Verify whether or not the species has been impacted (including number of individuals and frequency) at wind farm developments within the range of the species by accessing any publicly available reports. Neighbouring wind farms within this radius will be considered at the time the impact	If an impact trigger occurs in accordance with **Section 6.0**	Impact trigger reporting completed in accordance with content and timing requirements described in **Section 6.0.**	Development's Environmental Representative • Impact trigger breach notification Contracted Ecologist: • Preparation of impact trigger reporting

Report	Description	Timing	Performance Criteria	Responsible Person
	trigger is recorded to consider any future wind farms.			
Annual Report	Annual Reports are required each year for five years from the commencement of operation. The annual reports will be submitted to DEW, MMC and the Murraylands and Riverland Landscape Board. The reports will be sent following the completion of the carcass search program, the bird and bat surveys and the nest monitoring program. The annual reports will: • Contain a register of bird and bat mortality and statistical analysis to provide estimates of the annual total number of collisions for each species in consideration of the carcass search area and effort and the observed carcass persistence times and observer detectability rates. • Provide commentary on data collected throughout the preceding year's bird and bat monitoring program (including the bird and bat surveys, carcass search surveys, carcass persistence trial and carcass detectability trial). Discussion on the findings of the bird and bat survey will include comparison with baseline data and interpretation of the findings in the context of regional conditions. • Analyse, summarise, and provide commentary on data collected from impact trigger events, and analyse collision rates relative to impact trigger levels. • If implemented, document the nature and timing of mitigation measures and assess potential impacts of such. • Report on any environmental (abiotic and biotic) factors or significant events that contributed to the data collected.	Annually for five years [8]	Annual reports to be submitted to DEW, MMC and the Murraylands and Riverland Landscape Board within three months of completion of annual monitoring. Annual reports to include all information referred to description column within this table. All raw data collected as part of the monitoring program will be provided to DEW, MMC and the Murraylands and Riverland Landscape Board with the annual reports.	Development's Environmental Representative • Submission of Annual Reports Contracted Ecologist • Preparation of Annual Reports

[8] Following the annual reporting period, copies of the bird and bat mortality register will be provided to DEW and/or MMC within 10 business days of any written request.

8.2 Review

This BBMP and its implementation will be reviewed on an as needs basis during operation of the Development and prior to decommissioning. The review will consider the following:

- Developer, site personnel and relevant agency comments.
- Efficacy of management practices and mitigation strategies.
- Complaints.
- Incident reports.
- Changes in organisational structure.
- Changes in novel monitoring and mitigation strategies.
- Changes in legislation and standards.

Further to the above, specific milestones for review of the BBMP and the carcass search program have been identified, with these milestones being presented in **Table 8.2.**

Table 8.2 Bird and Bat Monitoring Program Review

Review	Description	Milestone	Timing
BBMP Review	A major review will be undertaken after two years of commencement of operation. The major review will: • Review roles and responsibilities identified and update with any organisational or operational changes. • Summarise and assess observations made during the bird and bat monitoring program and carcass search program, and trigger impact reports, and make any resultant adjustments to management and mitigation strategies. • Recalculate species risk using the risk assessment methodology (s**ection 3.0**) based on observations made and species struck during the preceding two years. • Introduce novel monitoring and mitigation strategies identified throughout the preceding years that have not already been implemented. Consultation with DEW will occur following this review.	After the second year, following completion of the annual report.	Completion of the BBMP review within four months of submission of the second year of annual monitoring.

Furthermore, the BBMP will be reviewed in response to:

- An incident.
- Submission of relevant reporting (refer to **Section 8.0**).
- Modification to the conditions of the Development Approval.

Where the review results in the revision to the BBMP, consultation with DEW will be undertaken as relevant, with the revised BBMP will be submitted for approval of the SPC.

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Appendix A

Bird and Bat Risk Assessment

umwelt

Palmer Wind Farm Variation Application

Bird and Bat Risk Assessment

FINAL

September 2025

umwelt

Palmer Wind Farm Variation Application

Bird and Bat Risk Assessment

FINAL

Prepared by
Umwelt (Australia) Pty Limited

On behalf of
Tilt Renewables (Tilt)

Project Director:	Alison Derry
Project Manager:	Ange Carpenter
Report No.:	31656 (previously EX230107)
Date:	September 2025

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

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Document Status

Rev No.	Reviewer Name	Date	Approved for Issue Name	Date
V1	Dr M. Louter	05/05/2023	Alison Derry	05/05/2023
V2	A. Derry	19/05/2023	Alison Derry	19/05/2023
V3	A. Derry	25/08/2023	Alison Derry	25/08/2023
V4	Dr M. Louter	26/02/2024	Alison Derry	26/02/2024

Executive Summary

Tilt Renewables (Tilt) has development plan consent for the Palmer Wind Farm Project, comprising up to 103 wind turbines with a maximum tip height of 165 metres (m). Tilt Renewables is seeking approval to vary the Project to reduce the number of turbines to 40 and to increase the maximum tip height to 220 m.

EBS Ecology (EBS) has been engaged by Tilt to undertake an Avian and Bat Risk Assessment using past EBS collected data and results from the bird utilisation surveys undertaken in October 2022 and January 2023 to inform the assessment of the Variation Application. A risk assessment was undertaken in 2014 (EBS 2014) regarding the potential impact on birds of 114 turbines with a 165 m maximum blade tip height. The 2014 risk assessment considered the risk to birds of turbines with similar turbine parameters and dimensions as the turbine design approved in 2019. As such, EBS has taken into consideration the 2014 risk assessment as well as previous data collected at Palmer Wind Farm and combined this information with more recent 2022/2023 data, to update the risk assessment.

The proposed Palmer Wind Farm is located approximately 50 kilometres (km) east of Adelaide and is situated within the eastern hills of the Mount Lofty Ranges. The proposed varied Project Area extends approximately 15 km in a north to south direction, centred on ridgelines, and is split into Area B (the central area) and Area C (southern area).

As of information supplied to EBS on 14 February 2024, Tilt have selected the locations of 40 wind turbine generator (WTG) proposed to be installed at Palmer Wind Farm. As Tilt have not finalised the designs, EBS understands that variations to the WTG locations within the defined micro-siting areas may occur in subsequent design iterations.

Advice is being sought on the potential impact of the proposed Project to birds and bats on:

The reduction in the number of WTG from 103 to 40 (reduction of 63 WTG); and

The selected WTG size increasing from a rotor diameter of 130 m to 180 m (increase of 50 m).

A risk assessment matrix was used to qualitatively define the risk of the proposed Project on threatened bird species observed in the Project Area and threatened bird species defined as

“possibly” or “likely” to occur within the Project Area (based on the database searches). Bird species identified as having performed at-risk-movements within the Project Area (such as raptors) were also assessed. A risk assessment matrix was also used to define the risk to all bat species identified during previous surveys as occurring within the Project Area, threatened bats identified and potentially in the region and other bat species determined as “likely” to occur in the Project Area (based on database searches). The assessment is an adaptation of the qualitative measures of likelihood and consequence used in the Australian Defence Risk Management Framework.

Risk Assessment – Birds

The maximum rotor diameter Tilt is considering as part of the WTG update is 180 m, with a 220 m tip height, resulting in a 40 m ground clearance.

Raptors

The assessment of the risk of raptor collisions with WTG identified the following:

Medium risk: Wedge-tailed Eagle, Brown Falcon, Nankeen Kestrel and Peregrine Falcon

Low risk: Black-shouldered Kite, Black Kite, Collared Sparrowhawk and Little Eagle.

Of the above listed raptor species, only the Peregrine Falcon (Falco peregrinus) has a formal conservation status, with it being listed as Rare under the NPW Act.

Woodland birds

Compared to the minimum blade tip height of the approved Project (2019), the risk to woodland birds being impacted by the turbines is reduced by the increase in blade tip height by 5 m as woodland birds typically utilise a low air space to fly between woodland habitats.

The assessment of the risk of woodland bird collisions with WTG identified the following:

Medium risk:

Two threatened bird species observed in the Project Area were assessed as having a medium level of risk: the EPBC Act listed species Diamond Firetail (*Stagonopleura guttata*), and the NPW Act listed Elegant Parrot (*Neophema elegans*); and

Two common bird species observed within the Project Area, Australian Pelican (Pelecanus occidentalis) and Rainbow Bee-eater (Merops ornatus), were assessed as having a medium risk level.

Low risk:

Three threatened bird species observed in the Project Area were assessed as having a low level of risk;

Four species assessed as "likely to occur in the Project Area" were assessed as having a low

level of risk; and

Seven common bird species identified as having performed at-risk movements within the Project Area were assessed as having a low level of risk.

Risk Assessment – Bats

The likelihood of collision causing mortality was determined as likely for all bat species, except the South-eastern Long-eared Bat (Nyctophilus corbeni) which was unlikely. As such the overall level of risk for all bat species was determined as medium, except for the Nationally threatened South-eastern Long-eared Bat which was assessed as low. For those species considered to have a risk level of medium, all efforts should be made to mitigate against potential impact on the species.

Discussion

If the level of risk for a species is determined as **high** to **extreme**, then resulting impact on an individual species and local population would be unacceptable. If the level of risk for a species is categorised as **medium**, then all efforts should be made to mitigate against potential impact on the species. If the level of risk for a species is determined to be **low**, then impact would be limited to the level of individuals only, and impact at a species level would be low, and is therefore considered to be unlikely to affect the viability of a local population.

The level of risk was categorised as medium for 8 out of 25 bird species and for 11 of 12 bat species. The species with medium risk level assessments were generally also defined as having a minor consequence at a species / population level. This implies that there may be an impact on the local population of this species in the event of collision with a WTG. As such all efforts should be made by Tilt Renewables to mitigate against potential impact on bird and bat species, in particular placing WTG away from woodland areas as much as possible and away from sensitive areas, such as raptor nest locations.

However, compared to previous designs, the number of turbines proposed for construction within the Varied Project is fewer and the overall rotor swept area for all turbines combined is 26% less than the approved Project design and as such may promote fewer collision events for both birds and bats compared to previous designs. In addition, 4 fewer turbines have been located in or near woodlands than the approved Project designs, reducing the potential risks for woodland birds and bats.

The location of the proposed wind farm relative to bird species that may be present, the layout of the turbines, particular landscape features and the behaviour of bird species, influence the likelihood that a bird flying through a wind farm will collide with a WTG. As such, where possible, features that increase the risk of birds colliding with WTG (such as placement of turbines near Wedge-tailed Eagle nest and Peregrine Falcon nest, or placement of turbines near woodlands) should be considered and mitigated against.

Recommendations

Based on the risk assessment, EBS recommends adopting exclusion buffers between turbines and avoiding identified bat habitat (such as woodlands) to minimise potential impacts on bat species using the Project Area.

Given the increase in WTG size, EBS would advise on incorporating a bird and bat strike monitoring program, including scavenger and detectability trials as this would assist with understanding the potential impact of the Varied Project on birds and bats. This information can then be used to determine the adequacy of mitigation measures.

If the tower height and/or blade length (and ultimately the lowest extent of the rotating tip and the rotor swept area) of proposed WTGs change, this risk assessment will need to be re-evaluated and updated accordingly.

EPBC Act Listed Threatened Species

The following EPBC Act listed threatened species have been identified in this risk assessment:

Hooded Robin (*Melanodryas cucullata cucullata*) (EPBC Act: Endangered).

Diamond Firetail (*Stagonopleura guttata*) (EPBC Act: Vulnerable).

Southern Whiteface (*Aphelocephala leucopsis*) (EPBC Act: Vulnerable).

Blue-winged Parrot (*Neophema chrysostoma*) (EPBC Act: Vulnerable).

South-eastern Long-eared Bat (*Nyctophilus corbeni*) (EPBC Act: Vulnerable).

Four of the bird species, listed above, are species that have been recently listed as being of national conservation significance under the EPBC Act. These include the Hooded Robin, Diamond Firetail, Southern Whiteface and Blue-winged Parrot. For all of the species mentioned above, an EPBC self-assessment should be undertaken to determine the potential impact the construction and operation of the proposed windfarm may have on these species. This risk assessment and information from the two-year bird utilisation survey monitoring can be used to inform impacts to these species. If a significant impact is identified as potentially occurring, an EPBC referral is required.

If additional EPBC Act listed threatened species are detected during additional bird utilisation surveys, then these species should also be included in a self-assessment to determine impacts.

Abbreviations

Abbreviation	Definition
DRMF	Australian Defence Risk Management Framework
BDBSA	Biological Databases of South Australia database search
EBS	Environmental and Biodiversity Services Pty Ltd, trading as EBS Ecology
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
MNES	Matters of National Environmental Significance, as defined under the EPBC Act
NPW Act	*National Parks and Wildlife Act 1972*
PMST	Protected Matters Search tool
Sp.	Species (singular)
Spp.	Species (plural)
Ssp.	Subspecies
Varied Project	Palmer Wind Farm (as proposed to be varied, by the reduction of the number of WTG to 40 and the increase of the maximum tip height to 220 m)
Project Area	Several blocks of farming and cropping land located 70 km east of Adelaide, South Australia on which the Varied Project will be located.
Tilt	Tilt Renewables (the Proponent)
TrustPower	Former name of Tilt
WTG	Wind turbine generator

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Appendix A Threatened Species and Raptors Recorded in the Varied Project Area in October 2022 and January 2023 in Relation to the Location of the Wind Turbine Generators

1.0 Introduction

Tilt Renewables (Tilt) has development plan consent for the Palmer Wind Farm Project, comprising up to 103 wind turbines with a maximum tip height of 165 m. Tilt Renewables is seeking approval to vary the Project to reduce the number of turbines to 40 and to increase the maximum tip height to 220 m. The Project Area is located near Palmer, approximately 50 km east of Adelaide (**the Project Area**), in South Australia (**Figure 1.1**). The Varied Project will incorporate wind turbine generators (herein referred to as WTGs or turbines) along with associated infrastructure, including access tracks, transmission lines and underground cabling.

EBS Ecology (EBS) has been engaged by Tilt to undertake a Bat and Avian Risk Assessment using previously collected data as well as results from the bird utilisation surveys undertaken thus far in October 2022 and January 2023, to inform the assessment of the variation application. A risk assessment was undertaken in 2014 (EBS 2014) regarding the potential impact on birds of 114 turbines with a 165 m maximum blade tip height. The 2014 risk assessment assessed the risk to birds of turbines with similar turbine parameters and dimensions as the turbine design approved in 2019. As such, EBS has taken into consideration the 2014 risk assessment as well as previous data collected at Palmer Wind Farm and combined this information with recent data, to update the risk assessment.

1.0 Project Area

The Project Area is located approximately 50 km east of Adelaide and is situated within the eastern hills of the Mount Lofty Ranges. Land use within the area is predominantly agricultural (e.g., grazing for sheep and cattle). Native vegetation in the area has been extensively cleared, with most of the Varied Project's footprint containing grasslands with large outcrops of rocks and boulders. Woodland vegetation is generally restricted within small patches and within creek lines.

The Project Area extends approximately 15 km in a north to south direction, centred on ridgelines, and is split into Area B (the central area) and Area C (southern area) (**Figure 1.1**).

Previously, there were three areas comprising the Project Area. Area A, which was located further north, will be excluded from the Project Area as a result of the variation (EBS 2014).

The Varied Project layout will be finalised pending this report and the finalisation of the flora and fauna ecological report (EBS 2024).

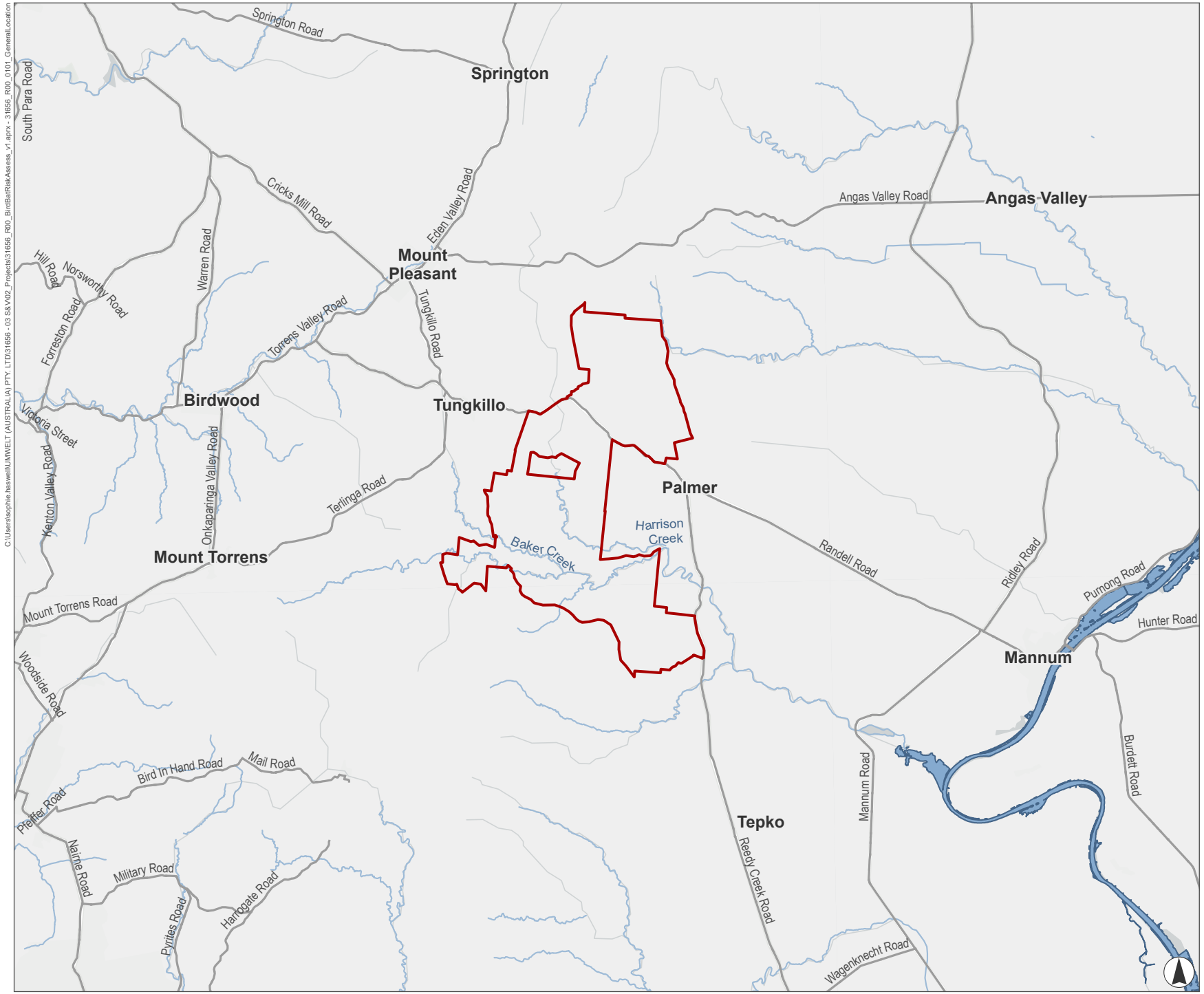
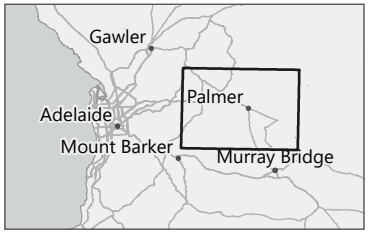


FIGURE 1.1

Location of the Varied Palmer Wind Farm Project Area

Legend

- Project Area
- River Murray
- Watercourse
- Main road



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GDA2020 MGA Zone 54

Image Source: ESRI Basemap (2025) | **Data Source:** Umwelt, Tilt, DIT, DEW (2025)

2.0 Background

2.1 Project Details

As of information supplied to EBS on 14 February 2024, Tilt have selected the locations of 40 turbines proposed to be installed at Palmer Wind Farm (**Figure 2.1**), which is a reduction of 63 turbines from the approved designs of 103 turbines (**Table 2.1**). Tilt have not finalised the designs, thus EBS understands that variations to the turbine design and locations within the defined micro-siting areas may occur in future design iterations.

Advice is being sought on the potential impact to birds and bats as a result of:

- The reduction in the number of WTG from 103 to 40 (reduction of 63 WTG); and
- The selected WTG size increasing from a rotor diameter of 130 m to 180 m (increase of 50 m).

Figure 2.1 shows the number and location of WTG, distributed across the two areas remaining in the Varied Project layout, following the variation:

- Area B (central area) – 24 WTG.
- Area C (southern area) – 20 WTG.

The Project commenced in 2009, with a Development Application lodged with the Mid-Murray Council pursuant to the *Development Act 1993* in February 2014 for a layout of 114 turbines. The Development Application was approved in December 2015, then appealed and approved at the Supreme Court in 2019 subject to conditions (the approved Project). WTG designs for early planning, the approved Project and the Varied Project are provided in **Table 2.1.**

2.2 Previous Risk Assessments

The following report was prepared by EBS:

- A risk assessment was undertaken by EBS in 2014 as part of the Flora and Fauna Ecological Assessment for bird species at risk of potential impacts from wind turbines at the proposed Palmer Wind Farm (EBS 2014).

2.3 Current Design Plans

The maximum rotor diameter Tilt is considering as part of the update is 180 m, with a 220 m tip height resulting in a 40 m ground clearance (**Table 2.1**). This is an increase from the previously approved turbine design of 25 m to the blade length, 50 m to the rotor diameter, 55 m to the maximum tip height and 5 m to the minimum tip height.

While the rotor swept area for each turbine has increased by 92%, overall the number of WTG's has decreased by 63 (61% reduction) and the total rotor swept area of all turbines proposed for Palmer Wind Farm has decreased by 26% when compared to the approved Project (**Table 2.1**).

Table 2.1 Changes in WTG Layout and Parameters for Palmer Wind Farm

Parameter	Early Planning (2014)	Approved Project (2019)	Varied Project (2024)	Change from Early Planning (2014) to Approved Project (2019)	Change from Approved Project (2019) to Varied Project (2024)
Number of turbines	114	103	40	Decrease by 11 WTG (10% reduction)	Decrease by 63 WTG (61% reduction)
Blade length (m)	65	65	90	No Change	Increase by 25 m (38% increase)
Rotor diameter (m)	130	130	180	No Change	Increase by 50 m (38% increase)
Maximum tip height (m)	165	165	220	No Change	Increase by 55 m (33% increase)
Minimum tip height / ground clearance (m)	35	35	40	No Change	Increase by 5 m (14% increase)
Rotor swept area per turbine (m2)	13,273	13,273	25,447	No Change	Increase by 12,173 m2 (92% increase)
Rotor swept area all turbines (m2)	1,513,122	1,367,119	1,017,880	Decrease by 146,003 m2 (10% reduction)	Decrease by 349,239 m2 (26% reduction)

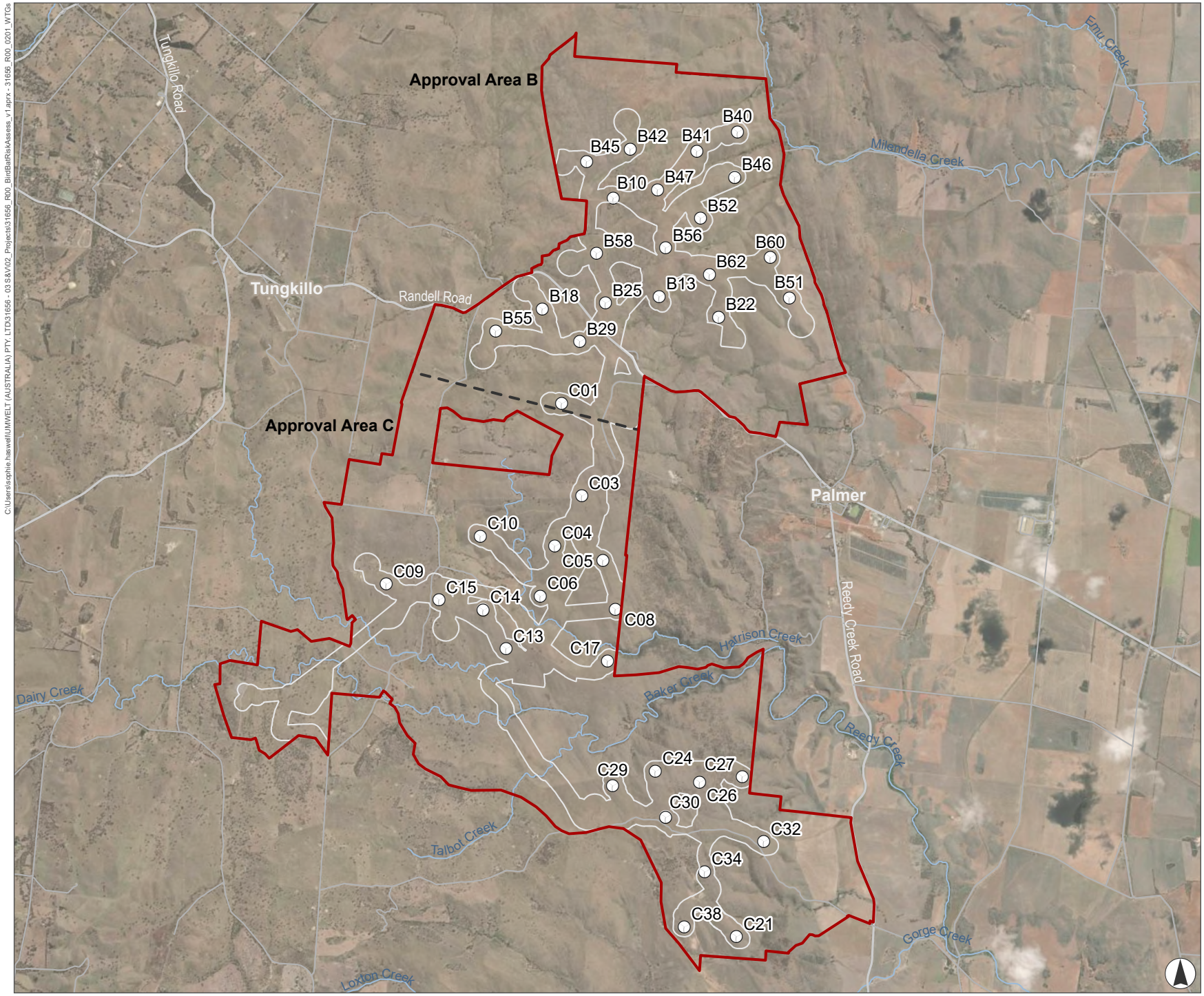
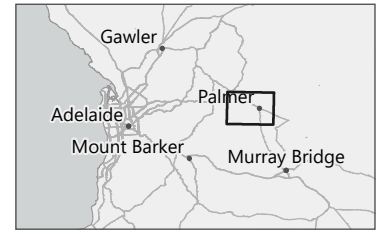


FIGURE 2.1

Location of WTG in Approval Areas B and C

Legend

- Project Area
- Micrositing Area
- Approval Areas
- WTG
- Main road
- Local road
- Watercourse



0 2 4

Kilometres

Scale 1:80,000 at A4
GDA2020 MGA Zone 54

Image Source: ESRI Basemap (2025) | **Data Source:** Umwelt, Tilt, DIT, DEW (2025)

2.4 Wind Farm Impacts on Avifauna

The potential impacts of wind farms on avifauna include:

- Rotor strikes (bird mortality).
- Barotrauma (bat mortality).
- Clearance and degradation of habitat.
- Acoustic masking.
- Behavioural avoidance.

2.4.1 Rotor Strikes

Bird species that regularly fly at heights swept by turbine rotors are prone to rotor strike. This includes raptors, which are one of the most at-risk groups of bird from wind farms due to their flight height, low fecundity and long lifespans (Beston *et al.* 2016), which means that the replacement of struck individuals within the population takes considerable time and energy, and population declines may occur (Dahl *et al*. 2012).

Worldwide, raptors and birds of prey have been extensively documented as a high-risk species for WTG collision (Thaxter *et al.* 2017), and in Australia collisions of raptors with WTG have been documented for Tasmania Wedge-tailed Eagle (*Aquila audax fleayi*) (Hull *et al.* 2015), Wedge-tailed Eagle (*Aquila audax*), White-bellied Sea Eagle (*Haliaeetus leucogaster*), Swamp Harrier (*Circus approximans*), Brown Falcon (*Falco berigora*), Black-shouldered Kite (*Elanus axillaris*), Australian Hobby (*Falco longipennis*), Brown Goshawk (*Accipiter fasciatus*), Collared Sparrowhawk (*Accipiter cirrocephalus*), Little Eagle (*Hieraaetus morphnoides*), Nankeen Kestrel (*Falco cenchroides*), Peregrine Falcon (*Falco peregrinus*), Whistling Kite (*Haliastur sphenurus*) and Black Falcon (*Falco subniger*) (Hull *et al* 2013; Maloney *et al.* 2019).

EBS has undertaken bird strike monitoring at Hornsdale Wind Farm. From the results analysed thus far (from either evidence of a carcass or feather spot), it has been determined that 4 raptor species (Wedge-tailed Eagle, Brown Falcon, Nankeen Kestrel and Peregrine Falcon) have collided with turbines at Hornsdale Wind Farm (EBS 2019). Additionally, EBS conducted raptor survey / monitoring at Snowtown Wind Farm over a six-year period (EBS 2013), whereby three Wedge-tailed Eagles were known to have collided with wind turbines. This number may be an underestimation of strike rates, as detectability and scavenging of the carcases may contribute to underrating collisions.

Bird collisions with seemingly slow-moving turbine blades occur as a result of the following possible reasons:

- Due to the optics of bird vision, as the bird approaches the spinning blades, the rate the image is transmitted to the bird's brain speeds up until the retina cannot keep up with it, creating a blur (called motion blur) that the bird likely translates as being safe air space (Hodos 2003). Birds could therefore assess this area as safe and risk colliding with the turbine blades.
- Due to birds narrow frontal field of view and expected high use of their lateral field of view for detecting prey, predators and other conspecifics, birds may not observe turbines while undertaking other activities, increasing their risk of collision (May *et al.* 2020).

2.4.2 Barotrauma

Bats succumb to barotrauma at wind farm turbines whereby the rapid air-pressure reduction near moving turbines causes tissue damage to air-containing structures (Baerwald *et al*. 2008). The number of bat mortalities at wind farms is expected to be substantial, with 44 bat carcasses identified within one year of monthly monitoring over 25 turbines at Ararat Wind Farm, Victoria (BL&A 2018). The true number of bat mortalities across these 25 turbines would be significantly higher than 44 deaths, as scavenging rates and surveyor error (failed detection during searches) was not accounted for. Bat monitoring at McArthur Wind Farm in south-western Victoria found annual bat mortality per turbine to be 1.41 ± 0.65 and 3.08 ± 1.68 in 2013 and 2014, respectively (AERS 2015).

2.4.3 Clearance and Degradation of Habitat

The proposed Project will result in the direct clearance of habitat for hardstands, access tracks, transmission lines and substations. For the construction of wind farms, clearance of remnant native vegetation is expected to be required and can contribute to habitat loss, fragmentation and degradation of habitat. In particular, habitat loss is expected to be unfavourable to small passerine species with specific habitat preferences and favourable to large generalist species (Szabo *et al*. 2011). If any hollow bearing trees, are to be cleared, this contributes to the loss of roosting and nesting habitat for bird and bat species with those specific habitat requirements. Furthermore, where native vegetation borders the infrastructure footprint, habitat is at a higher risk of to becoming degraded from weed invasion, erosion and other edge effects.

2.4.4 Acoustic Masking

The noise associated with a wind farm may have adverse impacts on songbirds (Zwart *et al*. 2016). Acoustic masking caused by wind farm noise may affect the ability of individuals with established territories to deter a rival (Zwart *et al*. 2016). As such, increased time and energy would need be spent for maintaining territories, which could result in reduced breeding success of sedentary territorial bird species (Zwart *et al*. 2016). In South Australia, acoustic masking is thought to be one of the key drivers of reduced songbird abundance in areas within 500 m of mining activity (Read *et al*. 2015).

2.4.5 Behavioural Avoidance

Raptors are known to substantially reduce their presence within an area following the construction of a wind farm. While this reduces the number of individuals that succumb to rotor strike, it may displace pairs from their established territories, which can reduce breeding success. The impact of rotor strike and displacement of individuals is considered to have reduced the breeding success of White-tailed Eagles (*Haliaeetus albicilla*) within occupied territories from 48% before wind farm construction to 22% post construction (Dahl *et al*. 2012). Displacement of raptors at a wind farm also occurred in Wisconsin, United States of America, where a 47% reduction in raptor abundance was recorded following wind farm construction (Garvin *et al*. 2011). At two wind farms in Tasmania, flight tracks and behaviour of Wedge-tailed Eagles were recorded over two years, which demonstrated that Wedge-tailed Eagles had avoidance rates of 81% to 97% higher compared to pre-construction, although this varied between sites and in different weather conditions (Hull & Muir 2013).

3.0 Methods

3.1 Risk Assessment

3.1.1 Assessment of the Likelihood of Species Utilising Project Area

A likelihood of occurrence rating (i.e., likelihood of that species occurring on or near the Project Area) was assigned to each threatened species identified in the Protected Matters Search Tool (PMST (DCCEEW 2023) and Biological Databases of South Australia (BDBSA) database search (DEW 2023 Recordset number: DEWNRBDBSA230614-1) with a 10 km search area around the Varied Project. The PMST identifies nationally threatened flora, fauna, migratory fauna and threatened ecological communities relevant to the search area. The BDBSA database search is comprised of an integrated collection of species records from the South Australian Museum, conservation organisations, private consultancies, Birds SA, Birdlife Australia and the Australasian Wader Study Group. As EBS records are submitted to the BDBSA databased, records from surveys conducted in 2014 are also included in the BDBSA database that are used to inform the likelihood of species using the Project Area.

This likelihood of occurrence rating, 'Highly Likely', 'Likely', 'Possible' and 'Unlikely' takes the following criteria into consideration:

- proximity of the records (distance to the Project Area).
- date of the records.
- landscape features, vegetation remnancy and vegetation type at the location of the record (taking into consideration similarities within the Project Area).
- knowledge of species' habitat preferences, causes of decline, and local population trends.

Bird and bat species observed in the Project Area during field surveys undertaken at Palmer Wind Farm were assigned as "known" to occur within the Project Area. Threatened species assessed as potentially occurring in the area (i.e., "possible", "likely", "highly likely", or "known") were included in the risk assessment. Common bird and bat species that are known to occur in the Project Area and that were assessed as at risk of flying within the rotor swept height of WTG were included in the assessment.

A detailed description of the criteria for likelihood assessments is provided in the ecological assessment report (EBS 2024).

3.1.2 Level of Risk

A risk assessment matrix was used to qualitatively define the risk of the Varied Project on threatened bird species observed in the Project Area and threatened bird species defined as "possibly" or "likely" to occur within the Project Area (based on the PMST search and BDBSA search). Bird species identified as having performed at-risk movements within the Project Area (such as raptors) were also assessed.

A risk assessment matrix was used to define the risk to all bat species identified during previous surveys as occurring in the Project Area, threatened bats identified and potentially in the region and other bat species determined as "likely" to occur in the Project Area (based on the BDBSA search).

The assessment is an adaptation of the qualitative measures of likelihood and consequence used in the Australian Defence Risk Management Framework (Gaidow and Boey 2005). The Australian Defence Risk Management Framework provides generic guidance on the introduction and ongoing implementation of a risk management process; it may be applied to different activities or operations of any corporate, community or public sector organisation (Gaidow and Boey 2005). The risk assessment matrix considered the risk consequences (impact or magnitude of effect) and likelihood (measured by frequency or probability) of risk occurrence to combine both into the overall level of risk.

The risk assessment methodology used within the Australian Defence Risk Management Framework was adapted to include likelihood and consequence of an event on a species or local population. EBS used the matrix to qualitatively define the risk of a proposed wind monitoring mast on birds within numerous proposed wind farms located in the mid-north of South Australia and has been accepted (when previously used by EBS) by the Environment, Resources and Development Court. State threatened bird species, raptors and migratory species were targeted in the assessment.

Likelihood was defined as how likely mortality from collision is to occur, and consequence was defined by significance of associated impact on species viability (**Table 3.1**):

- Categories A to E were used to define likelihood, ranging from chronic (the event is expected to occur in most circumstances) to rarely (where the event may occur only in exceptional circumstances).
- Categories 1–5 were used to define consequence, where one equated to nil/insignificant (individuals may be affected, but viability of local population was not impacted) and five equated to catastrophic disaster (potential to lead to collapse of a species) (**Table 3.1**).

Table 3.2 outlines the qualitative risk analysis matrix, which summarises four levels of impact: low, medium, high and extreme.

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

3.1.3 Limitations

The findings and conclusions expressed by EBS are based solely upon information available at the time of the assessment.

Existing flora and fauna records were sourced from the BDBSA. The BDBSA only includes verified flora and fauna records submitted to the Department for Environment and Water or partner organisations. Although much of the BDBSA data has been through a variety of validation processes, the lists may contain errors and should be used with caution.

There is limitation in determining the resulting impact of acceptability and significance with regard to the risk assessment matrix. The risk assessment matrix provides a guide to risk consequences and likelihood of risk occurrences, based on the bird species that were identified as performing flights considered as ‘at-risk’ movements.

Table 3.1 Qualitative Measures of Likelihood and Consequence

Likelihood (how likely is mortality from collision to occur)		Consequence (Significance of associated impact on species viability)	
Rating	**Definition**	**Rating**	**Definition**
Chronic	The event is expected to occur in most circumstances.	**Catastrophic/ Disaster**	Potential to lead to collapse of species.
Frequent	The event probably will occur in most circumstances (e.g., weekly to monthly).	**Major**	Critical event, very likely to have significant impact on species.
Likely	The event should occur at some time (i.e., once in a while).	**Moderate**	Likely to have impact on population, potential to impact on long-term viability under some scenarios.
Unlikely	The event could occur at some time.	**Minor**	May have impact on local population, no impact on species.
Rarely	The event may occur only in exceptional circumstances.	**Insignificant**	Individuals may be affected, but viability of local population not impacted.

(Adopted from AS/NZS 4360:1999, now superseded by AS ISO 31000:2018)

Table 3.2 Qualitative Risk Analysis Matrix – Level of Risk

Likelihood	Consequences				
	Insignificant 1	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
A (Chronic)	High	High	Extreme	Extreme	Extreme
B (Frequent)	Medium	High	High	Extreme	Extreme
C (Likely)	Low	Medium	High	Extreme	Extreme
D (Unlikely)	Low	Low	Medium	High	Extreme
E (Rarely)	Low	Low	Medium	High	High

(adopted from AS/NZS 4360:1999 [superseded by AS ISO 31000:2018] and HB 143:1999 [superseded by SA SNZ HB 436-2013])

4.0 Avian Risk Assessment

4.1 Results from Previous Risk Assessments (EBS 2014)

The risk assessment completed by EBS in 2014 was based on proposed turbines with a maximum tip of blade height of 165 m. The dimensions of the WTG tower and blade were yet to be decided by TrustPower. Indicative dimensions were 100 m for the tower height and 65 m for the blade lengths.

The 2014 risk assessment was based on the lowest extent of a rotating blade tip being 35 m from the ground.

Flight height and movement details were specifically recorded for 'at-risk' bird species; meaning those species with the potential to fly at heights within the rotor-swept area, making them at risk of collision with WTG. Flight height and movement details were used to assess the potential collision risk of avian species. In 2014 flights that were performed above 35 m over the top of a ridge were considered at-risk movements.

The overall level of risk for all bird and bat species was determined as **low** in the 2014 assessment (**Table 4.1**). The likelihood of collision causing mortality was determined as unlikely for six raptor species (including the Peregrine Falcon (*Falco peregrinus*)) and five threatened bird species. Two State threatened bird species known to occupy woodland habitats were assessed in the likelihood of a collision event causing mortality as rare. The consequence of mortality at a species/population level was determined as **minor** for four species: the Peregrine Falcon, Hooded Robin (*Melanodryas cucullata cucullata*), Elegant Parrot (*Neophema elegans*) and Diamond Firetail (*Stagonopleura guttata*).

4.2 Updated Avian Risk Assessment 2024

The updated risk assessment was undertaken to determine the potential impact of the proposed Project on bird species, where the risk element of concern remain unchanged, as collision. The maximum rotor diameter of proposed WTGs is 180 m, with a 220 m tip height, resulting in a 40 m ground clearance.

The updated risk assessment is based on the lowest extent of the rotating blade tip and the rotor swept area being 40 m from the ground, which is a difference of 5 m from the 2014 risk assessment. For the purposes of the updated risk assessment, flights that would be performed above 40 m over the top of the ridge would be considered at-risk movements, as this air-space would correspond with the rotor-swept area of turbines.

It is anticipated that with the varied WTG design, with the updated blade tip height, reduces the risk of woodland birds being impacted by turbines by 5 m compared to the approved Project, as woodland birds typically utilise a low air space to fly between woodland habitats. In addition, 4 fewer turbines have been located in or near woodlands than the approved Project designs, further reducing the potential risks for woodland birds.

New assessments were performed for additional raptor species (two species) and threatened bird species known to the Project Area since 2014 (three species), and any common bird species assessed in field surveys as flying within the rotor swept height of the turbines (eight species).

The Collared Sparrowhawk and Nankeen Kestrel were additional raptor species to be included in the risk assessment as they were observed in the Project Area and have been identified as colliding with turbines in a study of Victorian Wind Farms (Maloney *et al.* 2019).

One bird species listed as vulnerable under the EPBC Act and four species listed under the *National Parks and Wildlife Act 1974* (NPW Act), were observed during surveys at the proposed Palmer Wind Farm Project Area. Of the species recorded in the Project Area, eight raptors and nine common bird species were considered at risk, as determined by flight heights and / or flight behaviours (**Table 4.1**). One species not observed in the Project Area but assessed as possibly occurring in the Project Area (Blue-winged Parrot, *Neophema chrysostoma*) was also considered at risk due to the potential to fly in the rotor swept zone.

4.2.1 Raptors

As a result of bird strike monitoring data at other wind farms, as well as the larger rotor-swept area of the proposed wind turbines compared to the approved design, EBS has increased the risk assessment levels for four raptor species (**Table 4.1**). However, it is noted that the reduction in the number of turbines has decreased the total rotor-swept area of the Varied Project by 26% and the potential impact of this is discussed in **Section 6.0**. As such Wedge-tailed Eagle, Brown Falcon, Nankeen Kestrel and Peregrine Falcon have been assessed as having a **medium** risk level, and Black-shouldered Kite, Black Kite, Collared Sparrowhawk and Little Eagle have been assessed as having a **low** risk level of impact due to collision with turbines.

The risk assessment levels for raptors changed from the 2014 assessment as listed below:

- Wedge-tailed Eagle, Brown Falcon, Peregrine Falcon and Little Eagle
    - Change in likelihood of an event causing mortality increased from unlikely to likely.
    - Change in their consequence at a species / population level changed from nil / insignificant to minor.
    - Risk level increased from low to medium.
- Collared Sparrowhawk was assessed as being unlikely to have an event causing mortality and nil / insignificant consequences at a species / population level resulting in a low level of risk.
- Nankeen Kestrel was assessed as being likely to have an event causing mortality and minor consequences at a species / population level, resulting in a medium level of risk.

All species assessed as having a medium level of risk were identified as potentially being affected at the local population level, but not at the overall species level. For the species of which risk was determined as low, individuals may be affected, but the viability of local populations will not be impacted upon.

4.2.2 Woodland Birds

The risk of collision for woodland birds listed in **Table 4.1** has been increased for two species, due to the larger rotor-swept area of the proposed larger wind turbines. In general, the potential effects of a wind farm on woodland bird species are related to (1) possible loss of habitat and (2) disturbance from turbines if situated close to woodlands.

Direct interaction with turbine blades is now considered unlikely for woodland specific bird species (unless otherwise stated in **Table 4.1**), as the rotor-swept area is higher than typical flight heights observed for woodland birds at Palmer Wind Farm.

A summary of the risk assessment for threatened woodland birds known to occur in the Project Area is as follows (**Table 4.1**):

- One species of threatened bird had their likelihood of an event causing mortality changed from unlikely to likely (Elegant Parrot (*Neophema elegans*)). The consequence to the species / population for this species remained as minor and as such the risk level has been upgraded to **medium**.
- Two species assessments remained the same and their risk rating remained as **low** (White-winged Chough (*Corcorax melanorhamphos*) and Hooded Robin (*Melanodryas cucullata cucullata*)).
- The likelihood of an event causing mortality for the Diamond Firetail (*Stagonopleura guttata*) remained the same as unlikely and the consequence for the species / population was upgraded to moderate due to the absence of suitable habitat for this species in the broader landscape. As such the risk level increased to **medium**.
- White-bellied Cuckoo-shrike was added to the list and was assessed as having a **low** risk level due to vagrant presence in the area and low flight height between woodlands.

A summary of threatened birds listed as possibly or likely to occur within the Project Area is as follows (**Table 4.1**):

- Two newly listed EPBC Act listed threatened bird species have been added to the risk assessment: Southern Whiteface (*Aphelocephala leucopsis*) and Blue-winged Parrot (*Neophema chrysostoma*);
- Three bird species (Southern Whiteface, Jacky Winter (*Microeca fascinans*) and Restless Flycatcher (*Myiagra inquieta*)) have been assessed for the likelihood of an event causing mortality as rarely with a consequence of minor.
- The Southern Whiteface, Jacky Winter, Restless Flycatcher and Blue-winged Parrot have been assessed as having a risk level of **low**.

A summary of "at risk" common bird species within the Project Area is as follows (**Table 4.1**):

- Seven bird species observed flying in the rotor swept zone have been assessed as being likely to have an event causing mortality with nil / insignificant consequences. As such these species have been assessed as having a **low** risk level.
- Two bird species, Australian Pelican (*Pelecanus occidentalis*) and Rainbow Bee-eater (*Merops ornatus*), were assessed as having a **medium** risk level as they are likely to have an event causing mortality and the impact on the species / population will be minor.

In summary – level of risk

Eight species included in this risk assessment have been assessed as having a **medium** level of risk. Of these, four are raptors and two are threatened species (one of which are EPBC Act listed). The remaining seventeen species have been assessed as having a **low** level of risk.

If the level of risk for a species is determined as high to extreme, then resulting impact on an individual species and local population may be unacceptable when considered through regulatory approval processes. If the level of risk for a species is categorised as medium, then all efforts should be made to mitigate against potential impact on the species. If the level of risk for a species is determined to be low, then impact would be limited to the level of individuals only, and impact at a species level would be low, and is therefore considered to be unlikely to affect the viability of a local population.

Table 4.1 Updated Avian Risk Assessment of the Proposed Palmer Wind Farm

Scientific name	Common name	Aus. status	SA status	Likelihood of utilising	Likelihood of an event causing mortality		Consequence at a species / population level		Level of risk	
				Project Area	2014	2024	2014	2024	2014	2024
Raptor species										
Accipiter cirrocephalus	Collared Sparrowhawk			Known	-	Unlikely	-	Nil/ Insignificant	-	Low
Aquila audax	Wedge-tailed Eagle			Known	Unlikely	Likely	Nil/ Insignificant	Minor	Low	Medium
Elanus axillaris	Black-shouldered Kite			Known	Unlikely	Unlikely	Nil/ Insignificant	Nil/ Insignificant	Low	Low
Falco berigora	Brown Falcon			Known	Unlikely	Likely	Nil/ Insignificant	Minor	Low	Medium
Falco cenchroides	Nankeen Kestrel			Known	-	Likely	-	Minor	-	Medium
Falco peregrinus	Peregrine Falcon		R	Known	Unlikely	Likely	Nil/ Insignificant	Minor	Low	Medium
Milvus migrans	Black Kite			Known	Unlikely	Unlikely	Nil/ Insignificant	Insignificant	Low	Low
Hieraaetus morphnoides	Little Eagle			Known	Unlikely	Unlikely	Nil/ Insignificant	Minor	Low	Low
Threatened birds known to occur in the Project Area										
Coracina papuensis	White-bellied Cuckooshrike		R	Known	-	Unlikely	-	Nil/ Insignificant	-	Low
Corcorax melanorhamphos	White-winged Chough		R	Known	Unlikely	Unlikely	Nil/ Insignificant	Minor	Low	Low
Melanodryas cucullata cucullata	Hooded Robin	EN	R	Known	Unlikely	Unlikely	Minor	Minor	Low	Low
Neophema elegans	Elegant Parrot		R	Known	Unlikely	Likely	Minor	Minor	Low	Medium
Stagonopleura guttata	Diamond Firetail	VU	V	Known	Unlikely	Unlikely	Minor	Moderate	Low	Medium

Scientific name	Common name	Aus. status	SA status	Likelihood of utilising	Likelihood of an event causing mortality		Consequence at a species / population level		Level of risk	
BDBSA determined as 'Possible' or 'Likely' to occur in the Project Area										
Aphelocephala leucopsis	Southern Whiteface	VU		Possible	-	Rarely	-	Minor	-	Low
Microeca fascinans	Jacky Winter		R	Likely	Rarely	Rarely	Nil/Insignificant	Minor	Low	Low
Myiagra inquieta	Restless Flycatcher		R	Likely	Rarely	Rarely	Nil/Insignificant	Minor	Low	Low
Neophema chrysostoma	Blue-winged Parrot	VU	V	Possible	-	Unlikely	-	Minor	-	Low
"At risk" common bird species that occur in the Project Area										
Cacatua sanguinea	Little Corella			Known	-	Likely	-	Nil/Insignificant	-	Low
Corvus mellori	Little Raven			Known	-	Likely	-	Nil/Insignificant	-	Low
Eolophus roseicapilla	Galah			Known	-	Likely	-	Nil/Insignificant	-	Low
Gymnorhina tibicen	Australian Magpie			Known	-	Likely	-	Nil/Insignificant	-	Low
Hirundo neoxena	Welcome Swallow			Known	-	Likely	-	Nil/Insignificant	-	Low
Merops ornatus	Rainbow Bee-eater	Ma		Known	-	Likely	-	Nil/Insignificant	-	Low
Pelecanus occidentalis	Australian Pelican			Known	-	Likely	-	Nil/Insignificant	-	Low
Petrochelidon ariel	Fairy Martin			Known	-	Likely	-	Nil/Insignificant	-	Low
Platycercus elegans	Crimson Rosella			Known	-	Likely	-	Nil/Insignificant	-	Low

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). **SA:** South Australia (*National Parks and Wildlife Act 1972*). **Conservation Codes: EN/E:** Endangered. **VU/V:** Vulnerable. **R:** Rare. **Mi**: Migratory. Ma: Marine – protected in Marine Protected Areas. "**-**" = not assessed. Species in bold were not assessed in the 2014 assessment.

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

- Chronic – the event is expected to occur in most circumstance
- Frequent - the event probably will occur in most circumstances
- Likely - the event should occur at some time
- Unlikely – the event could occur at some time
- Rarely – the event may occur only in exceptional circumstances.

Consequence definitions (significance of associated impact on species viability):

- Catastrophic disaster – the event has the potential to lead to collapse of species
- Major– critical event, very likely to have significant impact on species
- Moderate– likely to have impact on population, potential to impact on long term viability under some scenarios
- Minor – the event may impact on local population, no impact on species
- Nil/Insignificant - individuals may be affected, but viability of local population not impacted.

5.0 Bat Risk Assessment

5.1 Results from Previous Risk Assessments (EBS 2014)

The risk assessment matrix (EBS 2014) was not used to determine the likelihood and significance of bat mortality associated with turbine collision. However, the potential risk of impact to bat species was considered to be very low (EBS 2014), based on the identification of only common bat species in the area and that the majority of bats recorded were within the vicinity of woodlands, open water and linear movement corridors. These location preferences reduced the likelihood of collisions.

AnaBat surveys confirmed the presence of seven bat species (EBS 2014), none of which had a conservation rating at state or national level. Although undetected, a further three species of bat were determined as likely to be in the Project Area and two threatened bat species (one national/state vulnerable and one state rare), were determined as potentially occurring within the region, which was based on potential habitat and distribution of the species. The state listed threatened species was determined as possibly occurring, although only infrequently and in low numbers (EBS 2014).

No flight heights were recorded for bat species recorded during the surveys conducted by EBS, due to the methods used to identify bat species (a combination of AnaBat and Harp Traps), as well as the fact that the methodology used was at a Level 1 bat survey (as per *AUSWIND Best Practice Guidelines 2006*).

5.2 Updated Bat Risk Assessment 2024

For the purposes of this risk assessment, EBS has assumed that all bat species recorded during the surveys and determined as likely to occur within the Palmer Wind Farm, are at risk of colliding with turbines.

There is a possibility of bats flying into the rotor swept area as they traverse between areas and through wooded habitats. Being nocturnal, bats need places to roost during the day that provide shelter from the weather and potential predators. Most microbats will roost in tree hollows or under bark; flight height of bats as they leave their roosting sites and fly between areas may coincide with the revised rotor swept area.

The risk assessment includes assessing 12 bat species (**Table 5.1**):

- Seven bat species (confirmed through AnaBat surveys);
- Three additional bat species, which were determined as likely to occur in the Project Area; and
- Two threatened bat species determined as potentially occurring within the region (based on habitat and distribution of the species).

The likelihood of occurrence for the EPBC Act listed South-eastern Long-eared Bat (*Nyctophilus corbeni*) was decreased from likely in the 2014 risk assessment to unlikely as the removal of turbines in Area A has increased the distance from past records and as such reduced the likelihood the species will occur in the Project Area.

The consequence of mortality at a species/population level was determined as minor for all 12 bat species; the consequence of mortality may impact on the local population for these species, however, is unlikely to impact on the overall species.

Updated literature indicates that bat species in Australia are known to have mortality events with turbines (Maloney *et al.* 2019) and as such the risk level was increased to medium for all bats, except the South-eastern Long-eared Bat. Risk to bats from this Project is discussed further in **Section 6.0**. As such the overall level of risk for all bat species was determined as **medium**, except for the nationally threatened South-eastern Long-eared Bat which was assessed as **low**.

Table 5.1 Updated Bat Risk Assessment of the Proposed Palmer Wind Farm

Scientific name	Common name	Aus status	SA status	Likelihood of utilising Project Area	Likelihood of an event causing mortality	Consequence at a species / population level	Level of risk
					2024	2024	2024
Bat species (ID AnaBat)							
Chalinolobus gouldii	Gould's Wattled Bat			Known	Likely	Minor	Medium
Chalinolobus morio	Chocolate Wattled Bat			Known	Likely	Minor	Medium
Mormopterus species 4 "big dick")	Southern Freetail-bat			Known	Likely	Minor	Medium
Nyctophilus geoffroyi	Lesser Long-eared Bat			Known	Likely	Minor	Medium
Tadarida australis	White-striped Freetail-bat			Known	Likely	Minor	Medium
Vespadelus darlingtoni	Large Forest Bat			Known	Likely	Minor	Medium
Vespadelus regulus	Southern Forest Bat			Known	Likely	Minor	Medium
Threatened bats (potentially in the region)							
Nyctophilus corbeni	South-eastern Long-eared Bat	VU	V	Unlikely	Unlikely	Minor	Low
Saccolaimus flaviventris	Yellow- bellied Sheath-tail Bat		R	Likely	Likely	Minor	Medium
BDBSA determined as 'Likely to occur in the Project Area'							
Mormopterus species 3.	Inland Freetail Bat	Likely			Likely	Minor	Medium
Scotorepens balstoni	Inland Broad-nosed Bat	Likely			Likely	Minor	Medium
Vespadelus vulturnus	Small Forest Bat	Likely			Likely	Minor	Medium

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). **SA:** South Australia (*National Parks and Wildlife Act 1972*). **Conservation Codes: VU/V:** Vulnerable. **R:** Rare.

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

- Chronic – the event is expected to occur in most circumstance
- Frequent - the event probably will occur in most circumstances
- Likely - the event should occur at some time
- Unlikely – the event could occur at some time
- Rarely – the event may occur only in exceptional circumstances.

Consequence definitions (significance of associated impact on species viability):

- Catastrophic disaster – the event has the potential to lead to collapse of species
- Major– critical event, very likely to have significant impact on species
- Moderate– likely to have impact on population, potential to impact on long term viability under some scenarios
- Minor – the event may impact on local population, no impact on species
- Nil/Insignificant - individuals may be affected, but viability of local population not impacted.

6.0 Discussion

The level of risk was categorised as medium for 8 out of 25 bird species listed in **Table 4.1** and for 11 of 12 bat species listed in **Table 5.1**. The species with medium risk level assessments were generally also defined as having a minor consequence at a species / population level. This implies that there may be an impact on the local population of this species in the event of collision with a turbine. As such all efforts should be made by Tilt Renewables to mitigate against potential impact on bird and bat species, in particular placing turbines away from woodland areas as much as possible and away from sensitive areas, such as raptor nest locations.

Since the designs were approved in 2019, two new species have been added to the EPBC Act list of threatened species: Southern Whiteface (*Aphelocephala leucopsis*) (EPBC Act: Vulnerable) and Diamond Firetail (*Stagonopleura guttata*) (EPBC Act: Vulnerable; NPW Act: Vulnerable). Both of these species are woodland birds, and with the minimum tip height for the turbines being 40 m as a result of the variation, the likelihood of these birds experiencing a collision is reduced. However, given the presence of Diamond Firetails in the Project Area and the limited connected woodland habitat within the broader region, the consequence of a collision event for the Diamond Firetail has been assessed as having a moderate impact on the species. As such, the consequence of mortality may have the potential to impact the long-term viability of the population for this species.

Four raptors remain at a medium impact level due to their flight behaviour (particularly while foraging) and that they are frequently recorded flying at heights within the rotor swept area. Additionally, raptor species listed as medium have been observed in the Project Area occurring near proposed turbine sites (in particular Nankeen Kestrel and Wedge-tailed Eagles) (**Appendix A**). Raptors such as Wedge-tailed Eagles and Peregrine Falcons generally reside and nest in permanent home ranges. As such when they intersect with wind farms there is a higher risk of collision (Smales 2006). These raptors are particularly at risk during the breeding season as they are restricted to a nesting location and are foraging more regularly to feed their young. Given there are known nest locations of Wedge-tailed Eagles and Peregrine Falcons at the Palmer Wind Farm, these species have been assessed as having a medium risk level.

Common bird species have been added to this assessment for the potential for these species to be impacted at the local population level. In particular, the Australian Pelican has been highlighted as having a medium risk level with the potential for collisions to impact on local populations as this species has been observed catching the thermal updrafts over the Project Area at potential turbine locations (pers. obs.). Additionally, Australian Pelicans typically fly in flocks and so if a collision is to occur, it is likely to result in the fatalities of multiple Pelicans at each collision event. There is, however, limited research into avoidance of turbines by these species, and if Pelicans do display avoidance behaviour, then the likelihood of collision incidence may be reduced.

All bats (except the South-eastern Long-eared Bat) were assessed as having a medium risk level. Despite not having flight height data for bats, the medium risk level was based on knowledge of bat movements and on the study by Maloney et al. (2019) which highlighted that six bat species that also occur at Palmer Wind Farm have previously been recorded in mortality events with wind turbines.

Bats are more at risk of rotor strike when traversing between woodlands, as such, similar to woodland birds, the proximity of turbines to woodlands and the minimum blade tip height are likely to be the main risk factors for strikes.

Tilt have reduced the number of turbines placed in woodland by 4 compared to the 2014 risk assessment, which may reduce the risk of strike for bats. However, as we do not have flight height data for bats we cannot decrease the potential risk to these species.

For bats, a risk level of medium can be defined as all efforts should be made to mitigate against potential impact on the species. If efforts cannot be made to mitigate against potential impacts, alternative methods should be considered. For example, curtailment (restricting operation of turbines at low wind speeds between dusk and dawn during periods of high bat activity (summer to autumn) may reduce bat strikes (Bennet et. al 2022).

Fewer turbines with larger turbine capacity versus collision rates

A systematic literature review of recorded collisions between birds and bats and wind turbines within developed countries was undertaken by Thaxter et al. (2017). Collision rate was related to species-level traits and turbine characteristics to quantify the potential vulnerability of 9538 bird and 888 bat species globally. For birds, larger turbine capacity (megawatts) increased collision rates; however, constructing a smaller number of large turbines with greater energy output reduced total collision risk per unit energy output (Thaxter et al. 2017). Compared to previous designs, the number of turbines proposed for construction within the Varied Project is fewer as a result of the variation. The overall rotor swept area for all turbines combined is 26% less than the approved Project design and as such may promote fewer collision events for both birds and bats compared to previous designs. In addition, 4 fewer turbines have been located in or near woodlands than the approved Project designs, reducing the potential risks for woodland birds and bats.

In the data summarised by Thaxter et al. (2017), vulnerability to collision was related to habitat, migratory status and dispersal distance for birds. It was found that high collision rates for species associated with agricultural habitats may reflect the disproportionate number of wind farms from agricultural landscapes that were in the sample. Results suggested that grassland species may also be more vulnerable to collision (Thaxter et al. 2017). Migratory species are often suggested as being vulnerable to collision with wind farms, for which the results outlined in Thaxter et al. (2017) were supportive.

Thaxter et al. (2017) cautioned that model certainty for bats was low, as more research is required to understand the relationship between collision risk and turbine size for larger (and more efficient) turbines, and how this may vary between habitats. For example, grassland cover may best reflect openness of a landscape, a factor generally associated with reduced bat activity and abundance that may also reduce turbine collisions. Thaxter et al. (2017) reported that for bats, optimum turbine size of approximately 1.25 MW may minimize collision and described that for bats, long-distance dispersers had the highest collision rates. It is known that tree-roosting bat species are frequently recorded in collision, potentially through attraction mechanisms (Cryan et al. 2014 in Thaxter et al. 2017), although this effect was weaker than dispersal.

The location of the wind farm relative to bird species that may be present, the layout of the turbines, particular landscape features and the behaviour of bird species influence the likelihood that a bird flying through a wind farm will collide with a turbine (Krijgsveld et al. 2009). As such, where possible, features that increase the risk of birds colliding with turbines (such as placement of turbines near Wedge-tailed Eagle nest and Peregrine Falcon Nest, or placement of turbines near woodlands) should be considered and mitigated against.

Mitigation undertaken by Tilt

Based on previous recommendations, since the approved 2019 wind farm layout, Tilt have reduced the number of turbines and amended locations to reduce impacts on sensitive areas in the following ways:

- All wind turbines have been removed from Area A (an area with a high density of Wedge-tailed Eagle and Peregrine Falcon nests);
- In Area B turbines are being placed outside of a 1,000 m exclusion buffer of Wedge-tailed Eagle and Peregrine Falcon nest sites, compared to the 500 m exclusion buffer included in the approved Project; and
- In Area C, near areas of multiple Peregrine Falcon and Wedge-tailed Eagle nests (such as Bakers Gorge and Harrisons Gorge) turbine numbers have been reduced with a reduction from 38 (Approved Project) to 21 (Varied Project).

7.0 Recommendations

Based on the risk assessment, EBS recommends adopting exclusion buffers between turbines and avoiding identified bat habitat (such as woodlands) to minimise potential impacts on bat species using the Project Area.

Given the increase in WTG size, EBS would advise that incorporating a bird and bat strike monitoring program, including scavenger and detectability trials, as this would assist with understanding the potential impact of the Palmer Wind Farm on birds and bats. This information can then be used to determine the adequacy of mitigation measures.

If the tower height and/or blade length (and ultimately the lowest extent of the rotating tip and the rotor swept area) of proposed WTGs change, this risk assessment will need to be re-evaluated and updated accordingly.

EPBC Act listed threatened species

The following EPBC Act listed threatened species have been identified in this risk assessment:

Hooded Robin (*Melanodryas cucullata cucullata*) (EPBC Act: Endangered)

Diamond Firetail (S*tagonopleura guttata*) (EPBC Act: Vulnerable)

Southern Whiteface (*Aphelocephala leucopsis*) (EPBC Act: Vulnerable)

Blue-winged Parrot (*Neophema chrysostoma*) (EPBC Act: Vulnerable)

South-eastern Long-eared Bat (N*yctophilus corbeni*) (EPBC Act: Vulnerable).

Four of the bird species, listed above, are species that have been recently listed as being of national conservation significance under the EPBC Act. These include the Hooded Robin, Diamond Firetail, Southern Whiteface and Blue-winged Parrot. For all of the species mentioned above, an EPBC self-assessment should be undertaken to determine the potential impact the construction and operation of the proposed windfarm may have on these species. This risk assessment and information from the two-year bird utilisation survey monitoring can be used to inform impacts to these species. If a significant impact is identified as potentially occurring, an EPBC referral is required.

If additional EPBC Act listed threatened species are detected during additional bird utilisation surveys, then these species should also be included in a self-assessment to determine impacts.

8.0 References

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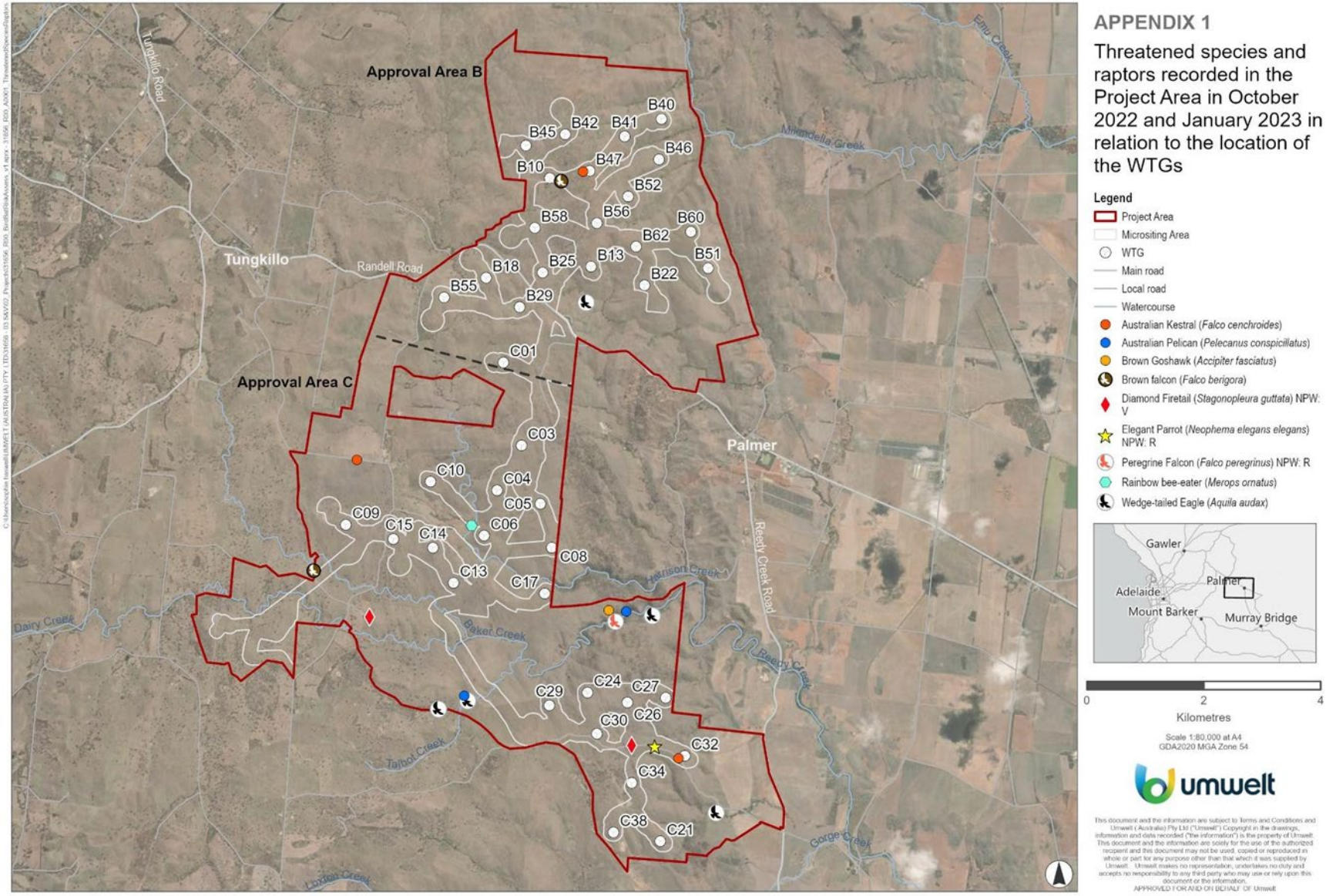
Appendix A

Threatened Species and Raptors Recorded in the Varied Project Area in October 2022 and January 2023 in Relation to the Location of the Wind Turbine Generators

umwelt

Figure A.1 Threatened species and raptors recorder in the Project Area in October 2022 and January 2023 in relation to the location of the WTGs



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Appendix B

Palmer Wind Farm BBMP statistical review

umwelt

symbolix

making your data work harder

To: Alison Derry
Umwelt (Australia) Pty Limited
Via email

Ref #: UMWPALM20250929
Date: 26 Februrary 2026
CC:

Re: Palmer Wind Farm BBAMP statistical review

Dear Alison,

Thank you for requesting our review of the proposed carcass detection and mortality estimation methods for Palmer Windfarm, SA. We understand that Umwelt Pty Limited (Umwelt) have prepared a second Bird and Bat Adaptive Management Plan (BBAMP) to fulfill the requirements of the Planning Consent (Reserved Matter 10), issued by SCAP, and the EPBC Approval (EPBC 2024/09884).

This letter outlines the scope of the review and our appraisal of the study methods.

Scope of works

Symbolix were engaged by Umwelt to carry out the following tasks:

- Review the proposed mortality study design within the final BBAMP[1] (Umwelt (Australia) Pty Limited 2026). Our review primarily focuses on Section 5, which includes the relevant subsections:
  - 5.4 Carcass Search Program
  - 5.5 Carcass Persistence Trial
  - 5.6 Carcass Detectability Trial
  - 5.7 Incidental Bird and Bat Carcass Find Protocol

[1] 31656 R06 BBMP_Palmer Wind Farm_FINAL.pdf

  - 5.8 Mortality Estimation
  - 5.9 Survey Schedule

• Prepare a formal letter advising on the efficacy of the proposed design, referencing statistical adequacy.

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 since 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, Austral Ecology, 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 Ashley Potter, with guidance from 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 has previously lead a project for DEECA (Vic) to deliver a state-wide analysis of wind farm post-construction data from multiple sites in Victoria.

Ashley has a PhD in evolutionary ecology, and has worked in ecology and data analytics for over 8 years. She is experienced in environmental analysis, being a primary statistician on a number of collision risk, mortality estimation, and survey design analyses across Australia.

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 over-sampling 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 then 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 goals for the Mortality Study?

The primary objective of a wind farm post-construction mortality program is to generate a statistical estimate of the number of bird and bat fatalities due to turbine collision over a period of time (typically annually). We will need to estimate total mortalities for groups of species and individual estimates for species of concern. This requires a statistical design so that the carcass counts can be expanded to estimate total 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)

$$\hat{M}_{ij} \cong \frac{C_{ij}}{\hat{g}_{ij}} \tag{1}$$

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

$$\hat{g}_{ij} \cong a_i p_{ij} r_{ij} \tag{2}$$

- 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
- r_{ij} is the fraction of the carcasses that arrived at turbine i but have not been lost to scavenge or decay before search j. This is a function of the rate of decay and the search interval, relative to the expected time to scavenge (Huso 2011)

We directly take $\mathbf{C}$ from the field observation data, and estimate $\hat{\mathbf{a}}$, $\hat{\mathbf{r}}$ and $\hat{\mathbf{p}}$ from a specific field survey design. It's important to highlight that this approach does not require that all or even most carcasses are found. We allow for loss of carcasses through scavenging and for some carcasses not being detected during surveys through $\hat{\mathbf{p}}$ and $\hat{\mathbf{r}}$. Therefore this approach depends upon scavenger efficiency trials and searcher efficiency trials being performed in accordance with best practices, as outlined below, to obtain good estimates of scavenge rate and detectability. Additionally, appropriate survey design is important so that we can be confident that the carcasses found are a representative sample of the population of all carcasses.

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.

Coverage factor

To estimate mortality, we require a ratio of the area searched to the (modelled) density of carcass - i.e. the 'coverage factor'. The density of carcasses as a function of distance will be estimated from methods in Hull and Muir (2010).

Searcher efficiency

The searcher efficiency (proportion of carcasses found) will be reported as a mean and variance measure (standard error and/or 95% confidence interval), potentially grouped by relevant covariates.

We model searcher efficiency using logistic regression. Logistic regression allows binary data (i.e. success = carcass found, failure = carcass missed) to be modelled, accounting for covariates such as carcass size and time of year.

A brief summary of the Generalised Linear Model (GLM) regression techniques are presented here, but we suggest referring to Agresti (2002) or a similar text for more detail. We refer to the probability of success in a trial i as $\pi(x_i)$ where x_i is a vector of covariates. We model the relationship between the probability of success and the log odds using the logistic model:

$$\text{logit}[\pi(x_i)] = \beta x_i \tag{3}$$

where

- logit$[\cdot]$ denotes the log-odds function $\text{logit}(p) = \ln \frac{p}{1-p}$
- β is a vector of regression coefficients.

As $\pi(x_i)$ is free to vary with each trial, this allows the mean to be modelled in a flexible manner depending on carcass size and so on. The logistic function is used because it allows probabilities (which are necessarily bounded between 0 and 1) to be modelled by a linear combination of predictor variables, without getting nonsensical outcomes like probabilities greater than 1.

The estimates of regression coefficients $\hat{\beta}$, are obtained via maximum likelihood estimates, which is the standard method of estimation in GLMs. Both estimates of the mean, and standard errors of those estimates, are obtained by this technique. This allows significance testing of covariates and reporting of confidence intervals.

Scavenger efficiency

The time to scavenge will be reported as a mean and variance measure (standard error and/or 95% confidence interval), potentially grouped by relevant covariates.

Time to scavenge will be estimated using survival analysis - we use the methods of Therneau and Grambsch (2000). Survival analysis is the standard statistical technique dealing with time-to-event data (in this case, "survival" can be interpreted as how long a carcass "survives" in field before taken by a scavenger or decay). It models the probability that a carcass will persist after a certain period of time.

A few key reasons why survival analysis is used over other techniques like simply taking the average are:

- It can account for censored data, generally one of:
  - when the exact time of scavenge is known within an interval, but not exactly; or
  - the carcass persists at the end of the trial.
- It can account for covariates, e.g. carcass size or ground type.
- It allows choosing different hazard rates, which are functions describing how risk changes with time.

There is sizable evidence (Stark and Muir 2020) that the log-normal hazards is the best description of carcass persistence, in an Australian context.

Survival regression is based around GLM modelling, so also uses maximum likelihood estimation. Standard errors and confidence intervals can be obtained for the mean times to scavenge.

What is the proposed design?

Coverage and search effort

The proposed carcass search survey design includes:

- 5 years of survey, commencing within 3 months of wind farm operations (reviewed after 2 years).
- Searches carried out at 16 turbines (40% of all turbines).
  - 7 turbines in Area B
  - 9 turbines in Area C
- Carcass searches carried out once monthly.
- A search area with a radius of 120 m around each turbine, comprising of an inner (60 m radius) and outer (120 m radius) area.

- The order of turbines searched will be randomised between surveys.

Detection dogs will be preferentially used (if available and practicable), which will traverse along paths 20-30m apart. Alternatively, humans observers will be used whom will traverse transects in the search area at 6m apart in the inner search area and 12m in the outer search area.

For each carcass found:

- carcass will be removed with gloves
- photographed
- labelled with date, turbine number, species names, and unique specimen code
- GPS location recorded

For each feather spot found:

- photographed
- species identified by an ecologist or DNA sample

Searcher efficiency

Each proposed 'carcass detectability trial' (or searcher efficiency trials) design includes:

- Surrogate carcasses laid within 60 m of turbine bases.
- Carcasses deployed at 8 randomly selected turbines (50% of the number of WTG to be monitored).
- A total of 8 carcasses (six birds and two bats) to be deployed.
- Carcasses 'tossed onto the ground' within the inner search area by a person not involved in searches for carcasses.
- The searcher not being aware of the number or location of carcasses deployed.

Two trials will be conducted during the Year 1 - one in Spring and the other in Autumn. The same carcasses used in the carcass persistence trial may be used in the carcass detectability trial if the carcass persistence and carcass detectability trials are conducted consecutively rather than concurrently.

According to the BBAMP, "The carcass detectability trial will be conducted at 8 turbines which are to be selected using a random number generator prior to the commencement of the trial." Since searcher trials are intended to assess searcher efficiency during the main surveys, they should be conducted at the same turbines as the main surveys. Therefore, we recommend randomising only the order in which the 8 turbines are surveyed, rather than re-selecting 8 turbines from the total 40 for each trial.

If searcher efficiency and scavenger efficiency trials are to be conducted consecutively (which we hightly suggest), we recommend using the same 16 turbines (instead of 8) and carcasses for both. This will increase statistical power to detect an effect and, in theory, would not require much additional field time. We also recommend a *minimum* of 10 carcasses for each species archetype of interest (i.e., 10 bird carcasses and 10 bat carcasses). The statistical reasoning for this is explained in the *Statistical suitability* section below and further illustrated in Figure 1.

If increasing the number of turbines is not feasible, then ensuring that all habitat types are represented proportionally to their coverage across the site is very important. For example, if 40 turbines are distributed as 75% in open grassland and 25% in woodland, then the distribution of carcasses should reflect this distribution. So if you have 10 carcasses, roughly 7-8 should be placed near turbines with open grassland and 2-3 should be placed at turbines in open woodland.

Proxies

If visual searchers (humans) are used it is acceptable to use stuffed replica or similar looking proxies. However this won't work for dogs, which search via scent.

Scavenger efficiency

Each proposed 'carcass persistence trial' (or scavenger efficiency trials) design includes:

- Surrogate carcasses laid within 60 m of turbine bases.
- Carcasses deployed at 16 randomly selected turbines.
- A total of 10 bird carcasses (comprising five small-medium sized carcasses and five large carcasses) and 6 bat carcasses to be deployed.
- Scavenging identified through the deployment of remote sensing cameras at each carcass, programmed to take three images upon detection of movement or otherwise set to take one image per hour in the case of sites where moving vegetation is likely to cause regular false triggers. These will be deployed for 30-days (checked manually at day 5 and 15). It is proposed that carcasses will be replaced if removed in less than a fortnight.

Four trials will be carried out, twice per year (in year 1 and 2), once in Spring and once in Autumn.

According to the BBAMP, "The carcass persistence trial (i.e., both spring and autumn) will be conducted at 16 turbines". Since carcass persistence trials are intended to assess scavenger efficiency during the main surveys, they should be conducted at the same turbines as the main surveys. Therefore, similar to searcher efficiency trials, we recommend randomising only the order in which the 16 turbines are surveyed, rather than re-selecting 16 turbines from the total 40 for each trial.

Proxies

If carcasses cannot be sourced, using proxies (or surrogate carcasses) may be suitable.

Our meta analysis over Victorian wind farm sites (Stark and Muir 2020) suggests the following results with respect to using proxy species:

- Mice are a reasonable proxy for bats. Their mean time to scavenge is slightly shorter than bats in general ($p \simeq 0.1$), with a similar scavenger loss function shape. A shorter time to scavenge implies that bats would then be modelled with a lower probability of a carcass persisting until a survey, and therefore would result in a conservative estimate (higher) of mortality.
- Chickens are not a reasonable proxy for birds ($p < 0.001$). In fact, their average time to scavenge is roughly similar to those of mice.

If proxies are used, we recommend that actual bird and bat carcasses are used along side proxies to compare scavenger rates and ensure that the proxies are suitable. We acknowledge that this may not be feasible due to the difficulty of sourcing carcasses.

Appraisal of the design

Sampling stratification

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

As outlined in the BBAMP the Development is located in a 'highly fragmented landscape' characterised by a mixture of remnant open grasslands, eucalyptus woodland and cleared agricultural land. However, following vegetation clearance for the development of the hardstand, roads and other infrastructure, the carcass search areas (120 m around 16 turbines) will comprise of two broad vegetation types: open woodland and open grassland. As such, searcher efficacy or carcass detectability (particularly if humans are used to search for carcasses rather than dogs) may be variable across the search area. If these vegetation types have differing visibility (influencing detectability) or species composition (potentially influencing scavenging rates), the ***searcher efficiency*** and ***scavenger efficiency*** trial survey design should be stratified by these vegetation types.

The 16 turbines to be surveyed have been randomly selected from across the site based on the following considerations:

- Spatial coverage across the site.
- Habitat variability, ensuring good coverage of woodland, open grassland, and shrubland.
- Access to wind turbines selection for monitoring - i.e., from existing tracks or linked tracks to other turbines.
- Location to features - i.e., ridges or creeklines.

- Agreeable landholders.

Because this site contains several habitat types, we would advise ensuring that the allocation of survey sites includes a proportional representation of the habitat types. For example, if 40 turbines are distributed as 75% in open grassland and 25% in woodland, then the 16 turbines selected for trials should reflect this distribution. This would equate to 12 turbines from open grassland and 4 from open woodland.

During the carcass search surveys, selected turbines should be maintained within the pool, and consistently revisited. This helps to reduce variance in any estimates.

Selection of turbines for carcass searches does not require stratification from a statistical standpoint. However, it will not create undesired bias if these are also stratified and sampled proportional to the number of turbines in each stratum.

Statistical suitability

Carcass searches

Search fraction

The proposed carcass surveys will sample 40% 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 within each stratum (as discussed above). This is the only way to enable an un-biased estimate of mortality.

We also recommend the same turbines are searched at roughly the same time 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.

If some areas within the search area are not able to be searched, a spatial file of all 'unsearchable areas' will need to be provided (Section 5.4.3) to properly calculate the fall zone coverage for analysis.

Search method

To reduce variability in carcass detectability, it is ideal to use a single survey method which is typically using detection dogs for carcasses searches. We understand that trained dogs may not always be available during the survey period, or may be unable to be used due to climatic and terrain conditions. The BBAMP indicates that the terrain across the search areas is suitable for humans and dogs and that the climate is typically suitable throughout most of the year for working dogs. As such, dogs should be used under most circumstances, given the known improvement in detection when using dogs.

If the survey does included the use of both human observers and detection dogs, the searcher efficiency trials will need to be modified. We have outline these modifications below ('Searcher efficiency trials').

Although it it is not always possible, as much as practicable, the time spent searching for carcasses at each turbine should be consistent by the human observer or dog handler maintaining a consistent walking pace. This should also be done for the searcher efficiency trials. Ensuring each area has a relatively even search effort helps reduce the variability in detection across areas.

Survey timing and duration

The BBAMP specifies monthly carcass searches. This will provide an unbiased estimate of mortality if the data is analysed and sufficient to provide overall estimates of all birds and all bats. While we can do individual species level estimates, there is naturally more variance when doing estimation based upon low counts. Therefore we recommend that impact triggers do not require statistical estimation, but are based on finding the carcass of a species of concern (which we note is what the BBAMP states).

Regarding the adequacy of a five-year survey period, 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 few years are usually sufficient to understand the magnitude of the mortality onsite (generally speaking).

Searcher efficiency trials

A total of 8 carcasses (6 bird and 2 bat) are to be used in the searcher efficiency trial.

Figure 1 shows the confidence intervals on two searcher types. The left plot shows the confidence interval when probability of success $p = 0.52$, which is a consistent with human observers looking for bats (Stark and Muir 2020). The right plot shows the confidence interval when $p = 0.86$, which is consistent with canine observers (regardless of species), or human observers looking for birds. In both, we can see diminishing returns in the size of the 95% confidence intervals with increasing sample size.

For observers with high searcher efficiency (right plot), or conversely, very low searcher efficiency (i.e. the proportion found is nearing the limits of 1 or 0), about $n = 20$ trials is a good balance between confidence interval size and sample size. However, if the searcher efficiency is closer to 50% (left plot), then approximately $n = 30$ trials are needed. (Note that trial here, refers to a statistical trial which is one search for one carcass).

Figure 1 also suggests that if the primary concern of the mortality surveys is detecting bats then detection dogs are significantly better option compared to human searchers. However the use of trained detection dogs is subject to availability and agreement of the landholders,

and therefore may not be possible.

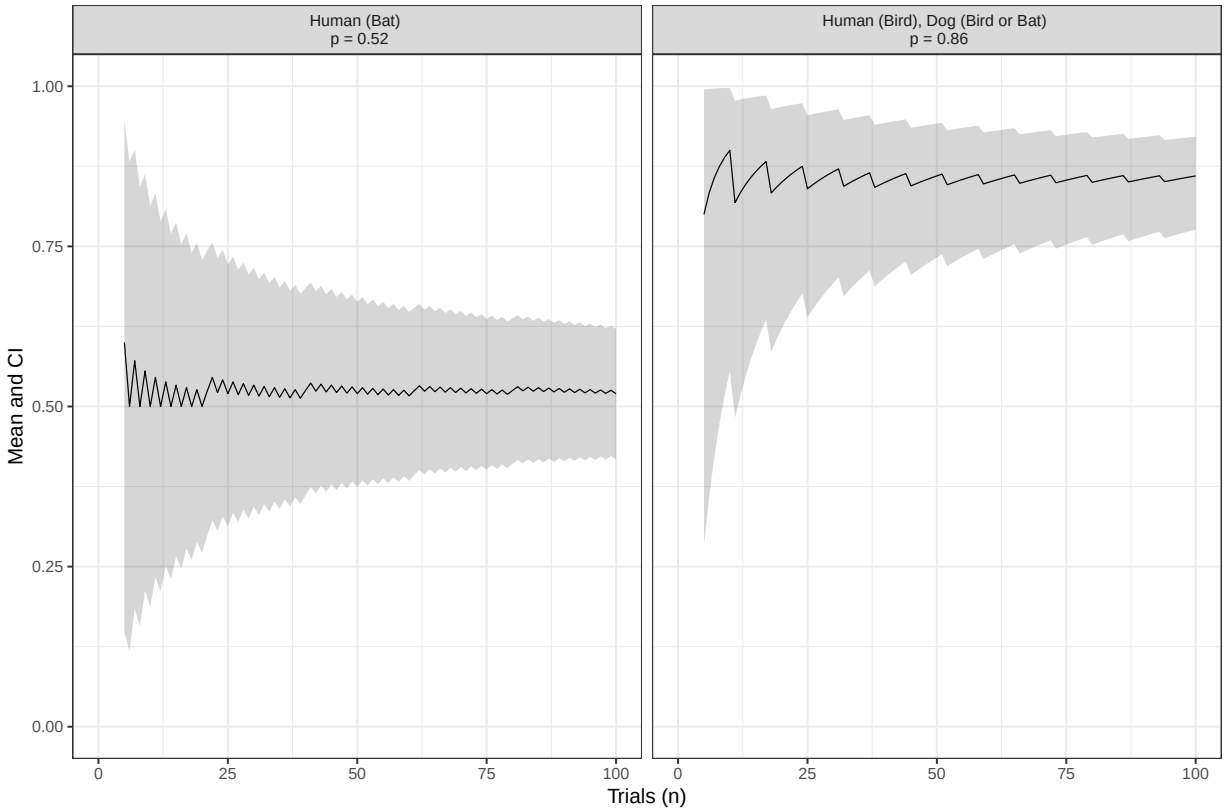

Figure 1: Confidence intervals of probability of finding a carcass.

A total of 8 carcasses (6 bird and 2 bat) would be insufficient due to the high uncertainty around the detection estimate (Figure 1; grey shaded region). We recommend a minimum of 10 carcasses per species archetype (i.e., bird or bat). Ten carcasses may be sufficient if only canine observers are used, as they are generally equally likely to detect both groups; however, there is still considerable variability at this sample size. If human observers are used, a higher number (e.g., 20 carcasses) should be considered, since humans are typically less likely to detect bats. In this case, replication across two trials would effectively provide 10 carcasses per archetype. Overall, the objective is to ensure adequate representation of each species on site, which requires having a sufficient number of carcasses for each species archetype.

Scavenger efficiency trials

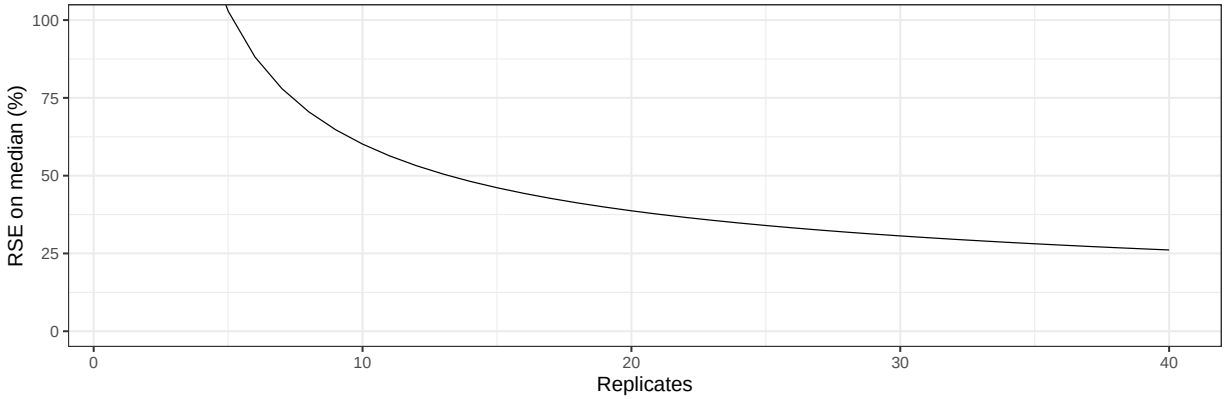

Figure 2: Relative standard error (RSE) on the median scavenge time, versus number of trials.

Although scavenger efficiency will be analysed using standard survival study methods to account for the uncertainty in measuring time of loss (Kaplan and Meier (1958), Therneau and Grambsch (2000)), using motion-trigger remote sensing camera will improve accuracy of carcass scavenging times. As such, this is an ideal method for determining scavenger efficiency.

The number of replicates proposed (64 carcasses split into 4 trials, with 10 birds and 6 bats per trial) is statistically reasonable for the scavenger efficiency. We can see that the relative standard error on the median scavenge time, has diminishing returns from 15-20 carcasses (Figure 2).

We would not recommend using the same carcasses across seasons, as the age of the carcass may influence the probability of scavenging. It is also not recommended to replace the carcass if it is removed in less than a fortnight from deployment as the two scavenging rates at this location will then be confounded. It is suitable to use the same carcass for the searcher efficiency trials and then the scavenger efficiency trials (within a single season) as proposed, assuming that the cameras are deployed after the searcher trials.

Mortality estimation

The proposed estimator of mortality included in Section 5.8 'Mortality Estimation' of the BBAMP aligns with the methods we recommend. We also highlight that the BBAMP has provided sufficient details in the methods as well as included the equations for searcher efficiency.

Final remarks

The survey program represents standard statistical practice and, except for some small suggested amendments, the survey design will provided data suitable for estimating mortality at Palmer Wind Farm. It is consistent with other sites in Queensland, NSW and Victoria, which enables future combined analysis.

Regards,

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Appendix C

Carcass Search Survey Data Sheet

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Carcass Search Survey Data Sheet

Survey Details

Date:	Observers/Personnel (Company):
Turbine ID:	
Start time: Finish time:	

Survey Methodology

Dog ID

Human observers

Incidental (Any bird or bat turbine mortality observed outside a routine survey)

Ground visibility:	High ☐	Moderate: ☐	Poor: ☐	NOTE: If not, estimate area covered as a percentage of a total search area:
Was the entire search area covered?	Yes ☐	No ☐		_____%

Survey limitations (e.g., long grass, any areas that were inaccessible / not surveyed and why):

Weather details

Temperature				
Precipitation:	Fine ☐	Showers ☐	Rain: ☐	
Wind strength	Fine ☐	Breeze ☐	Moderate: ☐	Strong ☐
Wind direction:		Cloud cover %:		

Turbine bird and bat mortality record

Dead/injured bird or bat record?		If yes, record total number:	Bird and Bat carcass/injury datasheet complete?		Photographs taken?	
Yes ☐	No ☐		Yes ☐	No ☐	Yes ☐	No ☐

Additional notes

Appendix D

Dead or Injured Bird/Bat Data Sheet

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APPENDIX F: Dead or Injured Bird/Bat Data Sheet

DATE AND LOCATION

Date:		Observers/Personnel (Company):	
Time animal was found:			
Turbine ID:			
Easting / Northing of carcass			
E:		N:	

Detection

Survey Method: NOTE: Turbine survey datasheet must also be completed.	Dog search ☐	Human search intensity ☐	Incidental ☐
Distance of carcass / injured animal from observer when first detected: (m)	Behavioural change in dog (if applicable):		
Approximate distance and orientation of carcass / injured animal to wind turbine:		(m)	(x°)
Describe ground visibility within a 1 m radius of where carcass / injured animal was found:			

Carcass / injured animal photographed?	**Photo and camera details**
	Camera number:
	Photo numbers:
Yes ☐ No ☐	File location:

Weather details at time of detection (please circle):

Temperature:				
Precipitation:	Fine ☐	Showers ☐	Rain ☐	
Wind strength	Calm ☐	Breeze ☐	Moderate ☐	Strong ☐
Wind direction:		Cloud cover (%):		

Carcass / injured animal information and condition:

Species (if unknown, the closest taxonomic group, e.g. raptor, bat):			
Age:	Unknown ☐	Adult ☐	Juvenile ☐
Sex:	Unknown ☐	Male ☐	Female ☐
Condition:	Dead (carcass) ☐	Injured but alive ☐	Feather spot (>10 feathers) ☐
Degree of decay:	Fresh ☐	More than 1 week ☐	Very old/highly decayed ☐
Describe conditions and type of any injuries evident:		Describe evidence of scavenging if any:	

Appendix E

Carcass Persistence Trial Data Sheet

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APPENDIX G: Carcass Persistence Trial Data Sheet

SURVEY AND TURBINE DETAILS

Date: Observers/Personnel (Company):

Time:

Turbine ID:

Ground visibility: High ☐ Moderate ☐ Poor ☐

Description of ground visibility
(e.g. grass, height, rock cover):

Carcass deployment record:

Carcass type:	Unique carcass identifier	Direction from turbine base:	Distance from turbine base:	Easting / Northing	Notes

Additional notes

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