Implementation Plan for two species of bats at Mount Emerald Wind Farm, Queensland

Prepared for Ratch Australia

23 April 2018

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Contents

Executive Summary

This document is an Implementation Plan prepared to meet the requirements of Condition 13 of approval for Mount Emerald Wind Farm under provisions of the *Environment Protection and Biodiversity Conservation Act* 1999. Condition 13 is focussed on minimising potential effects on the EPBC Act threatened Spectacled Flying-fox and Bare-rumped Sheathtail Bat.

In summary, the plan sets out details of:

- intended outcomes and measurable performance criteria for the Spectacled Flying-fox and Bare-rumped Sheathtail Bat;
- a study to evaluate the possible values to the two species of curtailed low wind-speed cut-in for wind turbines;
- monitoring of the wind farm's effectiveness against specified performance thresholds for the two species; and,
- contingency measures and potential corrective actions intended to ensure any effects on the two species do not exceed performance thresholds.

In addition to a detailed plan for implementation of specific items set out in Condition 13, explanatory background information and rationale underpinning the plan are provided.

1 Introduction

1.1 Background

Mount Emerald Wind Farm was approved, with conditions, under provisions of the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) in 2011. The approval (number 2011/6228) allows for a maximum of 63 turbines at the wind farm site. Conditions 12 to 17 of the approval relate to the EPBC Act threatened Spectacled Flying-fox and Bare-rumped Sheathtail Bat. A variation to the approval of Condition 13 was granted on 31/07/2017 and is incorporated in the conditions reproduced below.

12. Prior to commissioning, the approval holder must evaluate the effectiveness of suitable measures, including changed cut-in speed, avian radar system and SCADA system, to avoid and mitigate the impacts of turbine collision to Spectacled Flying-fox (*Pteropus conspicullatus*)and Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*) on the wind farm site.

13. Prior to commissioning, the approval holder must submit to the Minister for written approval, a Wind Farm Implementation Plan that is informed by the results of the evaluation required by condition 12. The Wind Farm Implementation Plan must include:

(a) details of intended outcomes and measurable performance criteria for the Spectacled Flying-fox and Bare rumped Sheathtail Bat which are based on information contained in relevant guidance material including:

- *Matters of National Environmental Significance: Significant impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (2013);
- *EPBC Act Policy Statement 2.3 Wind Farm Industry* (2009); and
- *Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act* (2015).

(aa) a program to implement a Low Windspeed Curtailment Study;

(b) a program to monitor the effectiveness of progress against performance criteria; and

(c) contingency measures and corrective actions that will be implemented if performance criteria are not being or are not likely to be met.

14. The Wind Farm Implementation Plan must be reviewed by a suitably qualified expert prior to submission to the Minister for approval. The Wind Farm Implementation Plan must include the findings of the review undertaken by the suitably qualified expert and details of how any recommendations made by the suitably qualified expert have been addressed.

15. The approval holder must not commission the wind farm until the Wind Farm Implementation Plan has been approved by the Minister in writing.

16. The approved Wind Farm Implementation Plan must be implemented.

17. Upon the direction of the Minister, the approval holder must cease to operate any specified wind turbine generator/s if the Minister considers that, based on compliance reporting required by condition 26, they are having an impact on Bare-rumped Sheathtail Bat and Spectacled Flying-fox greater than the performance criteria required by condition 13(a) that cannot be mitigated or compensated.

In compliance with Condition 12 of the approval, Mount Emerald Wind Farm Pty Ltd commissioned Biosis Pty Ltd to undertake the evaluation of potential measures to avoid and mitigate the impacts of turbine collision. The evaluation is contained in Biosis (2017a) *Evaluation of potential mechanisms to reduce turbine collision risk for threatened bats at Mount Emerald Wind Farm, Queensland.*

Prior to the variation to the approval of Condition 13 granted on 31/07/2017, Condition 13 included a clause providing that the Wind Farm Implementation Plan should include details of intended outcomes and performance criteria based on the outcomes of population viability analysis and numerical collision risk modelling for the Spectacled Flying-fox and Bare-rumped Sheathtail Bat. Biosis provided Ratch Australia with a letter of advice (Biosis 2017b, dated 4th May 2017) about those aspects. In summary, it noted that neither numerical collision risk modelling nor population viability analysis was feasible for either species because there is no realistic capacity to obtain the numerical data required to undertake those processes for either species. This was accepted by the Commonwealth and the variation to Condition 13, worded as above, was granted.

The present document has been prepared as the Wind Farm Implementation Plan required by Condition 13 of the approval under the EPBC Act.

1.2 Mount Emerald Wind Farm

Mount Emerald Wind Farm is situated on a single rural property, formerly described as Lot 7 on Plan SP235244, and covering an area of approximately 2422 ha approximately midway between Mareeba and Atherton and 5 kilometres west of Walkamin in north Queensland (Figure 1).

The site is at the northern most end of the Herberton Range, which forms part of the Great Dividing Range. The site varies in altitude from 540 m ASL at the northern-most point along Kippen Drive to 1089 m ASL in the south-eastern most section closest to Mt Emerald. The north-western section of the site is dominated by Walsh's Bluff (907 m ASL).

The site is dominated by a series of three, approximately parallel high rhyolite ridges running in a south-east to north-west direction. There is a large area (~500 ha) of relatively flat country located in the western section. The site is dissected by a series of steep rocky ephemeral drainage lines and gorges, including the headwaters of a tributary of Granite Creek.

The site is intersected by Powerlink's Chalumbin to Woree 275 kV transmission line that roughly traverses the property. The site is not currently grazed by domestic stock and aside from the wind farm infrastructure, consists entirely of remnant vegetation. The site is located on the boundary of the Einasleigh Uplands and the Wet Tropics Bioregions, both of which are characterized by high levels of bioregional endemic flora and fauna species.

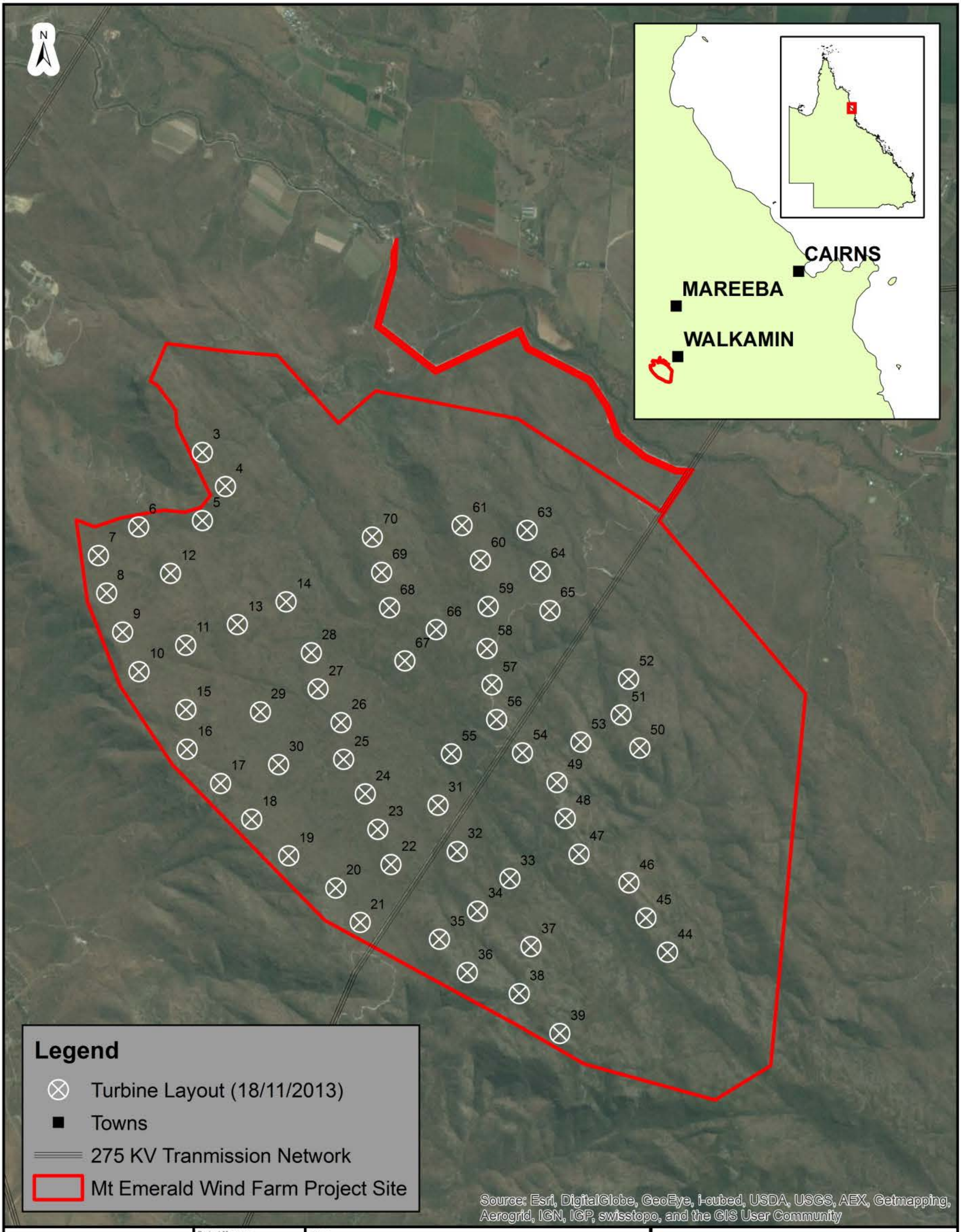
The constructed wind farm will consist of 53 wind turbines with an overall capacity of generating 180.5 MW. The complement of turbines is comprised of 37 x 3.45MW turbines with 117 meter diameter rotors on 90 metre towers and 16 x 3.3MW turbines with 112 metre diameter rotors on 84 metre towers. Associated infrastructure includes road access to all turbines, a hardstand under each turbine, a switchyard and staff facilities. The wind farm layout is shown in Figure 2.

The construction and operation of the facility has been subject to an environmental impact assessment process which identified a variety of potential effects on the biodiversity of the site. For the two species of bats that are the focus of the current plan, potential impacts include some permanent loss of habitat required for the wind farm infrastructure and the potential for collisions with turbines at are a risk for all volant fauna that may fly at rotor-swept height.

Condition 2 of the EPBC Act approval for the project says that,

> *"To minimise impacts to EPBC Act listed threatened species, the approval holder must not disturb more than 73 ha of habitat for EPBC Act listed threatened species on the wind farm site".*

Some of the vegetation removed may represent foraging habitat for the Spectacled Flying-fox and foraging and roosting habitat for Bare-rumped Sheathtail Bat. A detailed plan for habitat removal, including specifics of methods to avoid and minimise injury or mortality of bats during the construction phase has been provided by RPS (2010).



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Project Manager	M. JESS
Compiled by	JDM
Map Projection	MGAz55
Map Datum	GDA94
File Reference	PR100246-174.mxd
Sheet Number	1 of 1

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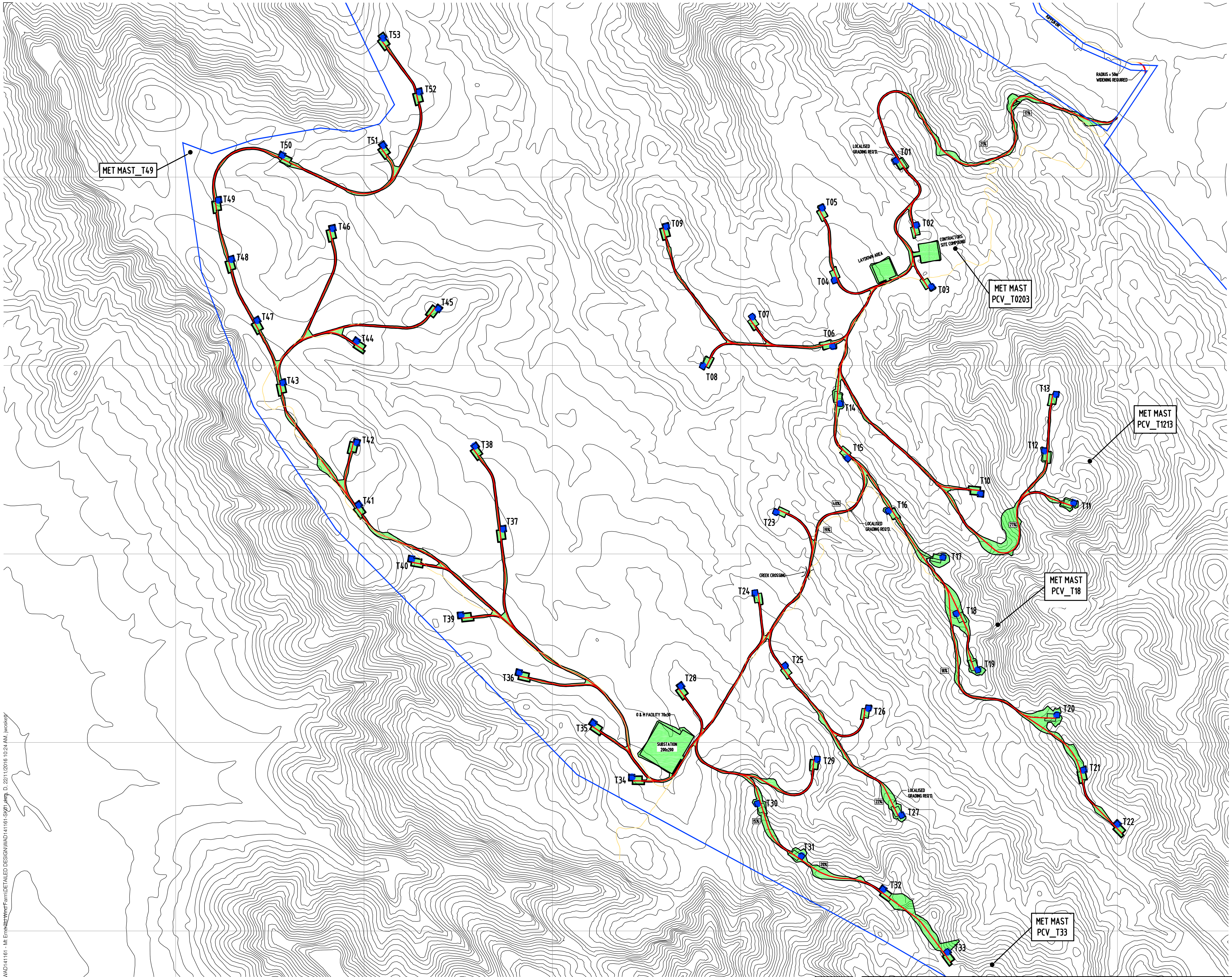

LEGEND

- T01 — PROPOSED TURBINE LOCATION
- PROPOSED WIND FARM ROAD
- 10m CONTOUR
- EXISTING ROADS
- PROPOSED BATTER EXTENTS (1 IN 2 BATTERS)

NOTE:

CONCEPT LAYOUT BASED ON 10m CONTOUR DATA ONLY
AREA OF PROPOSED BATTER EXTENTS = 71.8 HECTARES

TURBINE COORDINATES

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T02	E. 328903	N. 8102219
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T04	E. 328466	N. 8101926
T05	E. 328402	N, 8102310
T06	E. 328458	N. 8101575
T07	E. 328031	N. 8101732
T08	E. 327768	N. 8101472
T09	E. 327574	N. 8102211
T10	E. 329242	N. 8100793
T11	E. 329738	N. 8100745
T12	E. 329581	N. 8101021
T13	E. 329644	N. 8101320
T14	E. 328498	N. 8101272
T15	E. 328537	N. 8100981
T16	E. 328753	N. 8100703
T17	E. 329043	N. 8100457
T18	E. 329113	N. 8100157
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T40	E. 326222	N. 8100448
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T49	E. 325197	N. 8102351
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INFORMATION ISSUE
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B	17.11.16	TURBINES RENUMBERED	JJW	RB	
C	21.11.16	REVISED TURBINE NUMBERING AND MET MAST LOCATIONS	JJW	RB	
D	22.11.16	REVISED TURBINE NUMBERING	JJW	RB	

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MT EMERALD WIND FARM

TURBINE LOCATION AND DEVELOPMENT FOOTPRINT PLAN (TLDFP) ©

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2 Background information about Spectacled Flying-fox & Bare-rumped Sheathtail Bat for Mount Emerald Wind Farm

The Spectacled Flying-fox *Pteropus conspicillatus* and Bare-rumped Sheathtail Bat *Saccolaimus saccolaimus* belong to different suborders of bats and differ from each other in many respects.

Investigations into the occurrence of both species that were undertaken specifically to inform statutory decisions for Mount Emerald Wind Farm are detailed in RPS (2013a). Both species were recorded at the site of Mount Emerald Wind Farm. Bare-rumped Sheathtail Bat was documented from a relatively small number of species-specific ultrasonic calls recorded there between 2010 and 2013. Spectacled Flying-foxes were also positively identified at the site during both late dry season and late wet season between 2010 and 2013. However, the majority of observations made during surveys for that species using night-vision goggles and thermal imaging were not able to consistently or reliably distinguish Spectacled Flying-fox from Little Red Flying-fox, although one or other, or both of those two species were documented from a broad range of locations across the site.

There is no empirical information from operating wind farms about turbine collision risk for either Spectacled Flying-fox or Bare-rumped Sheathtail Bat. As a consequence, while both species have been recorded at the site of Mount Emerald Wind Farm, the actual risk that turbines there may pose to either species is not known and there are numerous uncertainties entailed in consideration of this risk.

Uncertainties are not only due to the lack of experience with the two species at existing wind farms. They also are the result of very limited general understanding of behaviour and biology, especially in the case of the Bare-rumped Sheathtail Bat. Despite substantial survey effort for the two species at the site (RPS 2013a, b), there is still very little information about how either species uses the site.

We consider the following information, drawn from general knowledge of the two species, is relevant to the purposes of this plan which is aimed at improved understanding of potential turbine collision risks and at minimising such risk at Mount Emerald Wind Farm.

2.1 Spectacled Flying-fox

General information and biology

The Spectacled Flying-fox is a fruit and blossom feeder with a wingspan exceeding one metre and weight of more than 500 grams. Camps comprised of hundreds to thousands of individuals of these bats roost in trees in or close to rainforests during daylight. They fly out nightly to forage and return to the camp and may travel many kilometres in doing so (Churchill 2009).

Crepuscular and nocturnal flights by Spectacled Flying-foxes may cover several tens of kilometres but they are principally for the purpose of moving to and from sources of food (Churchill 2009). A Spectacled Flying-fox was recorded by RPS (2013b) feeding at blossom on the site and it is expected the species makes flights associated with foraging within the site when appropriate tree species are in flower.

If, or when no foraging opportunities are present on the site, Spectacled Flying-foxes may fly through or over the site to reach food sources beyond it. It is possible such commuting flights may be concentrated on particular periods of the night (possibly close to dusk and prior to dawn), but that has not been determined.

The heights at which Spectacled Flying-foxes routinely fly are not known and attempts to determine them using night vision equipment and thermal imaging at the site were not successful (RPS 2013b). Flights above or below turbine rotor-swept height do not represent a collision risk. The risk of collision will be substantially influenced by the heights of the species flights at the site.

Similarly, it is not known how flight activity of Spectacled Flying-foxes is correlated with wind-speed, but they are large, powerful flyers and are not likely to be affected by relatively small changes in wind-speed to the extent some species of small bats are.

Flying-foxes use their excellent colour vision as their primary means for navigation in flight. They do not echolocate using ultrasonic calls. Consequently, it is likely their capacity to actively avoid collisions with turbines may be similar to that of crepuscular and nocturnally-flying birds and less like that of insectivorous bats that primarily use echolocation to navigate.

The species is known in Australia from major rainforest tracts in North East Queensland and Torres Strait. It also occurs in Papua New Guinea and the Solomon Islands (Churchill 2009).

Substantial census information for the Australian population of Spectacled Flying-fox is provided by CSIRO through the National Flying-fox Monitoring Programme which uses counts of flying-fox camps to census populations. A summary covering the period from 2005 to 2014 is contained in Westcott et al. (2015). The Australian Spectacled Flying-fox population counts declined from 214,750 in November 2005 to 92,880 in November 2014. The effects of two major cyclones on roost trees and food trees are considered to have been the primary causes of the observed decline, but human impacts are also believed to have involved. More recent information about individual roost camps is provided in reports of individual counts until August 2017 (http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf).

Spectacled Flying-fox at Mount Emerald

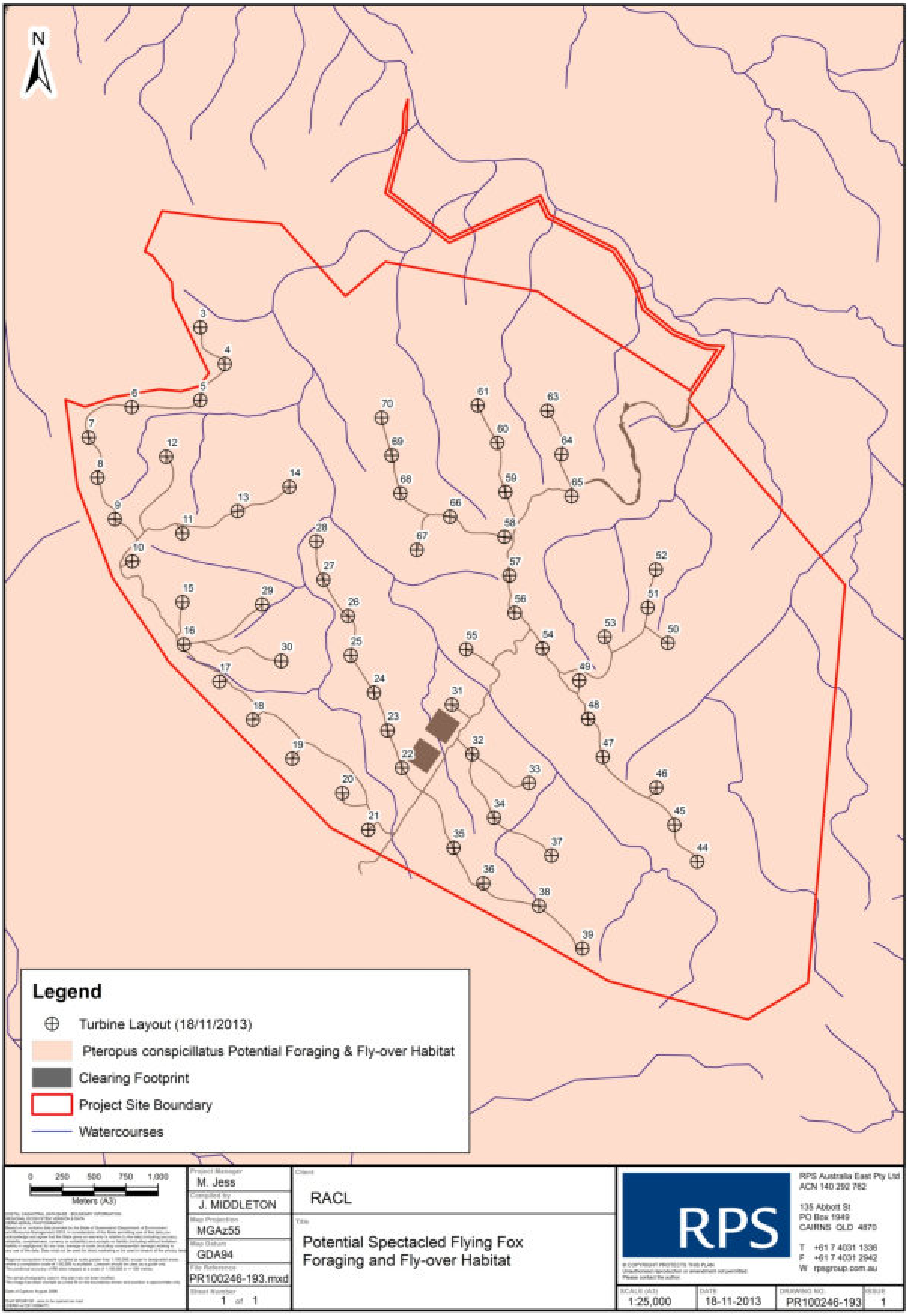
In regard to the suitability of the Mount Emerald Wind Farm site for Spectacled Flying-foxes RPS (2013b) said:

> *"The EPBC referral submitted for the project concluded that there was a low likelihood of* P. conspicillatus *occurring on the site due to the absence of closed rainforest roosting habitat (RPS, 2009). However,* P. conspicillatus *is now known to forage extensively in other vegetation communities such as eucalypt and Melaleuca e including the wet and dry sclerophyll habitats of the Herberton Range adjacent to the proposed High Road and [Mount Emerald] wind farms (D. Westcott, pers. comm.) and is also known to forage on the fruits of Wild Tobacco (*Solanum mauritianum*) (Eggert, 1994, Spencer et al., 1992), which is an abundant introduced plant occurring in disturbed habitats on the Atherton Tablelands."*

The *EIS Mount Emerald Wind Farm Volume 2* (RPS 2014) Figure 18.1 (reproduced below) shows foraging and fly-over habitat for Spectacled Flying-foxes across the entire wind farm site and surrounding local landscape.

Spectacled Flying-foxes frequently make flights during daylight in the immediate area in which they roost, however there is no rainforest suitable for daytime roost camps of the species on the site. Hence any risk of turbine collisions for this species will essentially be confined to the overnight period from dusk until dawn when animals may fly from nearby roost camps outside the site and either commute across the site or move into it to forage.

As noted in the *EIS Mount Emerald Wind Farm Volume 2* (RPS 2014), Spectacled Flying-foxes can have daily feeding ranges of over 50 kilometres from their roost sites. Figure 18.2 of that report shows potential for animals from known roost locations in the Wet Tropics to reach the Mount Emerald site.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Pteropus conspicillatus Potential Foraging & Fly-over Habitat
Clearing Footprint
Project Site Boundary
Watercourses
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Meters (A3)
Project Manager
M. Jess
Compiled by
J. MIDDLETON
Map Projection
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File Reference
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1 of 1
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Given that there are active roost camps within a closer radius of the site, all documented flying-fox roost camps within 30 kilometres of Mount Emerald Wind Farm were identified from the National Flying-fox Monitoring Programme (http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf accessed 09 February 2018). Information from all for these camps is summarized as follows. The closest active roost camps of Spectacled Flying-foxes are at Tolga Scrub, approximately 6 kilometres from the closest point of the wind farm; and four camps at Mareeba are approximately 15 kilometres from the closest point of the wind farm. Two other roost camps in the region (Mareeba, Leinster Park (866) and Nassers Fragment (838) at Atherton) have not been surveyed and are considered to be inactive. A site at New Powley Road (690), near Lake Tinnaroo has been surveyed but no flying-foxes found. The Lakeside (684) site near Yungaburra was estimated variously to have between 2,500 up to 49,999 in counts in 2012 and 2013 but no more recent information is available.

In targeted investigations of Spectacled Flying-foxes at the Mount Emerald Wind Farm site RPS (2013b) positively identified the species during late dry seasons and late wet seasons between 2010 and 2013. However, the majority of observations made during surveys for the species using night-vision goggles and thermal imaging were not able to consistently or reliably distinguish Spectacled Flying-fox from Little Red Flying-fox *Pteropus scapulatus*. *Pteropus* spp. individuals were recorded at 12 of 21 survey sites spread across the wind farm site, with individual flying-foxes observed in both the Wet Tropics Bioregion and the Einasleigh Uplands Bioregion portions of the site. A total of 67 individual observations were documented of *Pteropus* spp. during the surveys, of which only two individuals could be confidently identified as *P. conspicillatus*. As a result, although one or other of these flying-fox species was documented from a broad range of locations across the site, the actual utilisation of the site by Spectacled Flying-foxes remains poorly understood. It is possible Black Flying–fox *Pteropus alecto* may also occur at the site.

During incidental observations, RPS (2013b) observed a single Spectacled Flying-fox individual foraging in a flowering *Melaleuca viridiflora* tree approximately 3 metres above the ground. In evaluation of weeds at the site, RPS (2010) did not find Wild Tobacco.

Methods to detect Spectacled Flying-foxes tested by RPS (2013b) proved suitable for collection of presence/absence data on site, but detailed abundance and flight height data were not able to be obtained due to technical limitations of all techniques tested and difficulties of access and movement around the site due to the ruggedness of its terrain.

While it is known the Mount Emerald site does not contain suitable habitat for the species to use as roost camps, the limitations outlined above mean there is no empirical basis distinguishing or mapping any other resources or areas within the wind farm that may be more or less likely to be used by the species.

Information from the National Flying-fox Monitoring Programme shows the Australian population of Spectacled Flying-fox, which is confined to Queensland, is both relatively large and is subject to significant natural variation.

Table 1 shows information about the locations and census information for the species roost sites close to the Mount Emerald site obtained from the National Flying-fox Monitoring Programme (http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf accessed 09 February 2018). Two other roost camps in the region (Mareeba, Leinster Park (866) and Nassers Fragment (838) at Atherton) have not been surveyed and are considered to be inactive.

The National Flying-fox Monitoring Programme provides numbers of animals counted at each census for each roost camp categorised as follows:

Flying-fox Numbers category
1 = 1-499
2 = 500-2,499
3 = 2,500-9,999
4 = 10,000-15,999
5 = 16,000-49,999
6 = >50000

Table 1 Spectacled Flying-fox census data for five roost camps closest to Mount Emerald Wind Farm

Numbers for census months as per National Flying-fox Monitoring Programme categories

Site name & number	Count month										Census range (min - max) over past three years
	May 2015	Aug 2015	Nov 2015	Feb 2016	May 2016	Aug 2016	Nov 2016	Feb 2017	May 2017	Aug 2017	
Tolga Scrub (698)	5	5	5	4	3	3	3		3	3	**2,500 - 49,999**
Mareeba (686)				2							**500 - 2,499**
Mareeba Hospital (687)	3	2									**500 - 9,999**
Mareeba, Swimming pool (937)									3		**2,500 - 9,999**
Mareeba, Stewart St (890)								3			**2,500 - 9,999**

Queensland Department of Environment and Heritage (EHP) mapping (2016) provides less detail but shows the closest known Spectacled Flying-fox roost sites to be at Mareeba Granite Creek, Mareeba Barron River and Tolga Scrub (https://www.ehp.qld.gov.au/wildlife/livingwith/flyingfoxes/pdf/roosts/map39.pdf accessed 08 February 2018). These roosts are not among those routinely monitored by EHP.

The National Flying-fox Monitoring Programme census data for given roost camps provide estimates of maximum and minimum numbers within a range of several hundred or thousand individuals. We understand this is due to the difficulty of counting the animals in rainforest environments and to allow for natural variation and exchange of animals between nearby camps. For the five roost sites the cumulative total census numbers for the past three years range from a minimum of 8,500 to a maximum of 82,495.

In summary, it is likely that Spectacled Flying-foxes from nearby roost camps will visit the Mount Emerald Wind Farm site when flowering trees such as *Eucalyptus*, *Corymbia*, and *Melaleuca* species are in blossom. It is also possible Spectacled Flying-foxes may fly across the site between roost camps and locations of food resources outside the site. Any such flights that are at the height swept by turbine rotors will have some associated risk of collisions.

2.2 Bare-rumped Sheathtail Bat

General information and biology

The Bare-rumped Sheathtail Bat weighs approximately 50 grams. Little is known of the species biology as it is rarely trapped or recorded during bat surveys (Armstrong et al. 2014; Churchill 2009) using the range of techniques routinely used to detect insectivorous bat species.

In Australia the species is known from two distinct populations, one in coastal Queensland from around Townsville to near Coen, and another in the top end of the Northern Territory. The species has a wide distribution from India through south-eastern Asia and New Guinea to the Solomon Islands (Churchill 2009).

The most up-to-date collation of information about the population of this species in Australia is contained in the 2016 EPBC Act Conservation Advice for the species (Threatened Species Scientific Committee 06/09/2016). It includes the following information:

- There is no robust estimate of population size. Population data are limited as only a small number of roost sites have been found in Australia.
- Although there is no robust estimate of population size, considering the subspecies' wide distribution, the number of mature individuals is very likely to be greater than 1000.
- Woinarski et al. (2014) and Armstrong (2016) suspect the number of mature individuals to be greater than 10 000, given that there is likely to be good roosting potential for the species in a significant proportion of the available habitats across its broad distribution.
- Given the limited data available, the number of roost sites and average number of individuals per roost site across the species distribution cannot be reliably estimated.

Small groups of Bare-rumped Sheathtail Bats roost in hollows in large eucalypts during daylight hours. The heights at which Bare-rumped Sheathtail Bats routinely fly are not known, although they are believed to forage for aerial insects mainly above tree canopy height (Churchill 2009). Bare-rumped Sheathtail Bats echolocate using ultrasonic calls as their primary means for navigation in flight.

Distinguishing sonograms of recorded calls of Bare-rumped Sheathtail Bat from other species of *Saccolaimus* and of Beccari's Freetail Bat *Mormopterus beccarii* has proven difficult and many calls cannot be ascribed to a particular species with complete certainty. Use of full spectrum detectors has somewhat improved this because they have capacity to provide more information on call harmonics that are useful in discriminating the species, than could generally be obtained from zero crossed based systems. However, capture of calls that have sufficient definition for this purpose is reliant on the bat flying close enough to the detector microphone for the relevant parts of the call signal to be recorded.

Other suggested methods to survey for the species include mist-netting using nets set high within or above the tree canopy and targeted searches for roost sites in trees with large hollows (Commonwealth of Australia 2010).

Bare-rumped Sheatail Bat at Mount Emerald

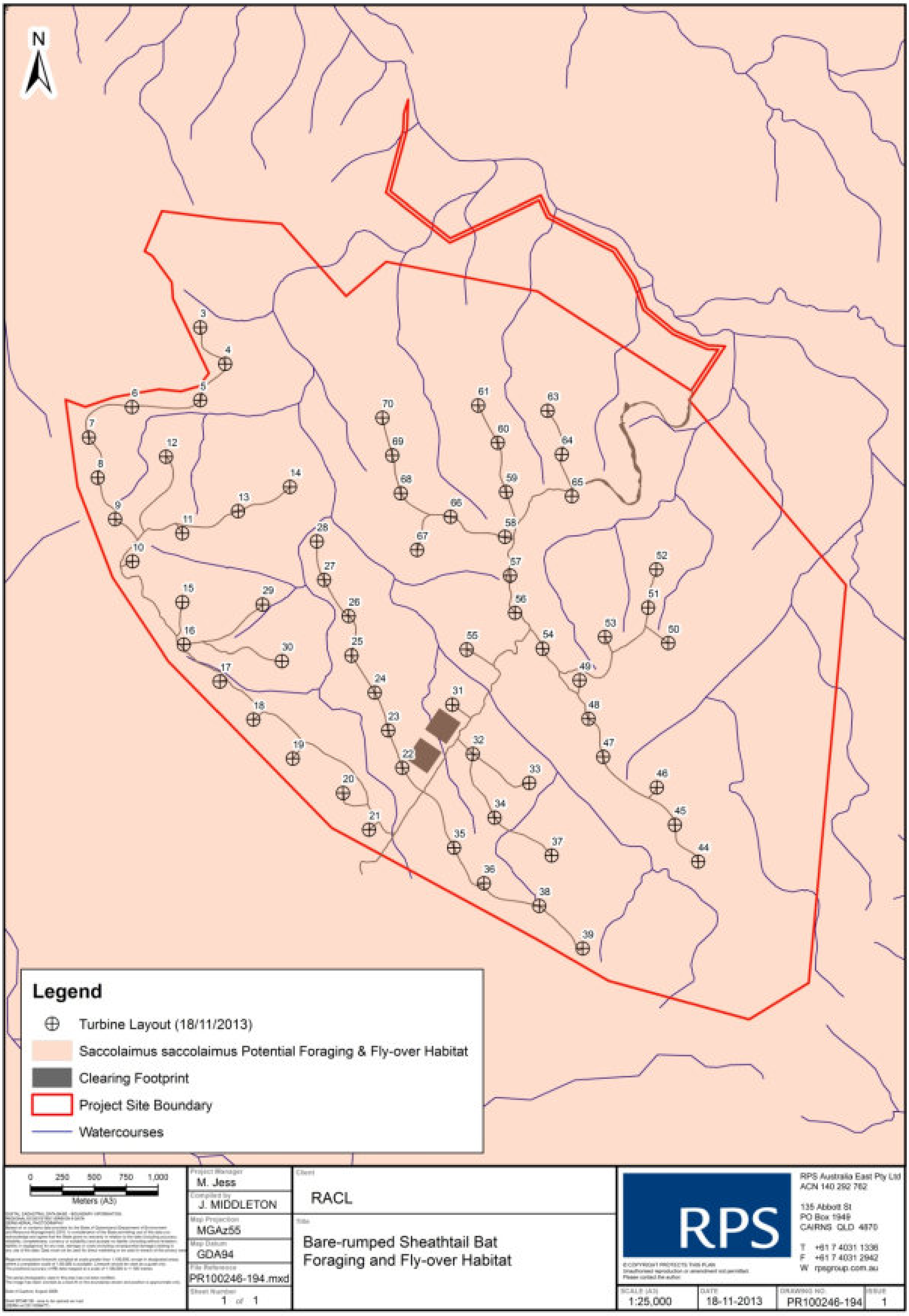
Bare-rumped Sheathtail Bat was recorded at the Mount Emerald Wind Farm site from a relatively small number of species-specific ultrasonic calls recorded there between 2010 and 2013, but they were from six locations spread widely across the site that sampled both the Wet Tropics Bioregion and the Einasleigh Uplands Bioregion portions of the site. A small number of additional calls detected may have been from this, or one of three other species (RPS 2013a).

Bare-rumped Sheathtail Bat was one of 17 microchiropteran bat species documented with a high degree of confidence at the site and a further three to six species were possibly recorded there (RPS 2013a). Calls of Bare-rumped Sheathtail Bats were not common when compared with those of some other small bat species encountered during surveys at the site (RPS 2013a). This agrees with a general low encounter rate despite the distribution of the species in Australia which extends along much of the coastal zone of northern Queensland.

Due to the high number of other small species of bats known to use the site, the capacity to distinguish the Bare-rumped Sheathtail Bat from other species is almost certainly limited to detection of bat-calls. Methods such as use of thermal imaging do not offer the capacity to discriminate between the various species present. Survey for the species using mist-nets set high within or above the tree canopy and targeted searches for roost sites in trees with large hollows would present significant challenges due to the difficult terrain and near complete cover of trees at Mount Emerald Wind Farm site and, while such surveys might provide further information about presence of the species there, neither would be likely to offer additional information about the risk of Bare-rumped Sheathtail Bat collisions with turbines.

Saccolaimus bats, including the Bare-rumped Sheathtail Bat, are thought to have capacity to travel substantial distances from roost locations to forage locations but it appears the Mount Emerald site offers habitat suitable for all the requirements of the species and it is likely to be resident there. It is thus possible the species may fly widely within the site on almost any night when weather conditions are suitable. The limitations outlined above mean there is no empirical basis distinguishing or mapping any particular resources or areas within the wind farm that may be more or less likely to be used by the species. The *EIS Mount Emerald Wind Farm Volume 2* Figure 17.2 (reproduced below) shows foraging and fly-over habitat for Bare-rumped Sheathtail Bats across the entire wind farm site and surrounding local landscape.

In summary, it appears a small number of Bare-rumped Sheathtail Bats are likely to use the Mount Emerald site. Any of their flights that are at the height swept by turbine rotors will have some associated risk of collisions.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Legend
Turbine Layout (18/11/2013)
Saccolaimus saccolaimus Potential Foraging & Fly-over Habitat
Clearing Footprint
Project Site Boundary
Watercourses
0 250 500 750 1,000
Meters (A3)
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Compiled by
J. MIDDLETON
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Title
Bare-rumped Sheathtail Bat
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3 Evaluation of potential measures to reduce or mitigate impacts on bats

Condition 12 of the approval of Mount Emerald Wind Farm under provisions of the EPBC Act required Mount Emerald Wind Farm Pty Ltd to undertake a review and evaluation of mechanisms that might assist in reduction of turbine collision risk for Spectacled Flying-foxes and Bare-rumped Sheathtailed Bats at the proposed wind farm. For the purposes of reducing impacts the term 'collision' is used to apply both to incidents in which a bat physically strikes, or is struck by the moving rotor of a turbine and to the potential for barotrauma. Barotrauma in bats has been described by Baerwald *et al.* (2008) as the fatal effect on an animal's respiratory tract due to its encountering a rapid change in air pressure close to a moving turbine blade. The effect has since been questioned as it has been shown to be difficult to diagnose and may have been confused with traumatic injury associated with direct collisions (Rollins *et al.* 2012). Nonetheless, it remains prudent to include the possibility of barotrauma in the present context.

Biosis (2017a) provided the required evaluation of a range of potential mechanisms and that report should be read in full for relevant details. Its findings and recommendations are summarized in Section 3.1. The review is specifically intended to assess the applicability of potential methods for the two species at the Mount Emerald Wind Farm.

3.1 Summary of potential mechanisms to reduce collision risk

The Biosis (2017) review found:

- Use of low wind speed turbine curtailment may be applicable although at present no information is available about response to wind speed by the two species of concern. An adaptive management approach for the use of this method was recommended. It would use initial controlled experiments in which a subset, or subsets, of turbines are programmed to cut-in at different defined wind speeds and the incidence of collisions by both species is documented to ascertain whether the incidence of collisions differs according to cut-in wind speed. On that basis a determination can then be made about whether low wind speed turbine curtailment would be of value to reducing collisions and if so, what wind speeds should be applied to turbine cut-in.
- Some methods intended to deter bats for approaching wind turbines have been tried overseas. Due to the entirely experimental nature of these possible deterrent techniques, they are not considered to be applicable for the two species of concern at Mount Emerald.
- Current information suggests that systems for turbine shut-down and re-start triggered by radar are not applicable to the specific and individual requirements for reduction of collision risk for the two bat species of concern at Mount Emerald.
- Systems for turbine shut-down and re-start triggered by ultrasonic bat calls are not applicable to Spectacled Flying-fox because the species does not use ultrasonic calls. Current limitations due to inability to obtain consistent, accurate identification of Bare-rumped Sheathtail Bat; call-detection distance relative to size of turbines; and time taken for turbine shut-down, indicate that such systems do not have capacity to achieve meaningful reduction of collision risk for the species.
- Systems using thermal imaging and acoustic sensors do not offer the capacity for automated shut-down and re-start of turbines and are not applicable to reduction of turbine collision risk.

On the basis of that evaluation, further consideration of low wind-speed curtailment is provided below.

3.2 Low wind-speed curtailment for bats

Background

A number of investigations overseas have demonstrated that flight activity of small species of bats is concentrated on periods when wind-speeds are relatively low (e.g. Arnett et al. 2009; Arnett 2017; Martin et al. 2017).

A wind turbine will not turn under zero wind conditions, but as the wind increases, the rotating speed of the turbine will also increase until it reaches a point where it is effective to generate electricity, this point is known as the 'cut-in' wind speed. The manufacturer's rated cut-in speed for both of two types of turbines planned to be used at Mount Emerald is 3.0 metres per second (m/s).

In recent years various studies have investigated whether a reduction in bat fatalities due to turbine collision can be achieved by the relatively simple measure of programming the turbines to alter their night-time operation so that their rotors do not turn during periods of specified low wind speed when many species of bats are most active (Arnett et al. 2009; Arnett 2017). This is termed 'low wind-speed turbine curtailment'.

There may be two phases to low wind-speed turbine curtailment. They are summarised as follows:

> **Phase 1**. The blades of some turbine models turn, at wind speeds between zero and the turbine's rated cut-in speed. In that situation a turbine 'freewheels' and has potential to kill bats even when no electricity is being generated. In this situation, the rotor blades can be feathered to prevent the rotor from turning until the rated cut-in wind speed is reached. This curtailment involves no loss of electricity generation.
>
> **Phase 2**. In this phase the turbine rotors are prevented from turning until a specific, pre-determined wind speed above the rated cut-in speed is reached. This curtailment involves loss of electricity generation for wind speeds between the rated cut-in speed and the pre-determined higher wind speed.

The majority of published studies of low wind-speed curtailment intended to protect bats have been undertaken in North America and the species primarily involved have been migratory, tree roosting bat species with relatively high incidences of collisions. They include Hoary Bat *Lasiurus cinereus*, Eastern Red Bat *Lasiurus borealis*, Silver-haired Bat *Lasionycteris noctivagans* and Big Brown Bat *Eptesicus fuscus*.

Low wind speed curtailment has been demonstrated to be an effective operational measure to reduce fatalities of these bats at a number wind farms in the U.S.A. and Canada. In some jurisdictions of the USA and Canada turbine cut-in speed has been mandated with a view to reducing collisions of migratory bats. All documented investigations of low wind speed curtailment have involved Phase 1 curtailment and the great majority have also involved Phase 2 curtailment up to a wind speed a little above the turbines' rated cut-in speed.

Arnett (2017) provides a review of current information which was set out in detail in Arnett et al. (2013). The latter provides a detailed synthesis of ten low wind speed curtailment studies. A number of variables between wind farms, turbines, study methods and species of bats were included among the ten studies, but all compared bat fatality rates at non-curtailed turbines with curtailed turbines. The great majority of the studies demonstrated at least a 50% reduction in bat fatalities when turbine cut-in speed was increased from manufacturers' rated cut-in speed by at least 1.5 m/s.

As an indication of the likely mechanism by which collision risk is influenced by cut-in wind speed, even at quite low wind speeds, Arnett et al. (2013) note that independent of blade length, most of the turbines under full operating conditions, had tip speeds at or above 160 km/h. Almost all turbines undergoing normal operations (i.e. when blades were not feathered) had tip speeds in excess of 80 km/h, even when wind speeds were below the normal cut-in, which suggests that measures such as feathering blades below rated cut-in speed can be taken to reduce tip speeds and consequent hazard to bats, even without increasing turbine cut-in speeds above the manufacturers' set cut-in speed.

One study demonstrated equally beneficial reductions with a low-speed idling approach, while another discovered that feathering turbine blades at or below the manufacturer's cut-in speed resulted in up to 72% fewer bats killed when turbines produced no electricity into the power grid (Arnett 2017).

The investigations detailed in Arnett et al. (2013) were all timed to coincide with the peak migration season of relevant species (late summer – early autumn in the northern hemisphere) and for all but one of them, in which the study encompassed the relevant season in two years, the study of curtailed turbines covered a period of less three months or less.

More recently, Forcey et al. (2016) conducted a 2-year study at Raleigh Wind Energy Centre in south-western Ontario to compare bat mortality at wind turbines curtailed at 3.5 m/s vs 4.5 m/s (2014) and 4.0 m/s vs 4.5 m/s (2015). In 2014, bat mortality at turbines with a 3.5 m/s cut-in speed were significantly higher than turbines curtailed at 4.5 m/s across all species ($P = 0.001$). During 2015, bat mortality at turbines curtailed at 4.0 m/s was similar to mortality at turbines curtailed at 4.5 m/s ($P > 0.10$). As the 2015 study did not show significant differences in estimated bat mortality between 4.5 m/s and 4.0 m/s cut-in speeds, they suggest that implementing the 4.0 m/s cut-in speed compared to a 4.5 m/s cut-in speed would not increase estimated bat mortality, but would increase the electricity generated at the project through increased operational time, while keeping the mortality below a prescribed threshold.

At two wind farms in Hawaii, Snetsinger et al. (2016) compared bat mortality data from 2 – 3 years of uncurtailed turbines with 1 – 2 years of data for turbines curtailed to cut-in wind speeds of 5 m/s and 5.5 m/s. They found substantial between-year variance in bat mortality and that low wind-speed turbine curtailment did not always coincide with reduced mortality of Hoary Bats, but it did in some seasons and they recommended the application of low wind-speed curtailment.

Two recent investigations have considered refinements to the simple blanket measure of a low wind-speed turbine curtailment, particularly with a view to enacting curtailment in a fashion that is better tailored to periods of actual bat activity. Sutter et al. (2016) and Martin et al. (2017) investigated the relationship of bat activity and/or bat turbine collisions to a combination of wind speed and ambient temperature. The results of these studies showed promise of capacity to reduce the incidence of bat collisions while minimizing the loss of electricity generation in the North American situation for migratory bats.

Applicability to Mount Emerald Wind Farm

Low wind speed curtailment is not known to have been undertaken in Australia and its applicability as a method to reduce turbine collisions by any species of bat here is unknown.

The present plan sets out an investigation of low wind speed curtailment for Mount Emerald. Because there are multiple uncertainties about the utility of low wind speed curtailment as a mechanism to reduce risk to Bare-rumped Sheathtail Bat and Spectacled Flying-fox, the study set out here is designed as an experiment that has potential value to the species concerned, but also offers good opportunity to learn about the values of this mechanism in an Australian environment.

Relative to what has been demonstrated in North America, a variety of factors may influence the applicability and values of low wind speed curtailment for Bare-rumped Sheathtail Bat and Spectacled Flying-fox at Mount Emerald. Amongst them are the following:

- A factor common to substantial incidence of bat collisions in America is that it involves long-distance migratory species and occurs during relatively short periods of the year that coincide with large numbers of bats during their migration movements. In general, Australia does not have migratory bats and the two species of bats of concern at Mount Emerald Wind Farm are not known to have seasonal and geographical concentrations of the types that occur in long-distance migratory species.

- The principal species of bats that have been benefitted by low wind speed curtailment in North America differ substantially in both morphology and behaviours from Bare-rumped Sheathtail Bat and Spectacled Flying-fox. The morphology and behaviours of Bare-rumped Sheathtail Bat and Spectacled Flying-fox are very different from each other and it seems likely the responses of the two species to wind turbines and to low wind speed curtailment may differ considerably.

4 Potential for significant impacts & defined performance criteria

While the most desirable outcome for Mount Emerald Wind Farm is that it will operate without any negative effect on the two species of bats, it is recognised some impact may occur.

The overarching objective will be that the wind farm does not have a significant impact on the viability of the population of either species.

It is important to define a level of effect on each of the Spectacled Flying-fox and Bare-rumped Sheathtail Bat which might constitute a 'significant impact' and to ascertain the likelihood of that occurring.

Secondarily, it is necessary to determine and set performance criteria and establish means to monitor the effectiveness of the wind farm in achieving performance goals.

4.1 Defining a significant impact

The following discussion outlines the approach to determine and define relevant criteria for measuring what would constitute a 'significant impact' on the two species of bats.

The Bare-rumped Sheathtail Bat and Spectacled Flying-fox are both listed as vulnerable under provisions of the EPBC Act. Australian Government policies for the EPBC Act provide a set of principles and criteria for determining what may constitute a 'significant impact' on a vulnerable species. We note the possibility of the wind farm resulting in a significant impact has been considered in the EIS process undertaken in the approvals process for the wind farm but at present there is no certainty about whether any impact may actually be significant as per the relevant criteria. The approach set out here uses the criteria and principles of EPBC Act policies to further consider the potential for the wind farm to result in a significant impact on either species.

The primary policy guidance and significant impact criteria relevant to Bare-rumped Sheathtail Bat and Spectacled Flying-fox are provided in:

- *Matters of National Environmental Significance: Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia 2013).

Guidance and relevant principles are also provided in:

- *EPBC Act Policy Statement 2.3 Wind Farm Industry* (Commonwealth of Australia 2009).
- *Draft referral guideline for 14 birds listed as migratory species under the EPBC Act* (Commonwealth of Australia 2015a).

The EPBC Act Policy Statement *Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (Commonwealth of Australia 2015b) is applicable to management actions within flying-fox camps. Mount Emerald Wind Farm site does not encompass any camps and the guideline is thus not applicable to the wind farm.

4.1.1 EPBC Act significant impact criteria

The criteria for what may constitute a significant impact on a vulnerable taxon are set out in *Matters of National Environmental Significance: Significant impact guidelines 1.1* (Commonwealth of Australia 2013) as follows:

> *"An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:*
>
> *• lead to a long-term decrease in the size of an important population of a species*
>
> *• reduce the area of occupancy of an important population*
>
> *• fragment an existing important population into two or more populations*
>
> *• adversely affect habitat critical to the survival of a species*
>
> *• disrupt the breeding cycle of an important population*
>
> *• modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*
>
> *• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*
>
> *• introduce disease that may cause the species to decline, or*
>
> *• interfere substantially with the recovery of the species."*
>
> *An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*
>
> *• key source populations either for breeding or dispersal*
>
> *• populations that are necessary for maintaining genetic diversity, and/or*
>
> *• populations that are near the limit of the species range.*

Spectacled Flying-fox

The site of Mount Emerald Wind Farm is not used for breeding by Spectacled Flying-foxes and this species disperses widely across all types of habitat. The population of the species that uses the site thus does not represent a key source populations either for breeding or dispersal.

As the site is not used for breeding by Spectacled Flying-fox, it does not contribute to maintenance of the species genetic diversity.

The site is not near the limit of the Spectacled Flying-fox distributional range.

The populations of Spectacled Flying-foxes that may use the site thus do not meet the defined criteria for an 'important' population' as used in dot points 1, 2, 3 and 5 of the criteria.

Within the wide range and diversity of habitats used by Spectacled Flying-foxes the Mount Emerald Wind Farm site does not represent *habitat critical to the survival of a species.*

Effects on habitat for Spectacled Flying-foxes associated with development and operation of Mount Emerald Wind Farm are not *to the extent that the species is likely to decline.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *result in invasive species that are harmful to the species becoming established in the species' habitat.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *introduce disease that may cause the species to decline.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *interfere substantially with the recovery of the species.*

In summary, evaluation of the potential effects on the Spectacled Flying-fox indicate they do not constitute a significant impact on the species.

Bare-rumped Sheathtail Bat

Bare-rumped Sheathtail Bats may breed at Mount Emerald Wind Farm site but information about the species indicates that it breeds in tree hollows across a widely dispersed range in Queensland and the Northern Territory. There are thus, no known 'key' source breeding or dispersal populations that can be differentiated from any others.

There is no information to suggest any subpopulation of Bare-rumped Sheathtail Bats or any resource used by the species is more important than any other for maintaining genetic diversity.

The site is not near the limit of the Bare-rumped Sheathtail Bat distributional range.

The population of Bare-rumped Sheathtail Bats that may use the site thus does not meet the defined criteria for an 'important' population' as used in dot points 1, 2, 3 and 5 of the criteria.

The Queensland population of Bare-rumped Sheathtail Bats is known to extend in a zone extending from approximately Bowen to Cooktown. Within this range there is no basis for consideration that the Mount Emerald Wind Farm site represents *habitat critical to the survival of a species*, and effects on habitat for the species, associated with development and operation of Mount Emerald Wind Farm will not be *to the extent that the species is likely to decline.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *result in invasive species that are harmful to the species becoming established in the species' habitat.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *introduce disease that may cause the species to decline.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *interfere substantially with the recovery of the species.*

In summary, evaluation of the potential effects on the Bare-rumped Sheathtail Bat indicates they do not constitute a significant impact on the species.

4.1.2 Further guidance regarding significance of impacts

The *EPBC Act Policy Statement 2.3 Wind Farm Industry* (Commonwealth of Australia 2009) provides some additional explanation and examples relative to potential effects of the wind industry. The following excerpt is useful in its indication that the risk should be considered as proportional to the population size of particular species:

> *"An activity that affects, or is likely to affect, a small number of individuals usually would not be expected to have a significant impact on the species as a whole. However, when a species or community is in small numbers nationally, or its distribution or habitat is limited, or if the habitat has particular importance for the species, the activity could have a significant impact. In general, this would apply to species or communities that are most at risk of extinction and are, as such, listed as critically endangered or endangered.*
>
> *An action is likely to have a significant impact on a species listed as vulnerable where it significantly affects an important population of that species. An example might be where a wind farm is proposed on an*

island or headland, or near a wetland, that has a key breeding population of a bird species listed as vulnerable. The breeding frequency and success rate for that species would also be relevant considerations."

As noted above, populations of either Spectacled Flying-fox or Bare-rumped Sheathtail Bat that are likely to use the Mount Emerald Wind Farm site do not meet defined criteria for an 'important population'.

The Commonwealth guidance documents clearly indicate the level of impact that may be significant is based on the measure of change that may be experienced by the population of a vulnerable species. In principle this 'population' approach is ecologically meaningful as it responds appropriately to the population sizes of different species.

The concept of impact on an 'ecologically significant proportion' of a population has been elaborated in *Draft referral guideline for 14 birds listed as migratory species under the EPBC Act* (Commonwealth of Australia 2015a). For an impact measured by mortalities of individual animals it defines a significant impact as one in which annual mortality rates meet or exceed 1% of the population. It also indicates a potential or real impact that may meet or exceed 0.1% of the population should be investigated further through more targeted surveys and be subject to mitigation.

4.2 Defining performance criteria

Numerical collision risk modelling is frequently used to determine an estimated range of the number of collisions that might occur at a proposed wind farm. It has been applicable almost entirely to diurnal birds because it is very difficult to obtain pre-requisite data about the rates and heights of flights by bats that might be at risk of colliding with turbines. Technologies that have capacity to detect and quantify flying bats, such as radar and thermal imaging, do not generally have capacity to distinguish between species of bats. Studies by RPS at Mount Emerald (RPS 2010; 2013a; b) experienced very low detection rates for the two species of interest and/or very limited capacity to identify them to species-level using routine and novel techniques. For these reasons, quantified collision risk modelling cannot be undertaken for either of the two species.

Numerical collision risk estimates would be required as a measure of mortality in order to place the potential effects of turbine collisions into a population viability framework. In addition, to undertake population modelling, it is necessary to have quite precise demographic details and numerical values for the population in question. Limitations on our understanding of the populations of both species have been discussed in Sections 2 and 4, above. In combination, these limitations mean population viability analysis also cannot be undertaken to evaluate the potential effects of the wind farm on the population of either Bare-rumped Sheathtail Bat or Spectacled Flying-fox.

Further details about collision risk modelling and population viability for the two species is provided in Biosis 2017b.

Published information about the numbers of bat fatalities that occur at Australian wind farms is very limited and is confined to insectivorous microbats. A search of the internet using the terms, 'flying, fox, fruit, bat, pteropus, wind, turbine' found no information about effects of operational wind farms on flying-foxes anywhere in the world. In large measure, this is considered to be because commercial-scale wind energy facilities are rare in parts of the world inhabited by flying-foxes, but also may reflect a lack of monitoring at such sites that do exist. Hull and Cawthen (2013) is the only peer-reviewed published investigation into turbine collision mortality of Australian microbats. It documented 54 fatalities of two species that were detected over an eight-year study at Bluff Point and Studland Bay Wind Farms in Tasmania. Other than Windy Hill Wind Farm (which has not been subject to detailed collision monitoring), there are no operational wind farms within the ranges of the Bare-rumped Sheathtail Bat or Spectacled Flying-fox. The Yellow-rumped Sheathtail Bat *Saccolaimus flaviventris* is closely related to Bare-rumped Sheathtail Bat and appears to have a similar ecology to it. It has a widespread distribution that includes regions of south-eastern Australia where there are a number of operational wind farms that have been monitored for bird and bat collisions. To date, we are not aware of any information to suggest the population of Yellow-rumped Sheathtail Bats has been significantly impacted by wind energy facilities within its range.

While the currently available information is clearly limited, it does not indicate that Mount Emerald Wind Farm is likely to result in mortalities of either Bare-rumped Sheathtail Bat or Spectacled Flying-fox that will impact on the viability of the population of either species.

4.2.1 Significant impact & performance threshold measures for Bare-rumped Sheathtail Bat & Spectacled Flying-fox at Mount Emerald Wind Farm

It is recognized the situation at Mount Emerald Wind Farm does not involve migratory birds covered in the guidance of Commonwealth of Australia (2015a). However, since demographic information about both species of bats is limited to the extent that more sophisticated techniques, such as population modelling are simply not feasible, and given the principle set out in this guidance is responsive to the population size of any threatened species regardless of how large or small it is, the principles of the approach described in that guidance, and set out here can be applied to the two species of bats of concern at Mount Emerald.

Condition 13 of the EPBC Act approval requires that,

"*details of intended outcomes and measurable performance criteria for the Spectacled Flying-fox and Bare rumped Sheathtail Bat which are based on information contained in relevant guidance material…*".

The criteria contained in the referenced EPBC Act significant impact guidelines documents and the Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (Commonwealth of Australia 2015a) have provided the basis for performance measures set out here. As noted above, the latter document provides a numeric approach based on population size of particular taxa. In accordance with the principles set out in that guideline, a significant impact would entail mortalities equalling or exceeding 1% of the populations of the two species per annum and further investigation would be required if it equalled or exceeds 0.1% of the populations of the two species. Thus, it is suitable to set performance thresholds for Mount Emerald Wind Farm on the basis that a management response will be required if collisions by either species with turbines were to equal or exceeds 0.1% of their populations.

4.2.2 Quantified performance measures

Census data for Spectacled Flying-foxes, including for each roost camp close to Mount Emerald, is measured only to within an order of magnitude for several thousand individuals (see Section 2.1) and the data indicates the local roost-site populations have varied substantially over the past three years. In light of the large range of counts of the population that may use the Mount Emerald site, it is evident additional mortality that may occur at the wind farm will be completely masked by those pre-existing variables. There is no similar information to quantify the population of Bare-rumped Sheathtail Bats in the area of Mount Emerald.

In light of this lack of precise information about the local populations of either species, the principles discussed above for their entire Australian populations are used here. Thus a performance threshold, requiring further investigation and consideration of a management response will be required if collisions by either species with turbines were to equal or exceeds 0.1% of their populations

Recent expert population estimates for the Australian populations of the two species are:

- Greater than 10,000 for Bare-rumped Sheathtail Bat (Woinarski et al. 2014)
- Approximately 100,000 for Spectacled Flying-fox (CSIRO 2015, 2016).

Using these population estimates, annual performance thresholds will be to ensure total annual mortalities due to operation of the wind farm do not exceed 0.1% of these population sizes, which equates to 10 Bare-rumped Sheathtail Bats and 100 Spectacled Flying-foxes.

4.3 Monitoring of performance

Assessment against performance thresholds will require a program for monitoring collisions in a sample of years. This will entail a regime of searches for dead bats under turbines as detailed in full in Section 5 *Post-commissioning bat studies at Mount Emerald Wind Farm*.

It is important to note the number of fatalities detected by searches will almost certainly not represent the total number killed because searches rarely detect all carcasses and because some carcasses will be removed by scavengers before they can be found. These effects are well known and there is an existing science for determining estimates of total mortalities from numbers of mortalities detected during searches (e.g. Huso et al. 2017). Performance thresholds for Mount Emerald relate to the total number of the two species that may collide with turbines. For this reason, the factors that may influence determination of appropriate estimates (see Section 5) will be used as the basis for mathematics to estimate the total number of either species that may have been killed and for 95% confidence intervals for those values.

An evaluation of potential measures to reduce turbine collision risk for threatened bats at Mount Emerald Wind Farm was undertaken in compliance with condition 12 of the EPBC Act approval of the project. It is set out in Biosis (2017a). The evaluation is summarised in Section 3.1 of this plan. It indicated that low wind-speed turbine curtailment is likely to offer the best option to minimise collisions, particularly for Bare-rumped Sheathtail Bat.

4.3.1 Adaptive management framework

A low wind speed turbine curtailment study is set out below (Section 5.3). Its results will be used to inform subsequent decisions about requirement for any further or additional management actions aimed at further reduction of effects on either of the two bat species (see Section 6).

5 Post-commissioning bat studies at Mount Emerald Wind Farm

The studies described here are intended to meet the requirements of Condition 13 of the EPBC Act approval for Mount Emerald Wind Farm. The following important principles have guided their design:

- To the extent possible, they will be simple and minimise extraneous variables.
- In order to maximise their potential to meet stated objectives, they will obtain the largest sample sizes that are practicable.
- They are be able to be implemented without significantly compromising the routine operation and management of the wind farm.

Statistical design and aspects related to biometry for the studies outlined below have been determined in collaboration with Dr Stuart Muir of Symbolix Pty Ltd, and his advice is acknowledged.

No other wind energy facility of the size of Mount Emerald Wind Farm exists in tropical Australia, and the great majority of other wind farms in Australia are situated within agricultural land-use settings. By contrast, Mount Emerald is located in an environment where the great majority of pre-existing remnant vegetation and natural ecosystems are retained. For these reasons alone, the potential interactions of the two species of concern with the wind farm are currently uncertain. In order to improve general knowledge of the interactions of bats with wind turbines and to demonstrate the outcomes at Mount Emerald, the results of the investigations described here will be made publicly available in reports to be prepared by Mount Emerald Wind Farm, within six months of their completion and appropriate analyses of their results. The information will be provided on the Mount Emerald Wind Farm website and every effort will be made to publish the studies in the peer-reviewed technical literature.

5.1 Turbine operation

Subject to confirmation of technical requirements by the turbine manufacturer, it is planned for all turbines operated at Mount Emerald Wind Farm to be programmed so that rotor blades will remain feathered to prevent the rotors from turning at wind speeds between zero and 3.0 m/s. Hence, all turbines will permanently operate with Phase 1 curtailment.

The benefits in reducing collision risk for birds and bats will not be able to be quantified because that will be the routine operation of the turbines, however Phase 1 curtailment of all turbines at all times will, at the very least, reduce the time in which turbines represent a collision risk to fauna. On the assumption that small bat species preferentially fly during conditions of low wind speed, Phase 1 curtailment represents a likely substantial measure aimed at reducing collision risk for all species of small bats.

5.2 Investigating numbers of bat collisions relative to performance thresholds

Study objectives
Results of the study are intended to be used in calculating an annual estimate of total fatalities of the two species. This will be used to assess the wind farm's annual performance relative to prescribed thresholds for the two species of concern. Depending on the numbers of collisions detected, the study may also be able to provide information about variable usage of the site by the two species.

The investigation will also be integral to the low wind-speed curtailment study set out in Section 5.3, below, and will provide the data required for it.

5.2.1 Experimental design

Carcass searches will be used to detect individuals of the two bat species of concern that may have collided with turbines. The numbers detected will provide the basis for estimations of the total mortality rates for the wind farm and/or for individual turbines. Searches will collect data for all species of birds and bats that may collide with turbines but any implications of collisions relate only to Spectacled Flying-fox and Bare-rumped Sheathtail Bat. The results of searches will be used along with relevant correction factors (see *Analyses of results*, below) to provide estimates of total collision mortalities for the two species.

At the time of preparing this plan, information about the two species at the Mount Emerald Wind Farm site is very limited and there is no strong evidence for habitat preferences for either species there. The locations where any carcasses of the two species are found may provide information about their fine-scale usage of the site.

Carcass search method

Specially trained dogs have been shown to be highly efficient at detecting carcasses (Mathews et al. 2013) and have been used for this purpose at a number of wind farms in agricultural environments in Australia (Bennett 2015). During the construction of Mount Emerald Wind Farm, detection dogs have successfully been used to identify and clear areas of the endangered Northern Quoll prior to the commencement of works. However, there does remain some risk the use of dogs will not be practicable at the Mount Emerald site because of the high risk to dogs from snakes and ticks. The alternative is to use human observers who have been trained in identification of bats of the region. Whichever method is chosen, searches of all turbines will be undertaken.

<u>Fall zone and estimation for unsearchable zones</u>

Hull and Muir (2010) provide the sizes of likely fall zones for different turbines and sizes of birds and bats based on ballistics theory. They note that distance from the base of a turbine is an important factor in dispersion of carcasses and that with increased distance the density of carcasses decreases. They provide modelled fall zones and radii for percentages of expected distribution for two size classes of birds and one for small bats. Huso and Dalthorp (2014) compared five estimators for the relationship of carcass density to distance from modern wind turbines. For all five estimators tested they found that density approached zero at about 70 metres horizontal distance from the turbine base for the size of turbines at the wind farms used in their work.

The greatest capacity to detect carcasses is obtained from intensive searches of defined areas of the potential fall zones and the most valid estimates of mortality come from distance-based carcass-density models (Huso and Dalthorp 2014). Because the densities of carcasses diminish with horizontal distance from a turbine, searching of large areas including the outer extremities of potential fall zones were shown by those authors to add little to detection rates but to add very substantially and disproportionally to search effort. Hence, intensive searches of the portion of the fall zone in which the majority of carcasses will be found, as defined for the size of turbines at Mount Emerald Wind Farm, will be the most effective and appropriate. The turbines at Mount Emerald Wind Farm are larger than those considered by Huso and Dalthorp (2014), but, since the density of carcasses will diminish with distance from the turbine base and in light of practical considerations about capacity to effectively search for carcasses, a search zone defined by a 70-metre radius of the base of the turbine is considered to be reasonable and the mathematics outlined in Huso and Dalthorp (2014) will be applicable to quantify carcasses that land beyond that zone.

Due to the rocky, dissected nature of the ground at Mount Emerald along with natural cover of vegetation, it will not be practical to effectively search the entire 70 metre radius around the base of each turbine. This is common to many wind farms internationally and Huso and Dalthorp (2014) and Huso et al. (2017) provide sound methodology for extrapolation from searchable areas and those methods will be used at Mount Emerald. Within a 70 metre radius of the base of the tower each turbine will have a hardstand area and a portion of road on which visibility will to be high. The combined hardstand and road at each turbine covers an area approximately 60 metres long and 50 metres wide. In the great majority of cases the access road extends to, and beyond a 70 metre distance from the turbine tower. Carcass searches will be undertaken on all such areas within a 70 metre radius of the base of the tower where visibility is high under each turbine. Prevailing wind direction; wind strength; and, the physical location of the hardstand and road relative to each turbine may introduce a small degree of variability in where carcasses may fall, but that is a minor factor common to all wind farms.

Turbines to be searched

In order to maximise capacity to provide statistically meaningful sample sizes and because collisions with turbines are likely to be infrequent events for these species, and could occur at any turbine within the wind farm, carcass searching will be carried out under all turbines.

Search duration and frequency

The regime of carcass searching will run for two years and will commence when all turbines are commissioned and become operational at the wind farm.

It is likely (but uncertain at present) that carcasses of small bats will be scavenged quickly at Mount Emerald. Carcass persistence trials will be undertaken during the course of the study (see below), particularly to inform analyses required to extrapolate from numbers of carcasses detected to estimate total number of collisions. In order for the search regime to accommodate the likelihood of rapid scavenging a relatively short period between initial searches is important.

A primary consideration is to ascertain the frequency at which collisions occur. This is necessary for use in extrapolation to estimate total fatality rates. A 3-day interval between two searches at the beginning of the search cycle is designed to provide good capacity to determine frequency of collisions, because there is a high probability that a carcass found on day 4 must have collided in the preceding three days.

One search will be undertaken followed by a second search three days later, followed by an interval of 27 days. In other words, there will be a search on day one, a search on day four, and a search on day 28. The search on day 28 becomes day one of the second cycle and will be followed by a search three days later. That cycle will be repeated for the life of the study. It is vital that the survey intervals be consistent, and rigidly maintained and enforced. It is important for analyses that the longer period is exactly divisible by the shorter. Of greater import however, is the rigid and consistent maintenance of the scheduling.

Carcass persistence trials

Carcasses of bird and bats that collide with turbines may be removed by scavengers or will ultimately disappear due to decomposition. Carcass persistence affects the detection of dead bats that collide with turbines and consequently influences estimation of the total number of fatalities for each species.

Trials to determine persistence time of carcasses are required to derive correction factors necessary to estimate total fatalities from the results of the carcass searches. Two persistence trials will be undertaken annually, one in each of the dry and wet seasons.

Remote cameras will be used to record persistence of carcasses placed on-site for the purpose. Carcasses for the trials will be sourced from other species of common bats, of similar size to the two species of concern, found at the site or from other local sources. Carcasses used for trials will be individually marked to ensure they are not confused with collision carcasses. Individual marking allows trial carcasses to be identified if they are simply moved by scavengers. Radio-frequency identification (RFID) microchips inserted into carcasses can provide individual identification. Cameras used for the purpose will be set to take a photograph every hour (day and night) and also when triggered by movement. This method has been demonstrated in Victoria to be highly efficient and substantially reduces potential influence on scavengers as may occur when human observers visit routinely to check carcasses. Cameras will be deployed and left to operate for the duration of the trial as this entails substantially less effort than having people check carcasses daily. Cameras have the additional advantage of recording the precise time of carcass removal and the species of scavenger that removes the carcass. As a result of the precise documentation of the time of carcass removal there is also no need to estimate the period of carcass persistence which is required when carcasses are checked only at an intervals of several days. Censored analysis must still be used, to account for those carcasses that persist beyond the trial period (Klein & Moschberger 2003).

It is possible that some scavengers at Mount Emerald, particularly mammalian scavengers, will move carcasses out of the field of view of cameras to den sites or other locations. In order to check for carcasses that have been moved out of camera view, each trial will commence approximately one week before the next routine search for carcasses. This will provide capacity to find any moved carcasses so that they are not lost from the trial.

Each trial will be run for up to one month, but cameras will be checked after two weeks to check on their operation and at that point the trial may either be terminated or a second carcass may be placed to increase the sample size of the trial.

The results of these trials will permit average carcass persistence times to be determined.

Searcher efficiency trials

Searchers do not routinely find all carcasses, so it is necessary to ascertain the efficiency of searches in order to determine and apply appropriate correction factors for carcasses missed to inform estimation of total collision mortality for each of the two species of concern.

The efficiency of each dog or person undertaking searches will be determined by the use of blind trials. Without the prior knowledge of searchers, a number of bat carcasses will be placed within search plots prior to routine searches. The number of carcasses placed in any given trial will not be known to the searcher, but over a number of routine searches at least ten carcasses of flying-foxes and ten of microbats will be placed at a minimum of ten different turbines and over sufficient time to permit the rate of carcass detection to be determined.

Two searcher efficiency trials will be undertaken for each searcher annually, one in each of the dry and wet seasons, over the entire search regime.

Carcasses for the trials will be sourced from other species of common bats, of similar size to the two species of concern, found at the site or from other local sources.

Data collection & management

During all searches, all species of birds and bats detected as carcasses will be recorded on a data pro forma designed for the purpose. All information, including metadata for each turbine search will also be recorded on the data sheet irrespective of whether a carcass is found during a given search. All data will be entered into a single database to be maintained by the Project Ecologist. The dataset will be updated following each search and a back-up copy of the database will be maintained by Mount Emerald Wind Farm Pty Ltd. Raw data will be available to DoEE (or successor) on request.

On finding a carcass, it will be photographed in situ and its location will be logged using a portable GPS device. If species identification of any specimen is uncertain it should be sent to the Queensland Museum for identification. Wherever possible the sex and age-class of each specimen will be recorded. All carcasses of threatened taxa, including the two bats species of concern, will be collected and frozen to permit any necessary investigations of cause of death. A freezer for this purpose will be available on-site. At the conclusion of the overall investigation, all specimens will be made available to the Queensland Museum.

Analyses of results

Estimates of the annual total number of collision mortalities for Spectacled Flying-fox and Bare-rumped Sheathtail Bat will be undertaken using current best-practice science to account for searched areas; carcass persistence times relative to search interval and searcher efficiency rates. Along with the estimates, 95% confidence intervals will also be determined as a measure of variance around the estimates. Current best practice (2017) for these analyses are provided by Huso et al. (2017) (see also Huso (2009, 2010), Huso and Dalthorp (2014) Dalthorp et al. (2017)). The analyses will be undertaken by a biometrician with a thorough understanding of the relevant science.

The locations where any carcasses of the two species are detected will be evaluated to assess whether they provide statistically valid indications of variable usage of the overall Mount Emerald site. Patterns of use by the two species may be related to the geographic distribution of habitats or in response to temporal seasonal changes.

5.3 Low wind-speed curtailment study

A study of low wind speed curtailment at Mount Emerald Wind Farm will involve an experiment designed to test the potential effects of Phase 2 curtailment as a means to reduce collisions by Spectacled Flying-fox and Bare-rumped Sheathtail Bat.

Study objectives

The purpose of the low wind-speed curtailment study at Mount Emerald Wind Farm is to demonstrate whether altered low wind-speed curtailment has a beneficial value to the two species of concern. It is intended to compare whether fatalities differ between turbines operated under Phase 1 and Phase 2 curtailed cut-in wind-speeds. It is intended that results of the study will be informative for on-going adaptive management of Mount Emerald Wind Farm, specifically in the event that performance thresholds for either of the two species is reached or exceeded.

The study will be the first of its kind in Australia and, due to the high diversity of bats species known from the site, it is expected it will offer important insights into minimisation of wind turbine effects on bats that will be of value widely within the wind energy sector. At completion of the study its results will be made publicly available on the Mount Emerald Wind Farm website and, if possible, in the peer-reviewed technical literature.

Ultimately the results of the study will be used to determine whether Phase 2 curtailment has an influence on collisions by the two species with turbines and thus whether or not it has utility as an on-going strategy for reducing impacts on them. If that is demonstrated, it will be implemented with a clearly defined cut-in speed and a set of other circumstances when that cut-in speed is not applicable.

5.3.1 Experimental design

The turbines proposed to be operated at Mount Emerald Wind Farm have a rated cut-in wind speed of 3.0 m/s and as outlined above, all turbines are proposed to be feathered to prevent their rotors from turning at wind speeds below 3.0 m/s (Phase 1 curtailment).

The study set out here will involve Phase 2 curtailment in which cut-in wind speed will be set at 4.5 m/s (i.e. 1.5 m/s above the rated cut-in speed of 3.0 m/s). For curtailed turbines the computer SCADA system will be programmed to cut-in at 4.5 m/s. This will require the blades of selected turbines to be programed to remain feathered to prevent them from turning until the increased cut-in speed is reached over an average number of minutes defined by the turbine SCADA operating system (usually 5–10 min), thus triggering the turbine blades to pitch back "into the wind" and begin to turn.

Wind data records collected from on-site monitoring (commenced in 2010), indicate the amount of time wind speeds are likely to be below 3m/s to be 5% of the year, with speeds below 4.5m/s likely to occur for 12% of the year.

The study will be undertaken as a controlled experiment using a Before-After-Control-Impact (BACI) design.

The BACI design will compare:

1. **Before**: baseline information about collisions at all turbines operating under Phase 1 curtailment
2. **After**: [Control] information about collisions at half of turbines operating under Phase 1 curtailment

   [Impact or treatment] information about collisions at half of turbines operating under Phase 2 curtailment.

Data about collisions by the two bat species will be collected in the course of the search regime set out in Section 5.2 *Investigating numbers of bat collisions relative to performance thresholds*, above.

'Before' component

The baseline information required for the 'before' component of the study will be obtained from all turbines operating under Phase 1 curtailment for 12 months.

'After' component

The 'after' component of the study will consist of simultaneous operation of one half of the complement of turbines operating under Phase 1 curtailment (control) and the other half of the complement of turbines (treatment) operating under Phase 2 curtailment with a cut-in wind-speed of 4.5 m/s. Running this portion of the study simultaneously using half of all the turbines in the subsets for both control and treatment will maximise statistical power of the study. It will also reduce the likelihood of variables other than cut-in wind-speed to influence collision risk. This 'after' portion of the study will run for 12 months.

As outlined above, information about the two species of concern at the Mount Emerald Wind Farm site is very limited and at present it is insufficient to indicate whether either might use parts of the site preferentially. Nonetheless, Mount Emerald Wind Farm site does support two basic vegetation types that occupy different portions of the site. Half of all turbines in each of the two vegetation types will operate under Phase 1 curtailment and half will operate under Phase 2 curtailment, but otherwise within each of the two vegetation communities the selection of which turbines will operate under each phase will be at random.

The rationale behind using a high cut-in wind-speed is to maximise capacity for the study to demonstrate whether wind-speed influences collision risk for either of the two species. In various American studies a cut-in wind-speed of 4.5 m/s has been shown to substantially reduce the rate of bat collisions compared to the rate that occurred using a cut-in wind-speed of 3.0 m/s (details provided in Arnett *et al.* 2013 and reviewed Arnett 2017).

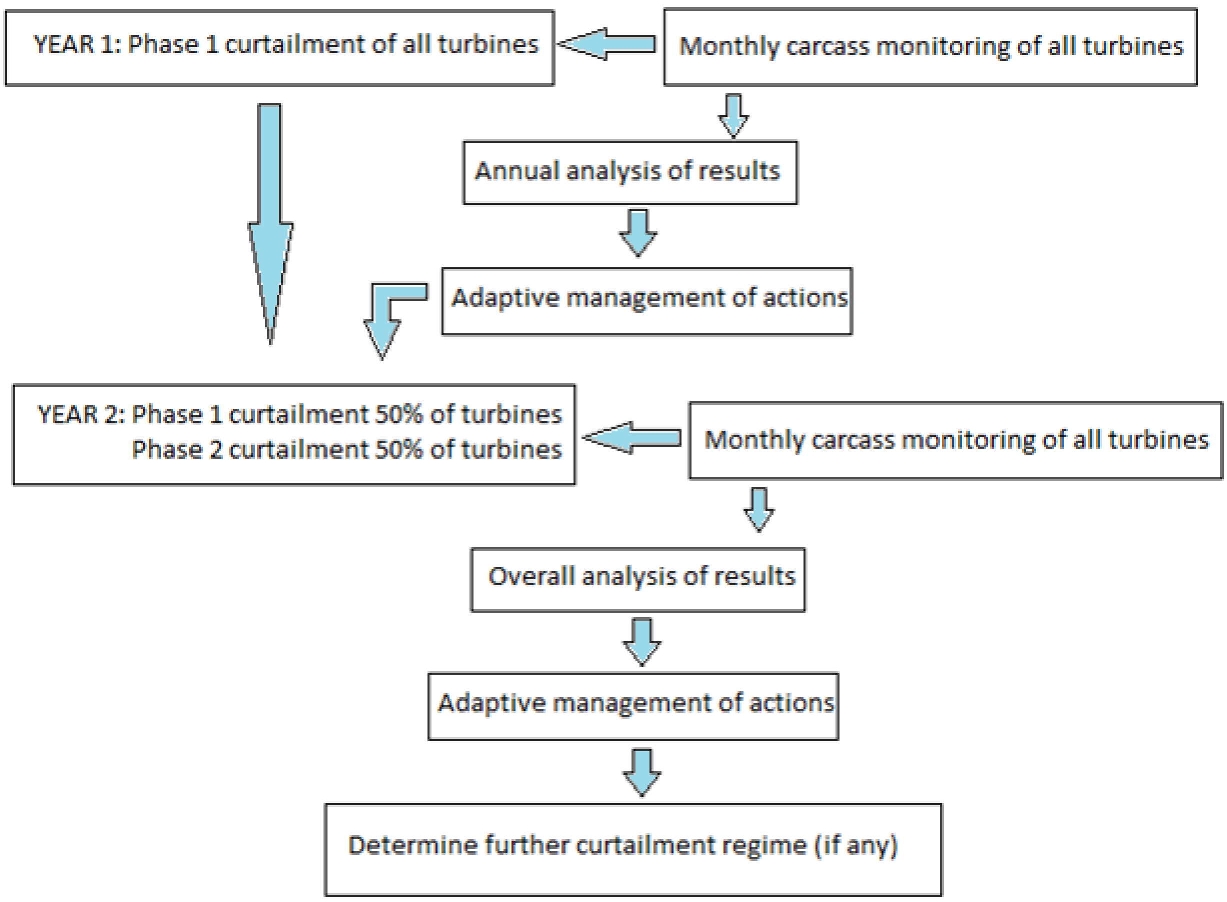
As bat flight activity is nocturnal, the study will entail simultaneous operation of the two subsets of turbines with different cut-in wind-speeds between sunset and sunrise (only).

Analyses

For the purposes of the low wind-speed curtailment study, the study design will compare numbers of the two species detected by searches, rather than derived estimates of total numbers of collisions.

5.4 Summary of study design

The schematic plan below provides a summary outline of the basic study design.



6 Potential contingency measures & corrective actions

As noted above, subject to confirmation of technical requirements by the turbine manufacturer, it is planned for all turbines operated at Mount Emerald Wind Farm to be programmed so that rotor blades will remain feathered to prevent the rotors from turning at wind speeds between zero and 3.0 m/s. Hence all turbines will permanently operate with this Phase 1 curtailment.

Implementation of additional long-term contingency measures and corrective actions will be necessary only if performance thresholds set out in Section 4.2, for impacts on either Spectacled Flying-fox or Bare-rumped Sheathtail Bat are exceeded.

6.1 Adaptive management measures

Assessment of performance will be undertaken in an adaptive management framework with annual reviews during the post-commissioning studies set out above.

At the time of preparing this plan, there are multiple uncertainties associated with its implementation. The likelihood of exceeding performance thresholds is unknown and the studies described here are intended to determine that and to improve general understanding about the possible interactions of the two species with wind turbines. In light of present uncertainties, a highly prescriptive approach is not considered to be appropriate. Rather, an approach that is responsive to the results of the studies is an important element of this plan.

For instance, if results of the curtailment experiment set out in this plan indicate that;

- it would be useful to test the relative effectiveness of turbine start-up wind speed(s) between 3 m/s and 4.5 m/s,
- individual turbines represent particular risk,
- or there may be some seasonality or other special conditions associated with collision risk for either species,

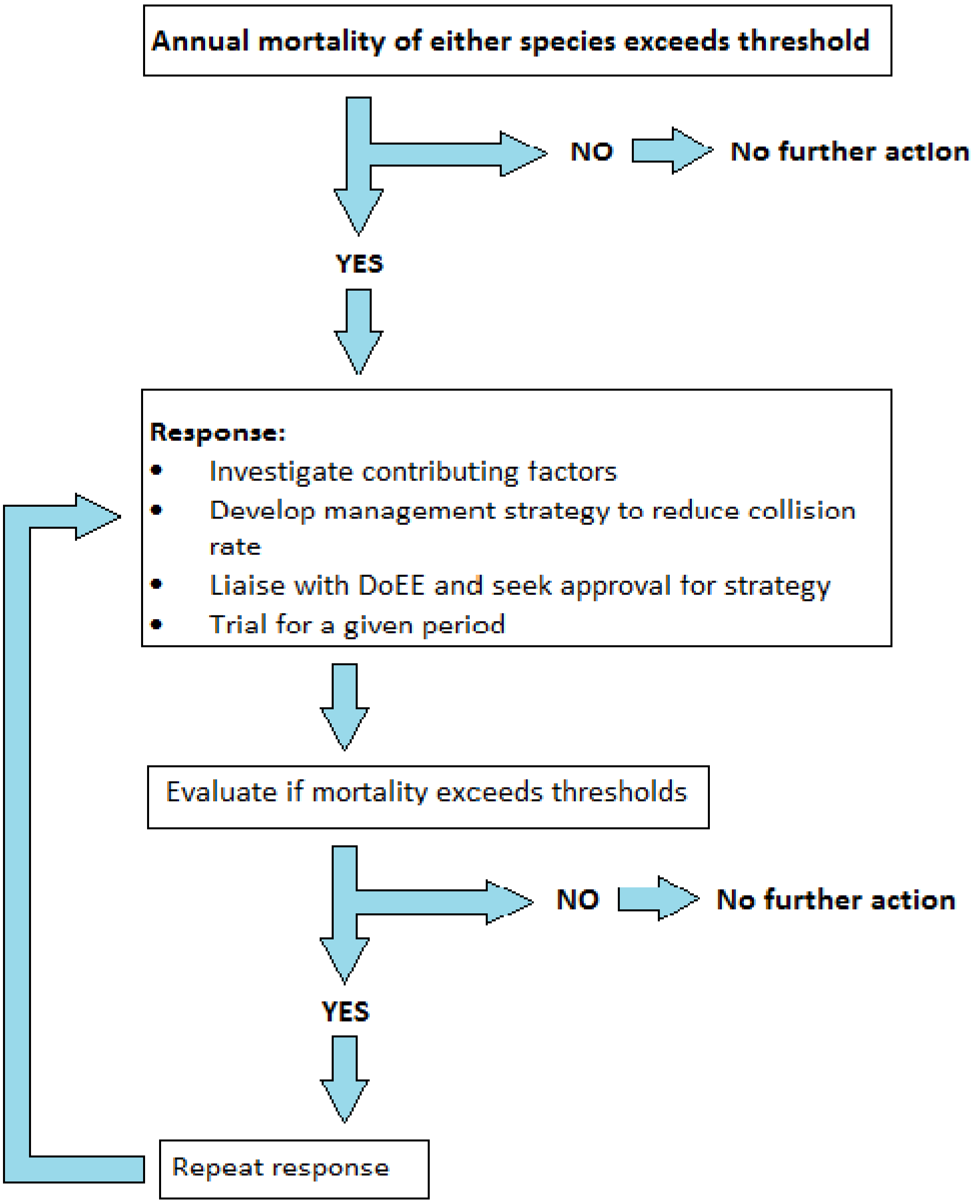
consideration will be given to further investigation or to management actions informed by data obtained from the study set out here.

In the event the annual estimated number of mortalities for either species reaches or exceeds the performance thresholds (i.e. equal to or greater than 100 Spectacled Flying-foxes or 10 Bare-rumped Sheathtail Bats in any 12 month period), as determined in accordance with Section 5.2 *Analyses of results*, then the results of the investigations detailed here will form the basis for consideration of potential corrective actions that may be taken.

Results of the low wind-speed curtailment study will be used to determine whether a higher turbine cut-in wind-speed represents a long-term method for reduction of collisions to a rate below prescribed performance thresholds for either or both of the key bat species. If so, and the relevant cut-in wind-speed is no higher than 4.5 metres per second, it will be implemented.

If necessary, results of the studies will be used to determine measures intended to reduce collisions to a level below prescribed performance thresholds. Such measures will be informed by results of the studies and depending on those results may take the form of implementing Phase 2 low wind-speed curtailment at specific turbines; during specified seasonal events; or under particular conditions.

The flow diagram below sets out the adaptive response process to be implemented in the event the annual mortality of either Spectacled Flying–fox or Bare-rumped Sheathtail Bat exceeds the defined threshold level.



6.2 Lifetime monitoring of the wind farm

The long-term operation of the wind farm will incorporate one or other low wind-speed curtailment regime which will be determined only after results of the two-year experiment set out in this plan are available.

Given the conditions may alter over the life of the wind farm monitoring of bat collisions will be undertaken at five year intervals throughout the full operational term. It is proposed for this regular monitoring to be conducted over a shorter period of three months, however this will be determined depending on results of previous studies.

If the initial two years of monitoring and experiment with low wind speed curtailment provide information that indicates collision risk for the two key bat species is associated with particular turbines, seasons, events or environmental conditions, that information will be used in tailoring future monitoring. Otherwise the search regime to be used will operate as set out in Section 5.2 *Investigating numbers of bat collisions relative to performance thresholds*.

7 Reporting

Conditions 24, 25, 26 and 27 of the EPBC Act approval for Mount Emerald Wind Farm specify requirements for reporting and provision of information relative to this plan. Mount Emerald Wind Farm Pty Ltd will do the following to ensure compliance with those conditions:

- Maintain a dedicated website about the project's compliance with the EPBC Act conditions of approval that is publicly available for the life of the approval. The webpage will include all monitoring results and documentation required under the conditions of approval and any other relevant information as directed by the Australian Government Minister for the Environment (or similar).

- Provide a copy of the documents published on the dedicated webpage to members of the public on request, within a reasonable timeframe.

- Maintain accurate records substantiating all activities associated with conditions of approval and this plan, including measures taken to implement the plan.

- Within three months of every 12 month anniversary of the commissioning of the wind farm publish a report on the webpage addressing compliance with each condition including implementation of this plan. The report will include information about whether the outcome required by condition 13 and this plan have been or are on track to being met.

- Provide a report to DoEE (or similar) within 2 business days of becoming aware of any contravention of conditions of approval under the EPBC Act that clearly specifies details of the contravention.

8 Roles & responsibilities

This section allocates responsibilities and details the roles necessary to ensure implementation of this plan.

Mount Emerald Wind Farm Pty Ltd is the approval holder under EPBC Act conditions of approval number 2011/6228 and is ultimately responsible to ensure this plan is fully enacted. Mount Emerald Wind Farm Pty Ltd will engage a qualified Project Ecologist who will have technical oversight of implementation of the plan.

8.1 Mount Emerald Wind Farm Pty Ltd

The key responsibilities of Mount Emerald Wind Farm Pty Ltd are to:

- Comply fully with all conditions of approval number 2011/6228 and any other relevant directions of the Australian Government Minister for the Environment (or similar).
- Engage, consult and collaborate with a suitably qualified Project Ecologist to ensure this plan is fully enacted.
- Ensure operations of the wind farm, including management of turbines and any other facilities or infrastructure, conform to requirements set out in this plan.
- Undertake all reasonable measures to ensure that any impacts on Spectacled Flying-foxes or Bare-rumped Sheathtail Bats remain below performance thresholds set out in this plan.
- In the event a performance threshold is reached or exceeded, consult and collaborate with DoEE and the Project Ecologist to ensure appropriate contingency measures, corrective actions or adaptive management measures are selected and are implemented.
- Ensure all requirements of conditions of approval numbers 24, 25, 26 and 27 related to reporting and provision of information are fully complied with.
- Liaise with the landowner and any other stakeholder/s, as necessary, to ensure this plan is implemented.

8.2 Project Ecologist

The key responsibilities of the Project Ecologist are to implement the technical and on-ground aspects of this plan. The Project Ecologist must have demonstrated experience in ecology. Ideally, the Project Ecologist will be a tertiary qualified zoologist with experience in the ecology of bats of tropical Australia.

The Project Ecologist must have a comprehensive understanding of the objectives, rationale and specifics of this plan. The key role of the Project Ecologist is to conduct and/or supervise all works set out in Section 5 *Post-commissioning bat studies at Mount Emerald Wind Farm.* Specific functions of the role are to:

- Conduct and/or oversee searches for bat carcasses.
- Undertake carcass persistence trials.
- Undertake searcher efficiency trials.

- Collect and manage all data required by the plan.
- Ensure Mount Emerald Wind Farm Pty Ltd is kept current with information about performance relative to mortality threshold set out in this plan for Spectacled Flying-fox and Bare-rumped Sheathtail Bat.
- In the event a performance threshold is reached or exceeded, consult and collaborate with DoEE and Mount Emerald Wind Farm Pty Ltd to ensure appropriate contingency measures, corrective actions or adaptive management measures are selected and are implemented.
- Undertake analyses of data, incorporating factors to account for searched areas; carcass persistence times relative to search interval and searcher efficiency rates to determine estimates of the annual total number (if any) of collision mortalities of Spectacled Flying-fox and Bare-rumped Sheathtail Bat, with 95% confidence intervals. As relevant, the analyses must provide comparative rates of collision by the two species for turbines with different low wind-speed curtailment regimes.
- Prepare reports on the monitoring and experiments, including information about methods, details of analytical methods used and results. The reports must be prepared in a timely manner and be submitted to Mount Emerald Wind Farm Pty Ltd with sufficient time for them to comply with conditions of approval numbers 24, 25, 26 and 27 related to reporting and provision of information.

9 Conclusion

This plan defines metrics against which to measure the performance of Mount Emerald Wind Farm relative to populations of Spectacled Flying-fox and Bare-rumped Sheathtail Bat. The performance is measured as numbers of collisions per annum with turbines at the facility.

The plan also details science-based studies designed to both assess whether performance thresholds are being met and to determine the effect of low wind-speed curtailment of turbines as a potential management measure to reduce collisions.

At the time of preparing this plan there are considerable uncertainties, including the extent to which either species utilises the site and whether possible collisions will have any measurable effect on their populations. Hence, a substantial outcome of enacting this plan will be to improve knowledge, and this has been built in as a responsive component to the plan.

The overarching intention of this plan is to minimise impacts of Mount Emerald Wind Farm on Spectacled Flying-fox and Bare-rumped Sheathtail Bat and to ensure any collisions that may occur will not have significant impacts on the viability of the population of either species.

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