Crudine Ridge Wind Farm Bird and Bat Adaptive Management Plan Implementation Report – Year One

CWP Renewables Pty Ltd

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Template 2.8.1

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Abbreviations

Abbreviation	Description
BBAMP	Bird and Bat Adaptive Management Plan
BC Act	*Biodiversity Conservation Act 2016*
BCS	NSW Biodiversity, Conservation and Science Directorate
CRWF	Crudine Ridge Wind Farm
CWPR	CWP Renewables Pty Ltd
ELA	Eco Logical Australia Pty Ltd
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
DPE	NSW Department of Planning and Environment
LGA	Local Government Area
MW	Megawatt
NPW Act	NSW *National Parks and Wildlife Act 1974*
NSW	New South Wales
RSA	Rotor swept area
SSD	State Significant Development

1. Introduction

Eco Logical Australia (ELA) was engaged by CWP Renewables Pty Ltd (CWPR) for the initial two year implementation of the Bird and Bat Adaptive Management Plan (BBAMP) for the Crudine Ridge Wind Farm (CRWF) project. This report details the results of Year One of operational phase monitoring, that was undertaken from June 2021 to June 2022.

1.1 Background

CRWF is located 40 kilometres south of Mudgee and 50 kilometres north of Bathurst in the central tablelands of New South Wales.

In May 2016, the NSW Department of Planning and Environment (DPE) issued approval for the CRWF project, approving up to 77 turbines. The Commonwealth Minister for the Environment and Energy issued approval of up to 37 turbines on 4 April 2017, selected from 57 approved turbine locations, under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The overall aim of the BBAMP is to provide a program for monitoring the impacts on birds and bats from CRWF and a strategy for managing and mitigating any significant bird and bat impacts arising from the operation of CRWF. Specific BBAMP objectives are outlined below (Section 1.3, CRWF BBAMP 2017).

- To provide baseline data on bird and bat populations that could potentially be affected by the CRWF, particularly identified at-risk species and groups.
- To implement a monitoring program capable of detecting any significant changes to the population of 'at-risk' birds and bats that can reasonably be attributed to the operation of the project.
- To directly record impacts on birds and bats through a robust carcass search sampling protocol and prompt carcass removal.
- To document an agreed decision-making framework that outlines the specific actions to be taken and possible mitigation measures implemented to understand and reduce any impacts on bird and bat populations, or in the event that an impact trigger is detected.
- To detail specific monitoring for 'at-risk' bird and bat groups.
- Minimising raptor activity in the area through controlling pests and minimising availability of raptor perches.
- Using best practice methods for bat deterrence; including managing potential lighting impacts.
- To detail specific and potential mitigation measures and related implementation strategies to mitigate any detected significant impacts on birds and bats.
- To identify matters to be addressed in periodic internal reports on the outcomes of monitoring, the application of the decision-making framework, mitigation measures adopted and their result/s.

1.2 Purpose of this monitoring report

CWPR developed a BBAMP (CRWF BBAMP 2017) to satisfy the requirements of Condition 22, Schedule 3 of the NSW SSD6697 Conditions of Consent. The BBAMP was also prepared to satisfy Condition 1 (a) of the Commonwealth Approval EPBC Ref: 2011/6206. Implementation of the approved BBAMP is

required in accordance with Condition 22 of the NSW SSD6697 and Condition 9 of Commonwealth Approval EPBC Ref: 2011/6206.

This Year One implementation report outlines the first year of operational phase monitoring undertaken during 2021-2022, with specific focus on; monitoring results, any impact triggers or unacceptable impacts identified, mitigation measures implemented, application of the decision-making framework, and recommendations for the following year, where required.

Table 1 below outlines the specific statutory requirements of the BBAMP which underlie the operational phase monitoring program and the associated methodology and performance measures applicable to the monitoring undertaken during Year One of the BBAMP implementation.

Table 1: Statutory requirements of the BBAMP and their relevant methods of assessment and performance measures

Statutory Requirements	Performance Measures	Assessment Methodology	Triggers for investigation
NSW SSD6697 Conditions of Consent			
Condition 22(b): develop a Bird and Bat Adaptive Management Plan (BBAMP) that includes: • Baseline data on bird and bat populations in the locality that could potentially be affected by the development, particularly 'at risk' species and threatened species; • A detailed description of the measures that would be implemented on site for minimising bird and strike during operation of the development.	Baseline bird and bat surveys completed; Bird Utilisation Surveys (BUS) (operational phase) undertaken as detailed in the BBAMP; Detail mitigation measures in approved BBAMP.	None specified	Baseline surveys not completed; Operational phase surveys not completed.
Condition 22(c): include a detailed program to monitor and report on: • the effectiveness of these measures and plans; and	Operational phase mortality surveys undertaken monthly at a minimum of 18 turbines for at least two years, with a review after the first year to determine if a change in the methodology is required	Carcass monitoring	Threatened species: A bird or bat species (or recognisable parts thereof) listed as threatened (not migratory) under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* or NSW *Threatened Species Conservation Act 1995* (now BC Act), is found dead or injured within 150 m of a

Statutory Requirements	Performance Measures	Assessment Methodology	Triggers for investigation
• bird and bat strike annually, or as otherwise directed by the Secretary.	(Table 12, CRWF BBAMP 2017).		wind turbine during any mortality search or incidentally by wind farm personnel (Section 6.1.1, CRWF BBAMP 2017). Non-threatened species: A total of four or more bird or bat carcasses or parts thereof, of the same non-threatened species are recorded at the same turbine over two successive monitoring events (excluding ravens, magpies, sulphur-crested cockatoos, corellas, and introduced species) (Section 6.2.1, CRWF BBAMP 2017).
	Scavenger and detector efficiency trials undertaken (Table 12, CRWF BBAMP 2017).	Scavenger and detector efficiency (observer) trials	Scavenger and observer trials successfully undertaken
Commonwealth Approval – EPBC Ref: 2011/6206			
Condition 1(a): implement the above NSW Conditions of Approval, where Management Plans: means the Biodiversity Management Plan, Biodiversity Offsets Management Plan, and Bird and Bat Adaptive Management Plan.	As above	As above	As above

The scope for the works undertaken by Eco Logical Australia to implement the BBAMP include:

- Bird and Bat carcass monitoring (including Scavenger and Observer field trials)
- Bird Utilisation Surveys (BUS)
- Targeted surveys of Wedge-tailed Eagle (*Aquila audax*) and other raptors.

Year One of operational phase monitoring was undertaken by a team of field ecologists from Eco Logical Australia.

2. Methods

2.1 Carcass monitoring

A robust carcass monitoring program was implemented to determine the actual impact of the wind farm on birds and bats through estimating the annual number of birds and bats that collide fatally with turbines. Monthly carcass monitoring commenced in June 2021, following the commissioning of all 37 turbines, with incidental recording of carcasses also undertaken from February to May 2021 as turbines progressively became operational. Monthly carcass monitoring was undertaken as per the methods prescribed in Section 4.4.2 of the BBAMP and detailed below.

A total of 19 turbines were selected for monitoring based on a 'stratified random' sampling design. This design ensured that the selected turbines are representative of the full spatial extent of the site (including approximately half of the turbines for both the Pyramul and Sallys Flat turbine clusters), the surrounding broad vegetation types and landscape position (**Table 2**). Photographs showing the inner search zone for each of the 19 turbines are provided in **Appendix D**.

Table 2: Selected turbines for carcass monitoring

Pyramul turbine cluster		Sallys Flat turbine cluster
A2	A24	A87
A4	A29	A94
A6	A32	A103
A7	A34	A104
A13	A38	A105
A17	A44	
A20	A52	

All 19 turbines were searched out to 100 m once per month within two designated zones (**Figure 1**):

- Inner zone: the inner zone, a circle with a 60 m radius from the turbine, targets the detection of carcasses of bats and small to large birds. Search transects within this zone are spaced every six metres across this circle
- Outer zone: the outer zone comprises the zone between the 60 m and 100 m radius circles. The outer zone ensures adequate detection of carcasses of medium and large birds, which can fall further away from the turbines. Search transects within this zone are spaced at 12 m and are carried out from the edge of the inner zone out to the edge of the outer zone.

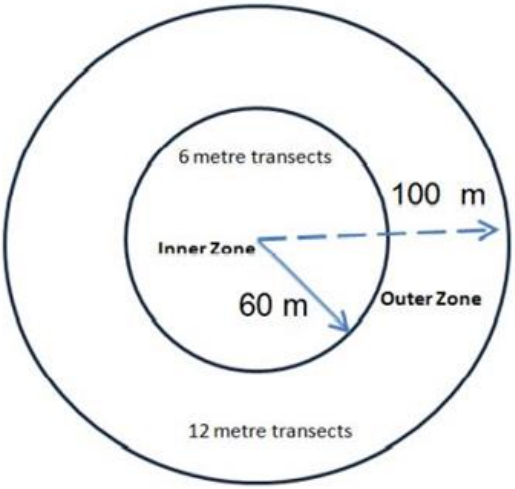

Figure 1: Inner and outer carcass search zones underneath the turbines. Source: CRWF BBAMP 2017

A follow-up 'pulse search' was then undertaken to 60 metres within the inner zone. This pulse search was also undertaken each month and was completed within several days of the first search. Its aim was to detect additional mortality of birds and bats and resulted in each of the 19 selected turbines to be surveyed twice per month. Whilst the same 19 turbines were surveyed each month, the order in which they were surveyed was randomised from month to month, to provide an estimate of overall mortality across the extent of the site that was less impacted by patterns arising from spatial and temporal auto-correlation.

For each carcass detected, the following variables were recorded in the carcass search data sheet:

- GPS position, distance in metres and compass bearing of the carcass from the wind turbine tower.
- Substrate and vegetation under the carcass, particularly if it was found on a track or hard-stand area without vegetation as this may assist in quantifying the number of carcasses not found in areas where ground cover makes carcasses less visible.
- Species, age, number, sex (if possible), signs of injury and estimated date of strike
- Weather (including recent extreme weather events, if any), visibility, maintenance to the turbine and any other factors that may affect carcass discovery; and
- If the species is not able to be immediately identified, photographs will be provided to identified experienced ecologists within 2 business days of the find for identification and the ecologist must reply within 5 business days.

The carcass will be handled according to the standard procedures, outlined in Section 4.4.2 of the BBAMP.

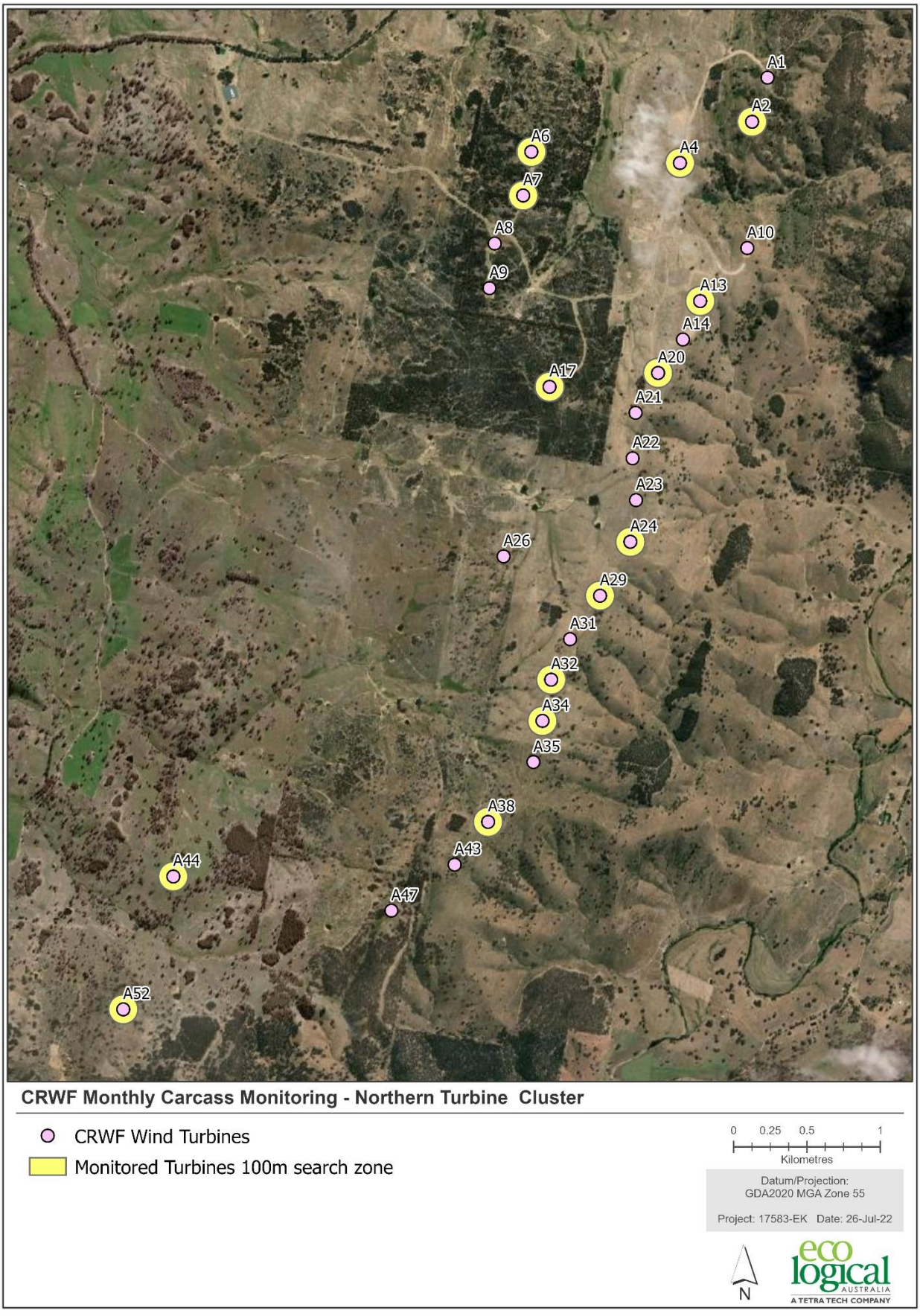

Figure 2: Northern portion (Pyramul cluster) of carcass monitoring turbines

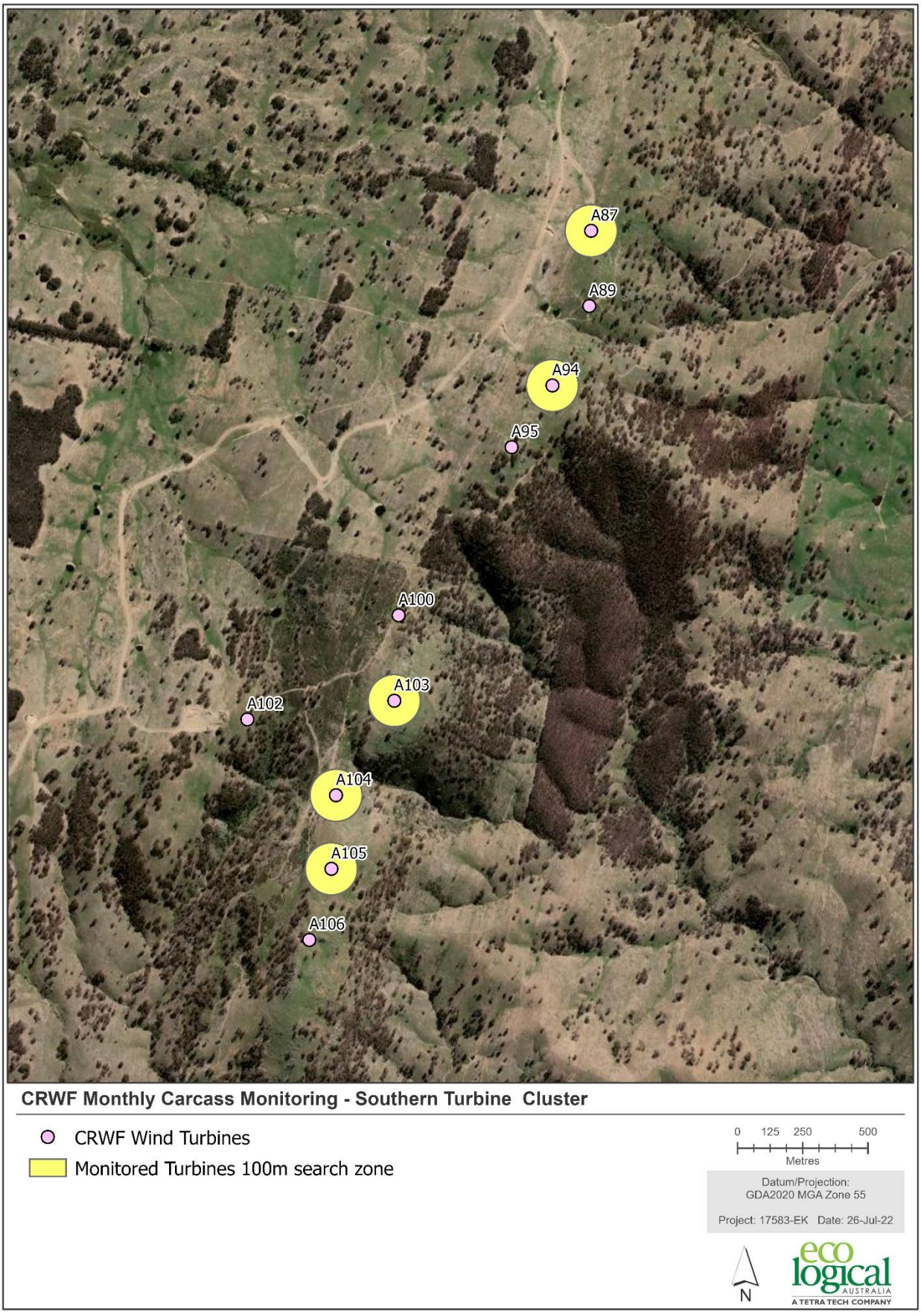

Figure 3: Southern portion (Sallys Flat cluster) of carcass monitoring turbines

2.2 Scavenger trials

Scavenger trials are required to ascertain the rate of carcass removal by scavengers, and thus can be used to develop a 'correction factor' to help inform the estimate of the bat and bird impacts of wind farms. Scavenger trials were undertaken twice during the first year of operational phase monitoring in accordance with the methods prescribed in Section 4.4.3 of the BBAMP and were conducted in August 2021 and April 2022.

The trials were conducted at eight of the same 19 randomly selected turbine sites used for mortality searches. To determine the potentially different scavenging rates on birds and bats, four size classes of carcasses were used (**Table 3**). Where exact carcasses for each size class were unable to be sourced, appropriate replicates were used including mice and rats, as surrogates for microbats and small birds. Carcasses from each size class were randomly placed within areas of varying ground cover (e.g. turbine pad, short grass, long grass) and surrounding vegetation (e.g. grassland, woodland) within the 60 m inner search zone across a total of eight turbines. Each carcass was checked twice daily for the first three days, then daily for two days, then every 48 hours for the following four days and then every three days until they disappeared or the end of the 30-day trial was reached. Remote motion-sensitive cameras were also placed on remaining carcasses at the end of Day One of the April 2022 trial, to record the nature and precise timing of scavenging.

Table 3: Number of replicates for each scavenger trial

Microbat	Small birds	Medium birds	Large birds
10	10	10	5

2.3 Observer trials

Observer detectability trials were undertaken to assess the probability that a searcher will detect an existing carcass. To maximise efficiency, these trials were undertaken concurrently with the monthly carcass searches and scavenger trials detailed above in August 2021 and April 2022. Observer trials involved the following:

- The carcass controller (a person not involved in the monthly carcass searches) will throw each carcass into the air and allow it to land on the ground to simulate at least some of the fall and the potential ruffling of fur and feathers.
- The carcass controller will mark the placement of carcasses with a handheld GPS
- Observers will then be asked to undertake a standard carcass search to locate any specimens placed out (random numbers will be placed out under a turbine including turbines with no carcasses)
- The observers will be personnel who have carried out monthly searches at CRWF to minimise observer variability.

The same carcasses used for the scavenger trials (**Table 3**) were utilised for the observed trials.

2.4 Bird Utilisation Surveys

The Bird Utilisation Survey (BUS) method involves a fixed point 15-minute survey undertaken by one observer, where the abundance of all species visible and/or audible will be recorded along with a range of covariate data including:

- Estimated flight height (in metres)
- Estimated distance from observer
- Bird behaviour (e.g. Flying above canopy; On ground; Nesting).

BUS were conducted in spring 2021 (17 - 27 September) and Autumn 2022 (5 - 6 April). The 14 BUS sites (**Figure 4**) were previously established and surveyed in 2008 and 2009 as part of the CRWF Ecological Assessment (ELA 2012). Each site was surveyed twice across separate days in spring and once in autumn to capture the seasonal variation likely to influence bird species assemblages, richness and abundance.

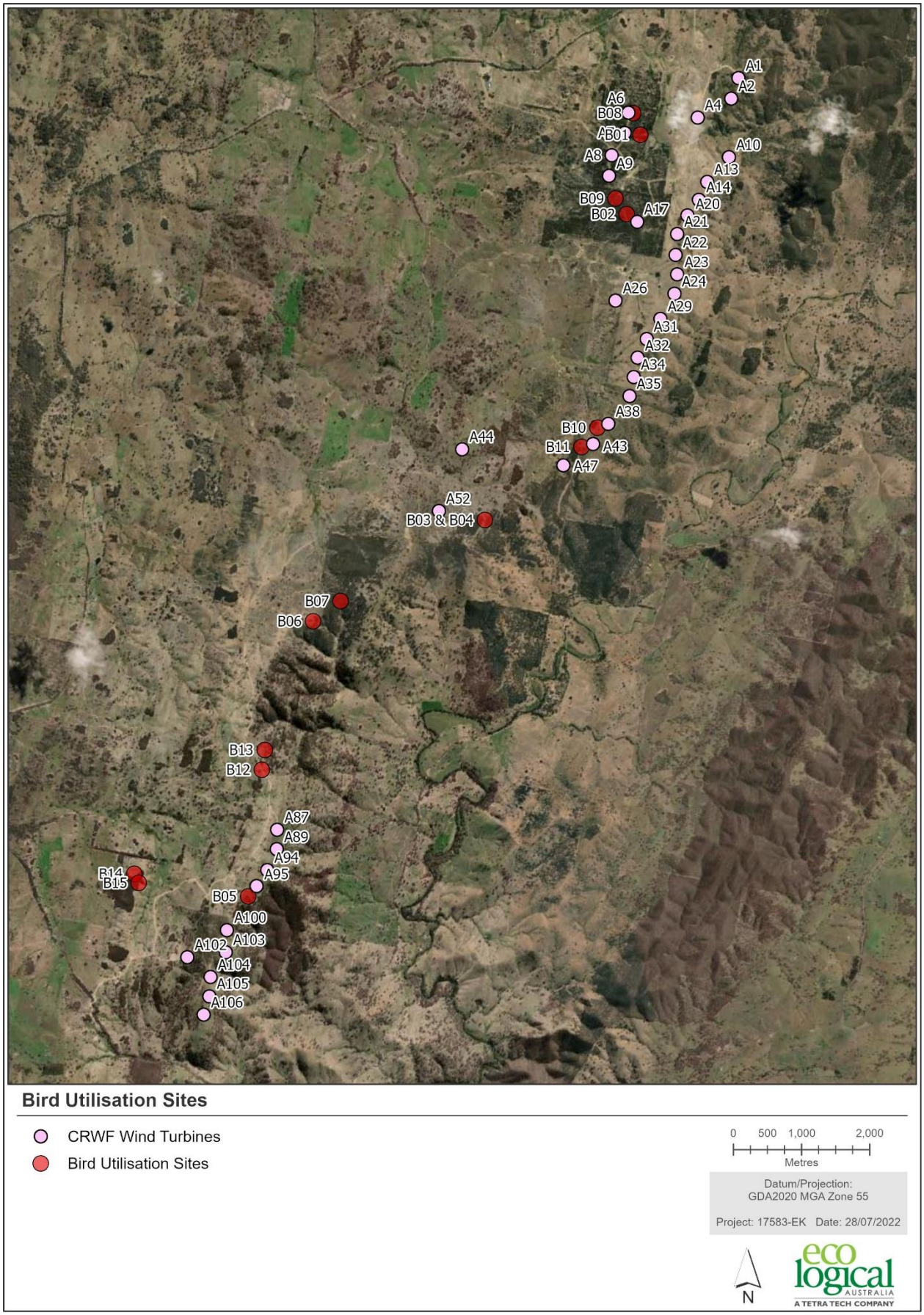

Figure 4: Location of operational phase BUS sites

2.5 Wedge-tailed Eagle (*Aquila audax*) and other raptors

Monitoring of raptor activity was undertaken throughout Year One of operational monitoring. The flight path of all observed raptors was recorded using the digital geo-referenced software program ESRI ArcCollector, with the following covariate data also collected:

- Species
- Quantity
- Flight height (below Rotor Swept Area (RSA), within RSA, above RSA)
- Notes e.g. behaviour, harassment from other species.

Raptor nest searches were undertaken within a 2 km buffer of the CRWF during the spring 2021 BUS, coinciding with the typical breeding season for Wedge-tailed Eagle (July to November). All data including nest locations, species activity and presence were recorded in ArcCollector.

3. Results

3.1 Carcass monitoring

A total of 25 bird and 21 bat carcasses were recorded during Year One of the CRWF BBAMP implementation monitoring. This includes three bat carcasses recorded incidentally before the commencement of formal monitoring in June 2021. Bird carcasses comprised a total of eight bird species, whilst bat carcasses comprised a total of five microchiropteran species and one megachiropteran species. Three unidentified microbat carcasses were also recorded (**Table 4**).

The two most common bird species recorded were *Cracticus tibicen* (Australian Magpie) and Wedge-tailed Eagle, with nine and five carcasses respectively. The two most common bat species recorded were the *Austronomus australis* (White-striped Freetail Bat) and *Vespadelus vulturnus* (Little Forest Bat), also with nine and five carcasses respectively.

No impact triggers were identified for non-threatened species, as the required four or more carcass threshold for a species at a single turbine over two successive monitoring events was not met. No listed threatened species were recorded throughout the first year of monitoring, therefore the threatened species impact trigger was also not met. Detailed carcass monitoring results are presented in **Appendix A**.

Table 4: Bird and bat carcasses recorded from Year One of carcass monitoring

Common Name	Scientific Name	Quantity	Turbine location(s)
Birds			
Australian Magpie	*Cracticus tibicen*	9	A10, A24, A34, A44, A94, A103, A105
Australian Raven	*Corvus coronoides*	1	A104
Australian Wood Duck	*Chenonetta jubata*	1	A06
Brown Falcon	*Falco berigora*	2	A04, A103
Galah	*Eolophus roseicapilla*	1	A32
Nankeen Kestrel	*Falco cenchroides*	5	A13, A23, A100, A104, A105
Pacific Black Duck	*Anas superciliosa*	1	A20
Wedge-tailed Eagle	*Aquila audax*	5	A13, A14, A29, A32
Bats – Microchiroptera			
Gould's Wattled Bat	*Chalinolobus gouldii*	1	A06
Large Forest Bat	*Vespadelus darlingtoni*	1	A01
Little Forest Bat	*Vespadelus vulturnus*	5	A02, A04, A34, A47, A52
Southern Free-tailed Bat	*Mormopterus planiceps*	1	A52
Unknown microbat	Microchiroptera (suborder)	3	A02, A24, A29
White-striped Freetail Bat	*Austronomus australis*	9	A02, A13, A24, A31, A34, A38, A52
Bats – Megachiroptera			
Little Red Flying-fox	*Pteropus scapulatus*	1	A29

Across Year One of carcass monitoring, the number of bird carcasses recorded peaked during spring, whilst microbat carcasses peaked during summer and autumn (**Figure 5**). For each season during which the carcass monitoring was fully implemented (winter 2021 to autumn 2022), the overall quantities of bird and bat carcasses recorded remained relatively consistent with a seasonal range of 4 to 9 bird carcasses and 3 to 5 bat carcasses per season (**Figure 5**). Per month, an average of 1.92 (+/- 1.19) bird and 1.38 (+/- 1.04) bat carcasses were recorded across the Year One of the BBAMP implementation monitoring.

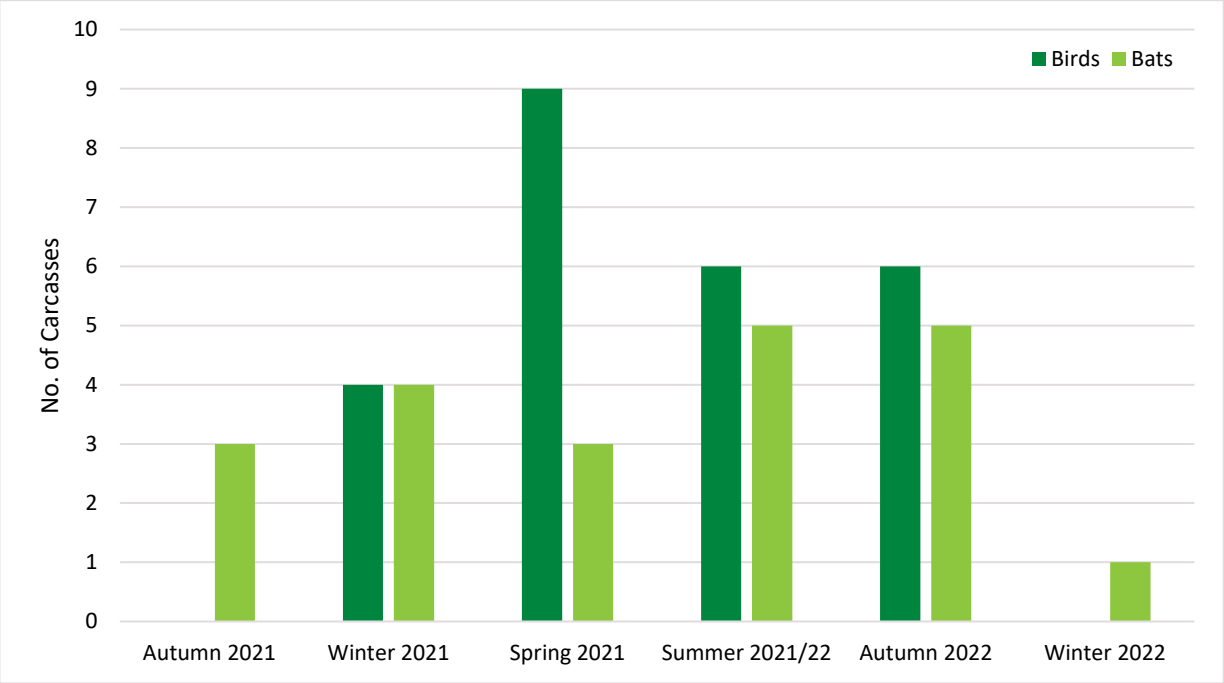

Figure 5: Bird and bat carcass seasonality from Year One of carcass monitoring. Note: autumn 2021 only includes incidental carcass finds recorded before the commencement of the formal monitoring program, and winter 2022 only includes carcasses recorded from June 2022

3.2 Scavenger trials

The results of scavenger trials undertaken in August 2021 and April 2022 are summarised in **Table 5** below and presented in full in **Appendix B**. Across both sets of trials, a higher scavenge rate for smaller carcass sizes (i.e. microbat and small bird) was observable, consistent with results from other Australian wind farms (Stark and Muir 2020). Mean time to removal for microbats and small birds was 3.6 and 3.5 nights respectively, while medium birds and large birds was 11.0 and 21.9 nights (**Table 5**). The majority of large bird carcasses were not removed by the completion of the 30-day trial period so the figure for this carcass class should be considered indicative only, with percentage presence a more accurate scavenge rate for large birds (**Table 5**). This result is consistent with trials undertaken at other Australian wind farms which shows large bird carcasses, such as Wedge-tailed Eagles, are rarely scavenged within 30 days (Stark and Muir 2020). Time to complete carcass removal was noticeably shorter in the April 2022 trial, compared to August 2021 trial for both microbats and small birds, whilst time to complete carcass removal for both medium and large birds remained largely consistent across both trial periods (**Table 5**).

Table 5: Number of nights before carcass removal and percentage of trial carcasses were present before scavenging for both August 2021 and April 2022 trials and overall results for each carcass class

Trial period	Measure	Microbat	Small bird	Medium bird	Large bird
August 2021	Ave. nights	4.9	5.7	11.1	23.0*
	Presence (%)	15.8	18.4	35.8	74.2
April 2022	Ave. nights	2.1	1.2	10.8	20.8*
	Presence (%)	6.9	3.9	36.1	69.2
Total Ave. nights		3.6	3.5	11.0	21.9*
Total presence (%)		11.7	11.2	36.0	71.7

*Average night calculation for large bird carcass size class is indicative only due to carcasses remaining present to the maximum upper-limit of the 30-day trial period

Remote cameras were placed on carcasses to record time and nature of scavenging. The precise time and species responsible for scavenging (complete removal of carcass) was recorded for 12 carcasses, with *Vulpes vulpes* (Red Fox) responsible for seven carcass removals, whilst Australian Raven was responsible for four carcasses and Australian Magpie one (see **Appendix B**). Several other species were recorded partially scavenging carcasses including both *Felis catus* (Feral Cat) and *Capra hircus* (Feral Goat), both of which are declared pest animal species in the region (Central Tablelands Local Land Services 2018).

3.3 Observer trials

The first observer trial undertaken in August 2021 recorded a microbat detection rate of 25%, 50% for small birds, 90% for medium birds and 100% for large birds. The second trial undertaken in April 2022 recorded a microbat detection rate of 80%, 90% for small birds and 100% for medium birds and large birds. Combined, the results from both trials indicate an increased detection rate with increased carcass size, as expected and recorded at other Australian wind farms (Stark and Muir 2020) (**Table 6**). With the exception of the large bird carcass size class which recorded an 100% detection rate in both trials, all other carcass size classes recorded an improved detection rate from the first to second trial (**Table 6**).

Table 6: Observer trial results for both August 2021 and April 2022 trials and total detection rate for each carcass class

Trial period	Microbat	Small bird	Medium bird	Large bird
August 2021	2/8	5/10	9/10	5/5
April 2022	8/10	9/10	10/10	5/5
Total detection rate (%)	55	70	95	100

3.4 Bird Utilisation Surveys

A total of 56 bird species were recorded during spring 2021 BUS, with a total of 68 species recorded during follow up BUS undertaken in autumn 2022. Combined, the total bird species richness recorded during operational phase BUS was 78 species. Bird species richness during spring ranged from 17 species at site B06 to 24 species at site B07, whilst during autumn, site B06 once again recorded the lowest species richness with seven and site B14 the highest species richness with 28. Across both operational phase BUS periods, total species richness per site ranged from 20 at site B06 to 36 at site B14. Average

species richness per site was relatively consistent between both spring and autumn BUS periods at 15 and 17 species respectfully.

Proximity to turbines did not appear to influence species richness at BUS sites, with variable results recorded at sites in closest proximity to turbines, including 28 species (fourth-highest diversity) recorded at site B08 which was located only 30-40 m and well-inside the 'fall zone' of turbine A06 (see **Figure 4**). Proximity and extent of woodland vegetation appears a more important determinant of species richness at BUS sites. This is evident in the varying species richness recorded at site B06 (20 species – lowest diversity) which contained only scattered and isolated woodland patches, compared to the adjacent site B07 (32 species – second-highest diversity) which was located in a relatively large and contiguous patch of woodland.

Acanthiza chrysorrhoa (Yellow-rumped Thornbill) was the most abundant species during the operational phase BUS with a total of 132 individuals recorded, whilst the Australian Magpie was the most common species having been recorded a total of 47 times across all 14 sites. Seven threatened species, all listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act) were recorded during operational phase BUS, along with six raptor species (**Table 7**). The full results of operational phase BUS are presented in **Appendix C.**

Table 7: Threatened species and raptors recorded from BUS data

Common Name	Scientific Name	BC Act	EPBC Act	No. of individuals	Sites
Threatened species					
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V	-	2	B12, B15
Diamond Firetail	*Stagonopleura guttata*	V	-	1	B14
Dusky Woodswallow	*Artamus cyanopterus*	V	-	7	B08, B09
Flame Robin	*Petroica phoenicea*	V	-	2	B10
Scarlet Robin	*Petroica boodang*	V	-	1	B12
Speckled Warbler	*Chthonicola sagittata*	V	-	7	B07, B08, B13
Varied Sittella	*Daphoenositta chrysoptera*	V	-	2	B07
Raptors					
Black-shouldered Kite	*Elanus axillaris*	-	-	1	B14
Brown Falcon	*Falco berigora*	-	-	1	B10
Collared Sparrowhawk	*Accipiter cirrocephalus*	-	-	1	B08
Nankeen Kestrel	*Falco cenchroides*	-	-	1	B06
Wedge-tailed Eagle	*Aquila audax*	-	-	6	B05, B09, B14, B15
Whistling Kite	*Haliastur sphenurus*	-	-	1	B05

V= Vulnerable to extinction

For all individual birds recorded during operational phase BUS, 5.2% were recorded as flying within the turbine Rotor Swept Area (RSA) of 20 – 160 m. Additionally, a pair of Wedge-tailed Eagles were recorded flying above RSA, whilst all remaining flights were recorded below RSA (<20 m). A total of 13 species

were recorded flying within the RSA, including all raptor species listed in **Table 7**, with the exception of Brown Falcon and Nankeen Kestrel. The Wedge-tailed Eagle was the most abundant (four individuals) and common (three records across three sites) raptor species recorded flying within the RSA. One threatened species, *Artamus cyanopterus* (Dusky Woodswallow) was recorded flying within the RSA, with a flock of five recorded at a maximum height of 35 m at site B08.

Australian Raven was the most abundant (22 individuals) and common (seven records across six sites) species recorded flying within the RSA, followed by the Australian Magpie. Both of these species, along with the Wedge-tailed Eagle, were recorded as confirmed fatalities during carcass monitoring (see **Section 3.1**). None of the remaining 10 species recorded flying within RSA height during operational BUS have been recorded during Year One of carcass monitoring. Proximity to turbines did not appear to influence bird flight height, with site B08 recording the highest diversity of species flying within the RSA (five individual species) of any BUS site, despite being located closest to operational turbines.

The relatively low percentage of birds recorded flying within the RSA is also reflected in the bird behaviour results, with only 8.4% of birds recorded 'flying above the canopy'. The predominant observed behaviour of birds during the operational phase BUS was of birds 'flying within the canopy' and 'in tree', or a combination of these behaviours. This observed behaviour, along with the typically low height of the canopy across the CWRF (6-12 m) and the relatively low percentage of birds flying within the RSA, is indicative of the overall low risk posed by the operation of the CRWF on the majority bird species and general bird activity.

3.4.1 Comparison with pre-approval surveys

Bird surveys were undertaken as part of the CRWF ecological assessment (ELA 2012) during November 2008 and January 2009. As these surveys were undertaken for the purpose of an impact assessment, they were undertaken across a broad area which extended beyond the final footprint of CRWF and involved a variety of methods including both nocturnal and diurnal surveys. Additionally, the full list of species, their relative quantities and results per site recorded during pre-approval surveys is not available. Given this, direct comparison with operational phase BUS is not possible. However, the results of both sets of surveys can be broadly compared based on available information as presented in **Table 8** below.

Table 8: Summarised results of pre-approval bird surveys and operational phase BUS

Survey period	Sites	Survey effort	Total species richness	Threatened species richness	Raptors
Pre-approval (Nov 2008, Jan 2009)	14 diurnal sites, 2 nocturnal sites	50 diurnal surveys, 10 nocturnal surveys	93 (includes opportunistic records)	6	4
Operational phase (Sept 2021, April 2022)	14 diurnal sites	42 surveys	78	7	6

Allowing for the overall greater survey effort during the pre-approval works, the results from operational phase BUS are largely consistent with that of the pre-approval surveys. Whilst the operational phase BUS recorded 15 fewer species than the pre-approval bird surveys, the 15 most common species

recorded in pre-approval surveys were also recorded during operational phase BUS. A greater quantity of threatened species and raptor species were also recorded in operational phase BUS compared to pre-approval bird surveys (**Table 8**).

3.5 Wedge-tailed Eagle and other raptors

The flight paths of eight raptor species were recorded during Year One of CRWF operational monitoring (**Table 9**). This includes one threatened raptor *Lophoictinia isura* (Square-tailed Kite) which is listed as vulnerable under the NSW BC Act and recorded opportunistically on one occasion. The Wedge-tailed Eagle was by far the most common and abundant raptor recorded, with a total of 33 flights recorded and tracked. This species has been recorded across the full extent of CRWF, however, both individuals and adult pairs are frequently recorded in the far northern (near turbine A02) and far southern (near turbine A106) sections of the site (**Figures 6-7**). Five Wedge-tailed Eagle carcasses from January to May 2022 have been recorded during carcass monitoring (see **Appendix A**). This coincided with an increased observation of flight activity during the same time period as observed through both BUS and incidental observations. Whilst this increased activity appears correlated with the observed increased mortality, it also demonstrates that relatively large numbers of Wedge-tailed Eagles are continuing to use the CRWF site and surrounds despite these fatalities and the ongoing operation of the site.

Of interest, all five Wedge-tailed Eagle carcasses recorded have been sub-adult birds, whilst the majority of records for the same period were of adult birds, including the aforementioned adult pairs, likely to be resident across the site. It is likely that some of the sub-adult mortality is from non-resident birds which are typically highly mobile (Debus 2019) and are also unlikely to be familiar with the site, hence placing these birds at greater risk of collision.

Falco cenchroides (Nankeen Kestrel) was the only other raptor to be recorded on multiple occasions, with a total of 11 flights recorded and tracked. All raptor species with the exception of *Falco berigora* (Brown Falcon) and *Accipiter fasciatus* (Brown Goshawk), were recorded flying within the RSA and as shown in **Figures 6-7**, several species were recorded flying in close proximity to operational turbines. The Brown Falcon is, however, know to fly within the RSA with two confirmed fatalities recorded during Year One of carcass monitoring (see **Section 3.1**).

Table 9: Observed raptor flights taken from incidental observations and BUS

Common Name	Scientific Name	BC Act	EPBC Act	No. of individuals	No. of flights	Below RSA	Within RSA	Above RSA
Black-shouldered Kite	*Elanus axillaris*	-	-	1	1	0	1	0
Brown Falcon	*Falco berigora*	-	-	1	1	1	0	0
Brown Goshawk	*Accipiter fasciatus*	-	-	1	1	1	0	0
Collared Sparrowhawk	*Accipiter cirrocephalus*	-	-	1	1	0	1	0
Nankeen Kestrel	*Falco cenchroides*	-	-	11	11	7	4	0
Square-tailed Kite	*Lophoictinia isura*	V	-	1	1	0	1	0
Wedge-tailed Eagle	*Aquila audax*	-	-	45	33	6	17	10
Whistling Kite	*Haliastur sphenurus*	-	-	1	1	0	1	0

V= Vulnerable to extinction

Searches were undertaken for Wedge-tailed Eagle and other raptor nest during spring 2021, within a 2 km buffer of the CRWF. No nests were recorded, as was also the case following the completion of pre-approval surveys.

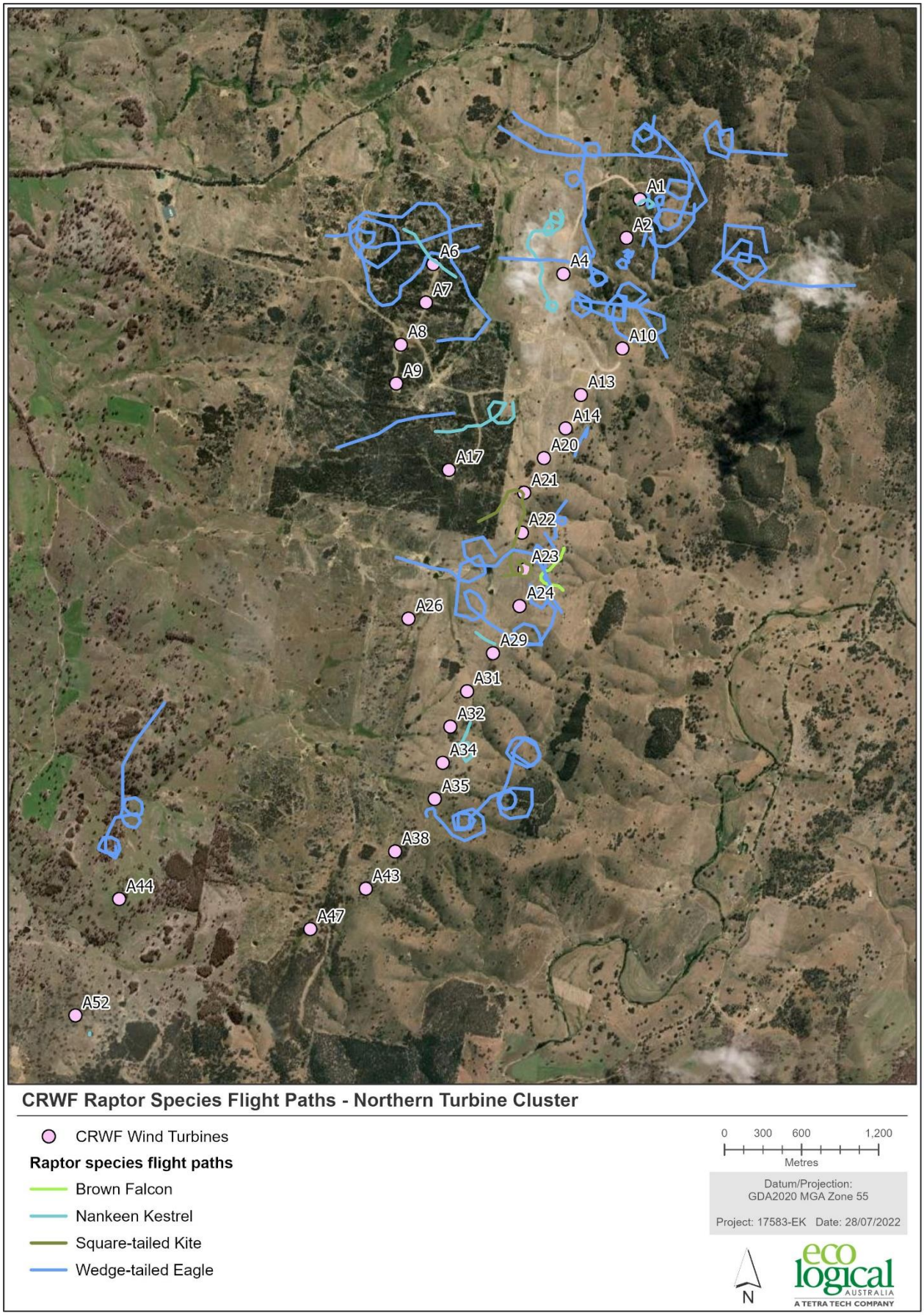

Figure 6: Raptor flight paths adjacent to northern (Pyramul cluster) portion of turbines

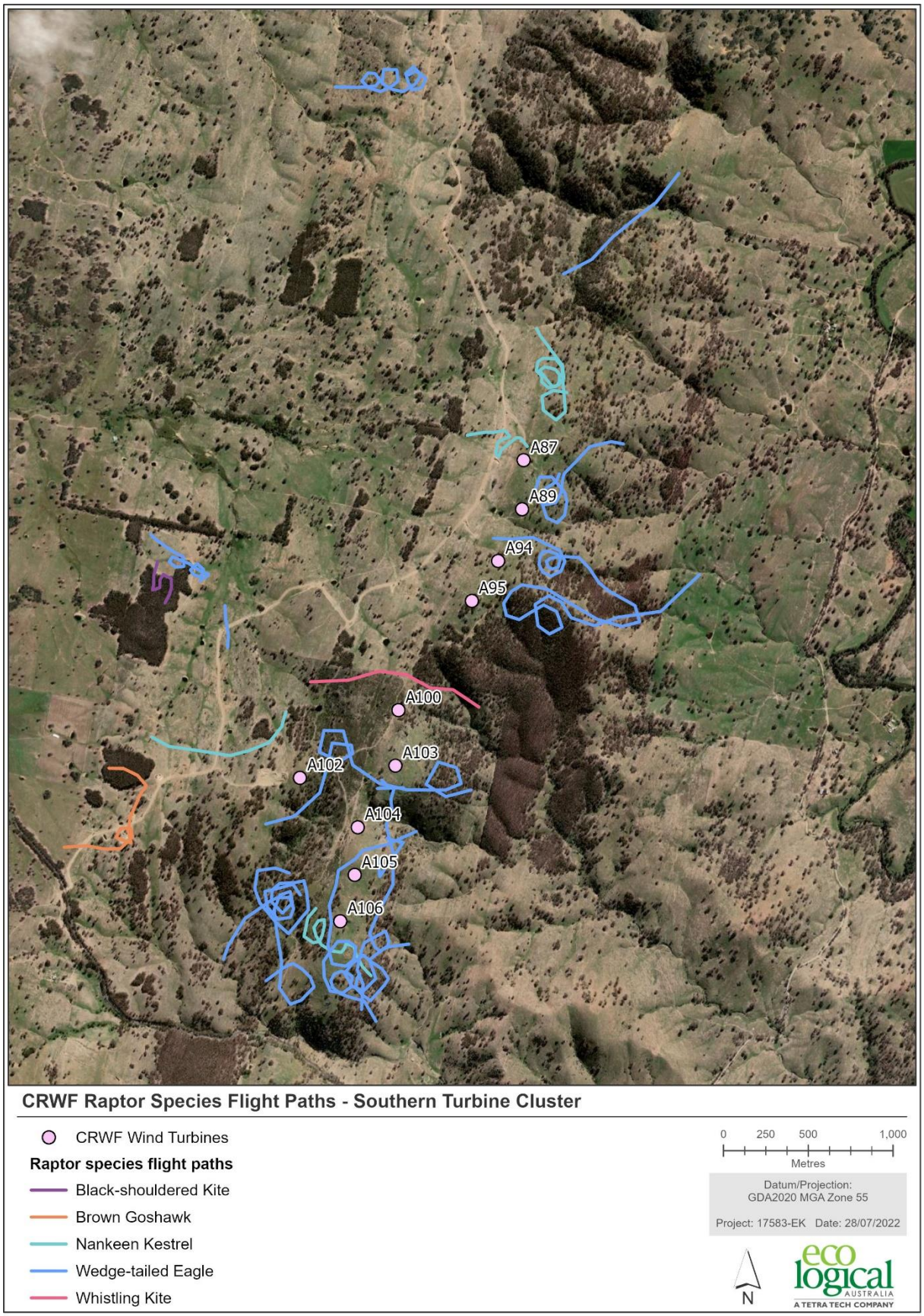

Figure 7: Raptor flight paths adjacent to southern (Sallys Flat cluster) portion of turbines

4. Discussion

The CRWF BBAMP outlines the monitoring requirements and performance criteria to be achieved with regards to the management of bird and bat species. The following section provides a summary of progress against each monitoring requirement and/or performance criteria relevant to Year One implementation of the BBAMP.

4.1 Progress of management objectives and completion criteria

Table 10 below details the specific management objectives and performance criteria relevant to the implementation of the BBAMP, along with a comment regarding relevant results and adherence based on Year One operational phase monitoring. All management objectives and performance criteria are currently being achieved.

Table 10: Management objectives and performance criteria and relevant results from Year One monitoring

Management objectives	Management activities	Performance criteria	Comments
Baseline surveys	Obtain pre-construction baseline and operational phase bird and bat utilisation and mortality data.	Baseline bird and bat surveys completed; BUS (operational phase) undertaken as detailed in the BBAMP.	Both baseline and operational phase surveys completed and available data from both survey periods compared (**section 3.4.1**).
Mortality monitoring	18 turbines to be searched each month to 100 m in accordance with the inner- and outer zone search protocol. The same turbines will be searched each month for a period of 24 months, following which the need for further surveys will be reviewed.	Operational phase mortality surveys undertaken monthly at a minimum of 18 turbines and for at least two years, with a review after the first years to determine if a change in the methodology is required.	Year One of monthly carcass mortality monitoring successfully completed across 19 selected turbines (**section 3.1**); No threatened species or non-threatened species impact triggers initiated from Year One results.
Scavenger and observer trials	Undertake two scavenger and detector efficiency (observer) trials in Year One of as detailed in the BBAMP.	Scavenger and detector efficiency (observer) trials undertaken.	Scavenger and observer trials successfully completed (**section 3.2 - 3.3**.
Annual reports	Preparation of annual reports to be submitted to relevant State and Commonwealth departments for the first two years after the completion of yearly monitoring activities.	Annual reports to be delivered within three months of completion of yearly monitoring; Annual reports to include results of yearly monitoring, any impact triggers or unacceptable impacts identified, mitigation measures implemented, application of the decision making framework and	This annual report (to be provided to State and Commonwealth departments) details all relevant results from Year one implementation monitoring.

Management objectives	Management activities	Performance criteria	Comments
		recommendations for the following year.	
Mitigation measures to reduce risk	Carrion removal program – stock and kangaroo carcasses will be removed from within 200 m of wind turbines on a monthly basis and disposed of; Restrict lambing and grain stock feeding within 200 m of turbines; Minimise external and internal lighting; Where required - use of visual deterrents (e.g. marker balls and/or flags) on overhead powerlines where they cross waterways.	Carcasses removed and activity recorded in management log book; No increase in raptor mortality during lambing season or due to grain feeding; Mortality at turbines near light sources does not significantly exceed that at unlit turbines. No incidental records of bird mortality from powerline collision around waterways.	Dead sheep identified for removal at turbines A04 and A34; No increase in raptor mortalities recorded in 2021 lambing season (August 2021). All turbines are located away from major light sources; No incidental records of bird mortality have been recorded underneath powerlines around waterways.

5. Conclusion and Recommendations

5.1 General conclusions

Year One operational phase monitoring of the CRWF BBAMP was successfully implemented from June 2021 to June 2022. The purpose of the monitoring program is to monitor the impacts from the operation of the CRWF on birds and bats through a range of methodologies, and effectively mitigate and manage any significant risks or impacts which arise.

Monthly carcass monitoring was undertaken across 19 selected turbines within a 60 m inner and 100 m outer search zone. A total of 25 bird carcasses and/or identifiable remains from eight species were recorded. A total of 21 bat carcasses and/or identifiable remains from five microbat and one megabat (flying-fox) species were recorded, with three of the microbat carcasses unable to be identified to an individual species (**section 3.1**). In no instances were four or more carcasses from the same non-threatened bird or bat species recorded at the same turbine during successive searches and as such, the impact trigger for non-threatened species was not exceeded in Year One of monitoring. Additionally, no threatened species carcasses were recorded during either monthly monitoring or opportunistically, and as a result, the impact trigger for threatened species was also not exceeded.

Two scavenger and observer trials were completed concurrently in August 2021 and April 2022. During each trial a total of 35 bird and bat carcasses from four different size classes were deployed to measure scavenging rate and observer detectability. Consistent with other trials undertaken across Australian wind farms, the overall scavenger rate was higher (fewer days passing before complete scavenger removal) for the smaller carcass size classes (microbats and small birds) compared to larger carcass size classes (medium and large birds) (**Table 5**). Similarly, larger carcass class sizes recorded a higher detectability rate (greater number of carcasses detected), compared to smaller size classes (**Table 6**), as has also been observed across other Australian wind farms.

Operational phase BUS were undertaken during spring 2021 and autumn 2022 across 14 sites previously established and surveyed during pre-approval surveys for the CRWF ecological assessment (ELA 2012). A total of 78 bird species were recorded across both surveys, including seven threatened species listed as vulnerable under the NSW BC Act, and six raptor species. 5.2% of all recorded flights occurred within the RSA and proximity to turbines did not appear to influence flight height. Overall, operational phase BUS results were comparable to pre-approval bird survey results based on total and common species richness, as well as both threatened and raptor species richness (**section 3.4.1**). The overall results of operational phase BUS monitoring do not indicate any significant changes to bird utilisation or species assemblages due to the operation of the CRWF.

The same conclusion can be drawn from the results of raptor activity monitoring which recorded a total of eight raptor species during Year One implementation monitoring, including four species not previously recorded during pre-approval surveys (**Table 9**). Whilst confirmed fatalities have been recorded for Brown Falcon, Nankeen Kestrel and Wedge-tailed Eagle during carcass monitoring, individuals of these species continue to be recorded across the wind farm, including adult Wedge-tailed Eagle pairs which are consistently recorded. The quantity of Wedge-tailed Eagle carcasses recorded during Year One of monitoring is consistent with that recorded at the nearby Bodangora Wind Farm and more broadly, across other operational Australian wind farms in rural landscapes (Nature Advisory

2020). Ongoing close monitoring of raptor activity and mortality will continue in Year Two of operational phase monitoring, as detailed in the BBAMP.

Given the successful implementation of Year One of the CRWF BBAMP monitoring program, CWPR are considered compliant with the relevant approval conditions with regards to bird and bats, as detailed in the BBAMP.

5.2 General recommendations

Based on the results detailed in this report, it is recommended that bird and bat monitoring continue as specified in the CRWF BBAMP for Year Two of operations. Extrapolation of carcass monitoring results across the whole of CRWF will be undertaken following the completion of Year Two monitoring when sufficient data will be available to allow such analysis. The framework of the BBAMP allows for an adaptive management approach, so should results during Year Two indicate the potential for significant impacts to birds or bats, or other significant changes to environmental conditions, appropriate management and mitigation measures as detailed in the BBAMP should be implemented.

References

Central Tablelands Local Land Services 2018. *Central Tablelands Regional Strategic Pest Animal Management Plan 2018-2023*. State of New South Wales.

CWP Renewables Pty Ltd (CWPR) 2017. *Crudine Ridge Wind Farm Bird and Bat Adaptive Management Plan*. Prepared by Brett Lane & Associates.

Debus, S 2019. *Birds of Prey of Australia – A Field Guide*. CSIRO Publishing, Melbourne.

Eco Logical Australia (ELA) 2012. *Crudine Ridge Wind Farm Ecological Assessment*. Prepared for CWP Renewables Pty Ltd.

Nature Advisory 2020. *Bodangora Wind Farm Annual Report on the Implementation of the Bird and Bat Management Plan*. Prepared for Bodangora Wind Farm Pty Ltd.

Stark, E and Muir, S 2020. *Post Construction Bird and Bat Monitoring at Wind Farms in Victoria*.

Appendix A Carcass monitoring data

Table 11: Monthly carcass monitoring data – Year One of operational phase monitoring

	Common Name	Turbine Number	Distance from Turbine (m)	Bearing from Turbine (degrees)	Groundcover beneath carcass	Monitoring methodology
3/03/2021	White-striped Freetail Bat	A24	13	N/A	Hardstand (e.g. pad/road)	Incidental
3/03/2021	Unknown Microbat	A24	15	N/A	Hardstand (e.g. pad/road)	Incidental
29/03/2021	Large Forest Bat	A01	5	N/A	Hardstand (e.g. pad/road)	Incidental
1/06/2021	Little Red Flying-fox	A29	56	75	Native grass and herbs	Formal
7/06/2021	Nankeen Kestrel	A23	14	10	Hardstand (e.g. pad/road)	Incidental
7/06/2021	Little Forest Bat	A47	44	30	Hardstand (e.g. pad/road)	Incidental
10/08/2021	Little Forest Bat	A34	8	350	Hardstand (e.g. pad/road)	Formal
10/08/2021	Unknown Microbat	A02	30	270	Hardstand (e.g. pad/road)	Formal
11/08/2021	Australian Magpie	A44	30	36	Native grass and herbs	Formal
21/08/2021	Australian Magpie	A24	5	100	Hardstand (e.g. pad/road)	Formal
23/08/2021	Australian Magpie	A10	20	N/A	Hardstand (e.g. pad/road)	Incidental
8/09/2021	Nankeen Kestrel	A13	36	100	Native grass and herbs	Formal
8/09/2021	Australian Magpie	A44	2	90	Hardstand (e.g. pad/road)	Formal
10/09/2021	Australian Raven	A104	74	315	Native grass and herbs	Formal
7/10/2021	Brown Falcon	A04	33	130	Hardstand (e.g. pad/road)	Formal
9/10/2021	Australian Magpie	A44	1	0	Hardstand (e.g. pad/road)	Formal
10/10/2021	Brown Falcon	A103	42	90	Native grass and herbs	Formal
11/10/2021	White-striped Freetail Bat	A34	35	310	Native grass and herbs	Formal
1/11/2021	White-striped Freetail Bat	A13	10	340	Hardstand (e.g. pad/road)	Formal
5/11/2021	Australian Magpie	A103	2	5	Hardstand (e.g. pad/road)	Formal

	Common Name	Turbine Number	Distance from Turbine (m)	Bearing from Turbine (degrees)	Groundcover beneath carcass	Monitoring methodology
5/11/2021	White-striped Freetail Bat	A38	7	135	Hardstand (e.g. pad/road)	Formal
5/11/2021	Galah	A32	80	40	Native grass and herbs	Formal
15/11/2021	Nankeen Kestrel	A105	40	135	Native grass and herbs	Formal
5/12/2021	Australian Wood Duck	A06	20	270	Bare soil / rock	Formal
6/12/2021	Australian Magpie	A105	40	180	Bare soil / rock	Formal
10/12/2021	White-striped Freetail Bat	A31	30	350	Hardstand (e.g. pad/road)	Incidental
4/01/2022	Wedge-tailed Eagle	A29	45	180	Hardstand (e.g. pad/road)	Formal
6/01/2022	White-striped Freetail Bat	A02	30	360	Hardstand (e.g. pad/road)	Formal
6/01/2022	Nankeen Kestrel	A100	30	360	Hardstand (e.g. pad/road)	Incidental
6/01/2022	Australian Magpie	A34	10	225	Bare soil / rock	Formal
12/01/2022	White-striped Freetail Bat	A38	27	355	Hardstand (e.g. pad/road)	Formal
31/01/2022	White-striped Freetail Bat	A38	50	300	Native grass and herbs	Formal
1/02/2022	White-striped Freetail Bat	A52	5	245	Hardstand (e.g. pad/road)	Formal
2/02/2022	Pacific Black Duck	A20	22	20	Hardstand (e.g. pad/road)	Formal
2/03/2022	Little Forest Bat	A52	25	200	Hardstand (e.g. pad/road)	Formal
2/03/2022	Southern Free-tailed Bat	A52	90	180	Native grass and herbs	Formal
2/03/2022	Unknown Microbat	A29	5	223	Hardstand (e.g. pad/road)	Formal
3/03/2022	Australian Magpie	A94	170	320	Hardstand (e.g. pad/road)	Formal
28/03/2022	Wedge-tailed Eagle	A14	6	280	Hardstand (e.g. pad/road)	Incidental
5/04/2022	Little Forest Bat	A04	14	200	Bare soil / rock	Formal

	Common Name	Turbine Number	Distance from Turbine (m)	Bearing from Turbine (degrees)	Groundcover beneath carcass	Monitoring methodology
5/04/2022	Wedge-tailed Eagle	A32	40	270	Bare soil / rock	Formal
5/04/2022	Little Forest Bat	A02	45	350	Hardstand (e.g. pad/road)	Formal
5/05/2022	Nankeen Kestrel	A104	10	350	Hardstand (e.g. pad/road)	Formal
6/05/2022	Wedge-tailed Eagle	A32	15	N/A	Hardstand (e.g. pad/road)	Formal
9/05/2022	Wedge-tailed Eagle	A13	5	200	Hardstand (e.g. pad/road)	Formal
2/06/2022	Gould's Wattled Bat	A06	3	15	Hardstand (e.g. pad/road)	Formal

Appendix B Scavenger trial data

Table 12: August 2021 Scavenger trial data

Turbine	Carcass Class	Carcass species	Date removed	Days present	% of trial present
A7	Microbat	White Mouse	12/08/2021	2	6.4
	Microbat	White Mouse	20/08/2021	10	32.3
	Small bird	White Rat	16/08/2021	6	19.4
	Small bird	White Rat	20/08/2021	10	32.3
	Large bird	Rooster	N/A	31	100
A2	Small bird	White Rat	12/08/2021	2	6.4
	Small bird	White Rat	23/08/2021	13	41.9
	Medium bird	Eastern Rosella	11/08/2021	1	3.2
	Medium bird	Southern Boobook	16/08/2021	6	19.4
A13	Medium bird	Australian Wood Duck	N/A	31	100
	Medium bird	Australian Wood Duck	30/08/2021	20	64.5
	Microbat	Little Forest Bat	20/08/2021	10	32.3
	Microbat	Little Forest Bat	20/08/2021	10	32.3
A20	Small bird	White Rat	12/08/2021	2	6.4
	Small bird	Striated Thornbill	12/08/2021	2	6.4
	Medium bird	Galah	14/08/2021	4	12.9
	Medium bird	Nankeen Kestrel	14/08/2021	4	12.9
	Large bird	Australian Magpie	6/09/2021	27	87.1
A29	Microbat	Little Forest Bat	12/08/2021	2	6.4
	Microbat	White Mouse	11/08/2021	1	3.2
	Medium bird	Galah	12/08/2021	2	6.4
	Medium bird	Little Red Flying-fox	N/A	31	100
A34	Microbat	House Mouse	11/08/2021	1	3.2
	Microbat	Southern Free-tailed Bat	23/08/2021	13	41.9
	Small bird	White Rat	11/08/2021	1	3.2
	Small bird	White Rat	11/08/2021	1	3.2
	Large bird	Sulphur-crested Cockatoo	N/A	31	100
A38	Small bird	White Rat	20/08/2021	10	32.3
	Small bird	White Rat	20/08/2021	10	32.3
	Medium bird	Galah	20/08/2021	10	32.3
	Large bird	Pied Currawong	30/08/2021	20	64.5

Turbine	Carcass Class	Carcass species	Date removed	Days present	% of trial present
A52	Microbat	White Mouse	10/08/2021	0	0
	Microbat	White Mouse	10/08/2021	0	0
	Medium bird	Southern Boobook	12/08/2021	2	6.4
	Large bird	Chicken	16/08/2021	6	19.4

Table 13: April 2022 Scavenger trial data

Turbine	Carcass class	Carcass species	Date/time removed	Scavenger species	Days present	% of trial present
A04	Microbat	White-striped Free-tailed Bat	4/04/2022	N/A	0.5	1.7
	Microbat	White-striped Free-tailed Bat	4/04/2022	N/A	0.5	1.7
	Large bird	Australian Wood Duck	7/04/22 8:32pm	Red Fox	3.5	11.7
	Medium bird	Australian Magpie	-	N/A	30	100
A07	Microbat	Southern Free-tailed Bat	13/04/2022	N/A	12.5	41.7
	Microbat	White-striped Free-tailed Bat	4/04/2022	N/A	0.5	1.7
	Small bird	Little Lorikeet	4/04/2022	N/A	0.5	1.7
	Small bird	Tree Martin	7/04/22 9:08pm	Red Fox	3.5	11.7
	Large bird	Wedge-tailed Eagle	-	N/A	30	100
A14	Large bird	Wedge-tailed Eagle	-	N/A	30	100
	Medium bird	Australian Magpie	-	N/A	30	100
	Medium bird	Galah	7/04/2022	N/A	3	10
	Small bird	Masked Lapwing (chick)	4/04/2022	N/A	0.5	1.7
	Microbat	White-striped Free-tailed Bat	6/04/22 9:21am	Australian Magpie	2	6.7
A29	Medium bird	Grey-headed Flying-fox	6/04/22 8:03pm	Scavenged by Australian Raven, removed by Red Fox	2.5	8.3
	Medium bird	Galah	5/04/22 4:25pm	Australian Raven	1	3.3

Turbine	Carcass class	Carcass species	Date/time removed	Scavenger species	Days present	% of trial present
	Microbat	Little Forest Bat	4/04/2022	N/A	0.5	1.7
	Small bird	House Mouse	4/04/2022	N/A	0.5	1.7
A38	Large bird	Australian Wood Duck	-	N/A	30	100
	Small bird	Musk Lorikeet	4/04/2022	N/A	0.5	1.7
	Small bird	Rainbow Lorikeet	4/04/2022	N/A	0.5	1.7
A52	Microbat	Little Forest Bat	4/04/2022	N/A	0.5	1.7
	Microbat	White-striped Free-tailed Bat	5/04/2022	N/A	1	3.3
	Medium bird	Little Corella	4/04/2022	N/A	0.5	1.7
	Medium bird	Little Corella	4/04/2022	N/A	0.5	1.7
A94	Small bird	House Mouse	4/04/22 6:12pm	Australian Raven	0.5	1.7
	Small bird	House Mouse	5/04/22 8:00am	Australian Raven	1	3.3
	Medium bird	Australian Magpie	9/04/22 9:50pm	Red Fox	30	100
	Medium bird	Galah	5/04/22 5:01am	Red Fox	1	3.3
	Large bird	Sulphur-crested Cockatoo	5/04/22 6:01am	Red Fox	1	3.3
A103	Small bird	House Mouse	5/04/22 4:31pm	Australian Raven	1	3.3
	Small bird	House Mouse	7/04/2022	Unknown - Not recorded on camera	3	10
	Medium bird	White-throated Nightjar	7/04/2022	Unknown - Not recorded on camera	3	10
	Medium bird	Nankeen Kestrel	21/04/22 9:47pm	Red Fox	17.5	58.3
	Large bird	Wedge-tailed Eagle	-	N/A	30	100

Appendix C Bird Utilisation Survey data

Table 14: Operational phase BUS data

Common Name	B01	B02	B03 & B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	Sites	Abundance
Australian King-Parrot						2								2	**2**	**4**
Australian Magpie	5	6	6	4	6	11	8	5	7	6	8	10	16	4	**14**	**102**
Australian Pipit		1									2				**2**	**3**
Australian Raven	4	2	5	5	6	1	3	5	2	2	8	5	4	10	**14**	**62**
Black-faced Cuckoo-shrike		1				2			1	1	1		1	2	**7**	**9**
Black-shouldered Kite													1		**1**	**1**
Brown Falcon									1						**1**	**1**
Brown Thornbill	1	1				2	5	3	1						**6**	**13**
Brown Treecreeper (eastern subspecies)											1			1	**2**	**2**
Brown-headed Honeyeater				8		1		2		2		1	1		**6**	**15**
Buff-rumped Thornbill	10	6	2		6	1	13	9	3	2	2	1	3	7	**13**	**65**
Collared Sparrowhawk							1								**1**	**1**
Common Starling			5				2								**2**	**7**
Crested Pigeon													2		**1**	**2**
Crimson Rosella	4		10	5	4	14	6		2				2	10	**9**	**57**
Diamond Firetail													1		**1**	**1**
Double-barred Finch				4				6							**2**	**10**
Dusky Woodswallow							5	2							**2**	**7**

Common Name	B01	B02	B03 & B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	Sites	Abundance
Eastern Rosella			2	6	2	4			4	8	5		3	4	**9**	**38**
Eastern Spinebill	1	1				2	3	3				1			**6**	**11**
Eastern Yellow Robin		1				1	1				3	1			**5**	**7**
Fan-tailed Cuckoo		1	1												**2**	**2**
Flame Robin									2						**1**	**2**
Galah			7						5				2		**3**	**14**
Golden Whistler						1	1						1		**3**	**3**
Grey Butcherbird					1	1		1	1	2	1	1	2		**8**	**10**
Grey Fantail	2		2	1		4		3		3	1	2	1	2	**10**	**21**
Grey Shrike-thrush	2		1			1	1						1	1	**6**	**7**
Laughing Kookaburra	2	1			2	1	2		3	3			2		**8**	**16**
Leaden Flycatcher			1												**1**	**1**
Magpie-lark				2				1		2			2	2	**5**	**9**
Mistletoebird	1		1	1		1									**4**	**4**
Musk Lorikeet				4											**1**	**4**
Nankeen Kestrel					1										**1**	**1**
Noisy Friarbird			5		2	4				2			1		**5**	**14**
Noisy Miner					1				5		3				**3**	**9**
Olive-backed Oriole								1							**1**	**1**
Pallid Cuckoo												1			**1**	**1**
Pied Butcherbird		2	1						1		1		1		**5**	**6**
Pied Currawong	5		1			4	3	4	1	2	1	1	1	1	**11**	**24**
Rainbow Bee-eater							2								**1**	**2**

Common Name	B01	B02	B03 & B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	Sites	Abundance
Rainbow Lorikeet														4	**1**	**4**
Red Wattlebird	1			1		1		2		1	2		2	1	**8**	**11**
Red-browed Finch								3							**1**	**3**
Red-rumped Parrot				2					7		2				**3**	**11**
Rufous Whistler	4		2				3	3		2			1		**6**	**15**
Scarlet Honeyeater													1		**1**	**1**
Scarlet Robin											1				**1**	**1**
Southern Boobook													1		**1**	**1**
Southern Whiteface													2		**1**	**2**
Speckled Warbler						2	2					3			**3**	**7**
Spotted Pardalote	3	2	6	2		4	4	2		1		5	5	2	**11**	**36**
Striated Pardalote	2		4	1	2	3	2	2	1	3		5	5	3	**12**	**33**
Striated Thornbill	4	14	10	5	8	13	4	8	2	7	2	5	8	2	**14**	**92**
Sulphur-crested Cockatoo									1						**1**	**1**
Superb Fairy-wren	11	7	2		4		14	6							**6**	**44**
Tree Martin											1	5			**2**	**6**
Varied Sittella						2	5								**2**	**7**
Variegated Fairy-wren								4							**1**	**4**
Wedge-tailed Eagle				2				1					1	2	**4**	**6**
Weebill	3	1	6	2	2	2		8		3		6	3	4	**11**	**40**
Welcome Swallow			1						2						**2**	**3**
Whistling Kite				1											**1**	**1**
White-browed Scrubwren							2								**1**	**2**

Common Name	B01	B02	B03 & B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	Sites	Abundance
White-browed Woodswallow				6											**1**	**6**
White-eared Honeyeater	5			1	1	3								1	**5**	**11**
White-faced Heron								1							**1**	**1**
White-naped Honeyeater				4				2			1	5			**4**	**12**
White-plumed Honeyeater				2	2				2				1		**4**	**7**
White-throated Gerygone	2	1				1	2	1			1	1			**7**	**9**
White-throated Treecreeper	4	1	3	4	2	5	3	3		3	3	1	3	3	**13**	**38**
White-winged Chough	16	6				25	12				8				**5**	**67**
White-winged Triller										1					**1**	**1**
Willie Wagtail			5	2	3			2	2	3	2		2	4	**9**	**25**
Yellow Thornbill		4		2		4	6						7		**5**	**23**
Yellow-faced Honeyeater	6	4		8	1	9	8	2	2	1		2	2	7	**12**	**52**
Yellow-rumped Thornbill	6	4	14	31	5		4	3	26	10	13	11	4	8	**13**	**139**
Yellow-tufted Honeyeater		2													**1**	**2**
Species Richness	**24**	**22**	**25**	**27**	**20**	**32**	**29**	**30**	**24**	**23**	**24**	**21**	**36**	**24**		
Abundance	**104**	**69**	**103**	**116**	**61**	**132**	**127**	**98**	**84**	**70**	**73**	**73**	**96**	**87**		

Appendix D Turbine search area photos

Turbine A2

Turbine A4

Turbine A6

Turbine A7

Turbine A13

Turbine A17

Turbine A20

Turbine A24

Turbine A29

Turbine A32

Turbine A34

Turbine A38

Turbine A44

Turbine A52

Turbine A87

Turbine A94

Turbine A103

Turbine A104

Turbine A105

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