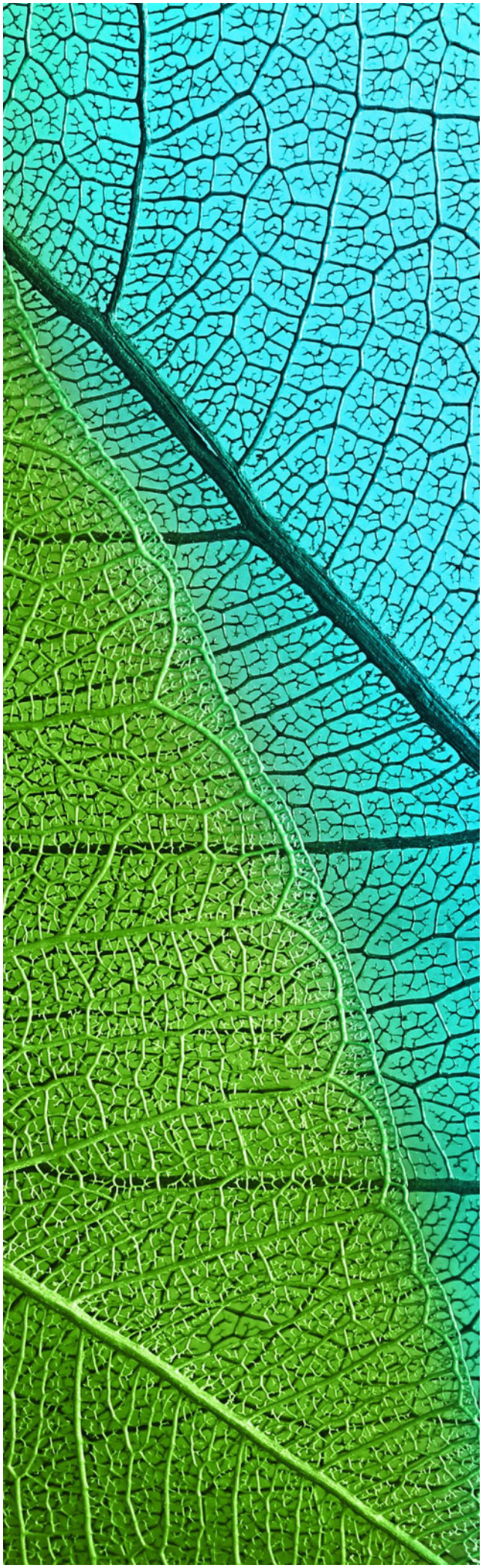

Crookwell 2 Wind Farm

Annual Report on the Implementation of the Bird and Bat Adaptive Management Plan

Prepared for
Crookwell Development Pty Ltd

February 2020
Report No. 8172 (25.0)

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1. Executive summary

Crookwell 2 Wind Farm is located 14 km south-east of Crookwell township in the Southern Tablelands region of New South Wales (NSW). A total of 32 wind turbines and associated infrastructure are sited within approximately 2,088ha of cattle and sheep grazing farmland. Crookwell 2 Wind Farm is owned by Crookwell Development Pty Ltd.

Development consent was granted in 2009 for the first modification (Mod-1) from the initial approval (DA 176-8-2004-i), increasing the size of turbines and relocating 20 of the 46 proposed and providing an alternate access road via Woodhouselee Road. Further developments in wind turbine technology led Crookwell Development Pty Ltd to seek approval to modify Mod-1 further increasing the size of the turbines and reducing the total number to 32 (Mod-2).

As part of the approval process for Mod-2, the Office of Environment and Heritage (OEH) requested Crookwell Development Pty Ltd on November 14th, 2016 develop a Bird and Bat Adaptive Management Plant (BBAMP) in accordance with condition 84 of the Development Consent.

Brett Lane & Associates Pty Ltd (BL&A), the predecessor to Nature Advisory Pty Ltd (Nature Advisory) was commissioned by Crookwell Development Pty Ltd to develop the BBAMP following pre-construction Bird Utilisation Surveys which were undertaken in February and November 2017 at the site.

Stage 2 of the monitoring program comprised post-construction surveys including:

- Monthly monitoring of bird and bat collisions with turbines through carcass searches, including scavenger surveys (to determine carcass removal rates before detection), and observer efficiency trials (to determine how well observers detect carcasses);
- Monitoring 'at risk' groups of birds, including raptors and White-throated Needletail; and
- Assessing the effects of the wind farm on bird activity at the site, based on bird utilisation rates.

During the formal carcass searches in the year 2019, a total of 45 bird and bat remains were discovered beneath the random sub-set of searched turbines during the first year of monitoring. These 45 remains included 15 bird carcasses, 18 bat carcasses and 12 feather-spots. In addition, one bird carcasses and one bat carcass were recorded incidentally (outside the formal carcass searches) by wind farm personnel and others. With one exception, all remains consisted of common farmland and woodland species with no assigned threatened species status and a "secure" conservation status in New South Wales.

One threatened species — Black Falcon — was recorded as a casualty at the wind farm. Black Falcon is listed as vulnerable under NSW *Biodiversity Conservation Act 2016*. This finding triggered a response in accordance with the BBAMP — targeted raptor surveys were promptly initiated to determine the status of the species at the C2WF site. This work involved undertaking point count surveys from vantage points across the site. Black Falcon was observed sporadically from July to October 2019 and was only recorded incidentally while traversing around the site, never during the point-count raptor surveys. The point-count surveys ceased in November as the Black Falcon was not recorded during the previous two surveys and was considered no longer to be in the area.

The Wedge-tailed Eagle and Australian Magpie were the most common bird species found during carcasses searches, with four carcasses of each found. This is not unexpected as these species were observed flying at Rotor Swept Area heights during the bird utilisation surveys. These two species are common and wide-spread birds favouring open farmland habitats.

A total of nineteen bat carcasses were recorded during the first year of monitoring. The White-striped Freetail Bat was most commonly found, with 12 individuals. The high rate of mortality for this species compared with other bat species on the wind farm is expected, given its regular occurrence at rotor swept area (RSA) height and regular collisions at other wind farms in south–eastern Australia.

Searcher efficiency and scavenger trials were undertaken. The average searcher efficiency was 70 percent detectability. The average number of days the bird and bat carcasses are left in the field before they are scavenged was six days.

Raptor and White-throated Needletail were identified as 'at risk' species and surveys were undertaken for these species. No White-throated Needletail were observed during the first year of monitoring. The Wedge-tailed Eagle and Nankeen Kestrel were the most commonly-occurring raptor species at the wind farm site. Two threatened raptor species — Black Falcon and Little Eagle — listed as vulnerable under the *Biodiversity Conservation Act 2016* were recorded at the site.

Bird utilisation surveys (BUS) on the site recorded predominantly farmland and woodland species with some records of raptors and waterbirds. A similar number of bird species were recorded during pre- and post- construction BUS. The most common species recorded in pre–construction surveys were still common after turbines became operational.

Four threatened bird species — Black Falcon, Diamond Firetail, Dusky Woodswallow and Little Eagle — have been recorded in low numbers at the wind farm site.

2. Introduction

Development consent (DA 176-8-2004-i) was originally granted in June 2005 for the Crookwell 2 Wind Farm (C2WF), comprising up to 46 wind turbines and associated infrastructure. This development consent was modified in 2009 (Mod-1). A total of 28 turbines, of the 32 approved, were constructed.

C2WF is approximately 14 kilometres south-east of Crookwell and approximately 28 kilometres north-west of Goulburn in the Southern Tablelands of New South Wales. The site lies on a series of higher ridges that have been used for decades for sheep and cattle grazing. The majority of the area has been either completely or mostly cleared of its original native vegetation. As a consequence of the long grazing history, the vegetation present lacks an indigenous ground cover — introduced pasture grasses now dominate the ground cover.

Crookwell Development Pty Ltd engaged Nature Advisory to implement the approved Bird and Bat Adaptive Management Program (BBAMP) for the C2WF. Specifically, the scope of the investigation included:

- Operational Bird and Bat Carcass (Fatality) Monitoring Program;
- Monitoring 'at risk' groups of birds; and
- Bird utilisation surveys.

This report is divided into the following sections:

Section 3 provides the methods and results of the carcass search program.

Section 4 provides the methods and results of the monitoring 'at risk' bird species.

Section 5 provides the methods and results of the bird utilisation survey.

Section 6 discusses the conclusions of the first year of monitoring at C2WF.

This investigation was undertaken by a team from Nature Advisory, comprising Beau Meney (Zoologist), Guille Mayor (Zoologist), Jackson Clerke (Zoologist), Khalid Al-Dabbagh (Senior Zoologist), Peter Lansley (Senior Zoologist), Justin Sullivan (Senior Ecologist) and Alan Brennan (Senior Ecologist and Project Manager).

3. Carcass searches

3.1 Methods

3.1.1 Carcass searches

From January to December 2019, monthly carcass searches were carried out at C2WF. To ensure a valid dataset for statistical analysis, the mortality detection search was based on 16 turbines (representing more than 50% of the turbines at the C2WF), split into the four operational areas of C2WF (North east, North west, South East and South West – comprising the two chains of ridges). Turbines were selected randomly to ensure representativeness and are listed in Table 1.

Table 1: List of turbines searched

Turbine number	Turbine number	Turbine number	Turbine number
1	7	13	24
3	8	15	25
4	10	18	26
6	12	21	27

Carcass searches were undertaken at each of the 16 turbines twice every month during a five-day period. The turbines were searched to a radius of 120 metres once per month followed by a 60m radius "pulse" search within the same month (Figure 1).

- The inner zone: walking transects are spaced six metres apart and carried out up to 60 metres from the turbine tower; nearly all microbats, and the majority of small to medium birds are expected to be found in this inner zone (based on Hull and Muir 2010); and
- The outer zone: between 60 and 120 metres radius from the turbine tower base to detect the medium and larger bodied birds; walking transects are spaced twelve metres apart.

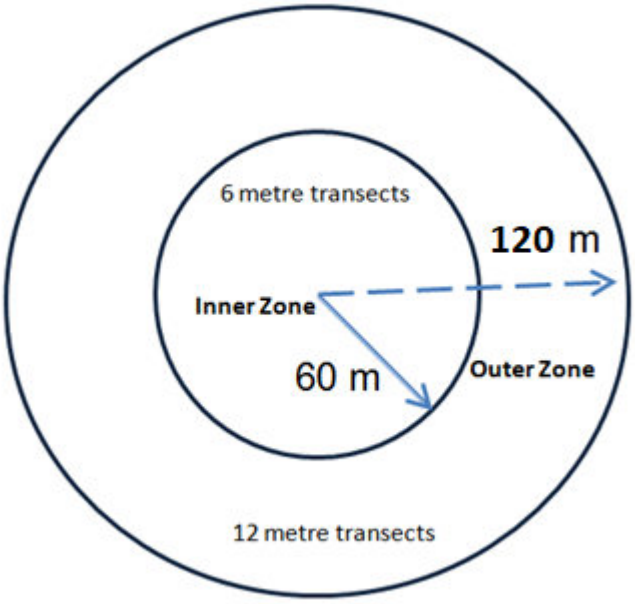

Figure 1: Diagram of inner and outer search zones at turbines

When a dead bird or bat was recorded under a turbine, a pro-forma was filled out and numbered, and a photograph of the carcass *in* situ taken. When only feathers were recorded this was recorded

as a feather spot. It is likely that feather spots represent a bird that has collided with a turbine and has later been scavenged.

On finding a dead bird, feather-spot or dead bat, the searcher:

- Removed it from the site to avoid re-counting; and
- Transferred fresh carcasses to a freezer at the site office for storage so it could be identified and used later in observer efficiency and scavenger trials (see below).

An incidental record is a carcass that was found under a turbine outside of the formal carcass search program (e.g. by wind farm personnel during routine inspections of infrastructure or during turbine searches under a turbine not selected for monthly searches).

The location of all the turbines and the turbines searched are shown in Figure 2.

3.1.1 Searcher efficiency trials

The searcher efficiency trial was undertaken on the 16th July 2019. The purpose of this trial was to assess the efficiency of the observer (Beau Meney) who conducted the most of the searches.

The BBAMP (BL&A 2018a) states that four searcher efficiency trials will be conducted over the two-year monitoring period, two trials when grass height is short and two when grass height is long.

The initial trial was undertaken during winter when the grass height was considered to be short. With grazing pressure compounded by very dry conditions were experienced across C2WF throughout the year so typical seasonal changes in grass density and height were not observed. A searcher efficiency trial was undertaken when grass was meant to be long in the first year but it was short. A further three such trials will be conducted during the second year of operation, beginning in February 2020, with two during spring 2020 when grass is expected to be tall.

A total of twenty carcasses were used in each trial. This included ten bats and ten birds (Table 2). These 20 carcasses comprised those which had been collected during previous searches, as well as road killed bird carcasses collected in preceding months and stored in a freezer at the wind farm office. Additional bird carcasses comprised Common Myna species that were sourced from the control programs of Common Myna Action Groups.

Two to three carcasses were placed under seven pre-selected turbines. The positions of the placed carcasses were randomly generated (distance and bearing from tower) using the Microsoft Excel random number function. Birds were placed within the 120-metre inner and outer zones, and all bats within the 60-metre inner zone.

The observer searched all turbines within two hours of the carcasses being placed and recorded the number of carcasses found on the first search. The observer efficiency was calculated as the percentage of carcasses found of those placed.

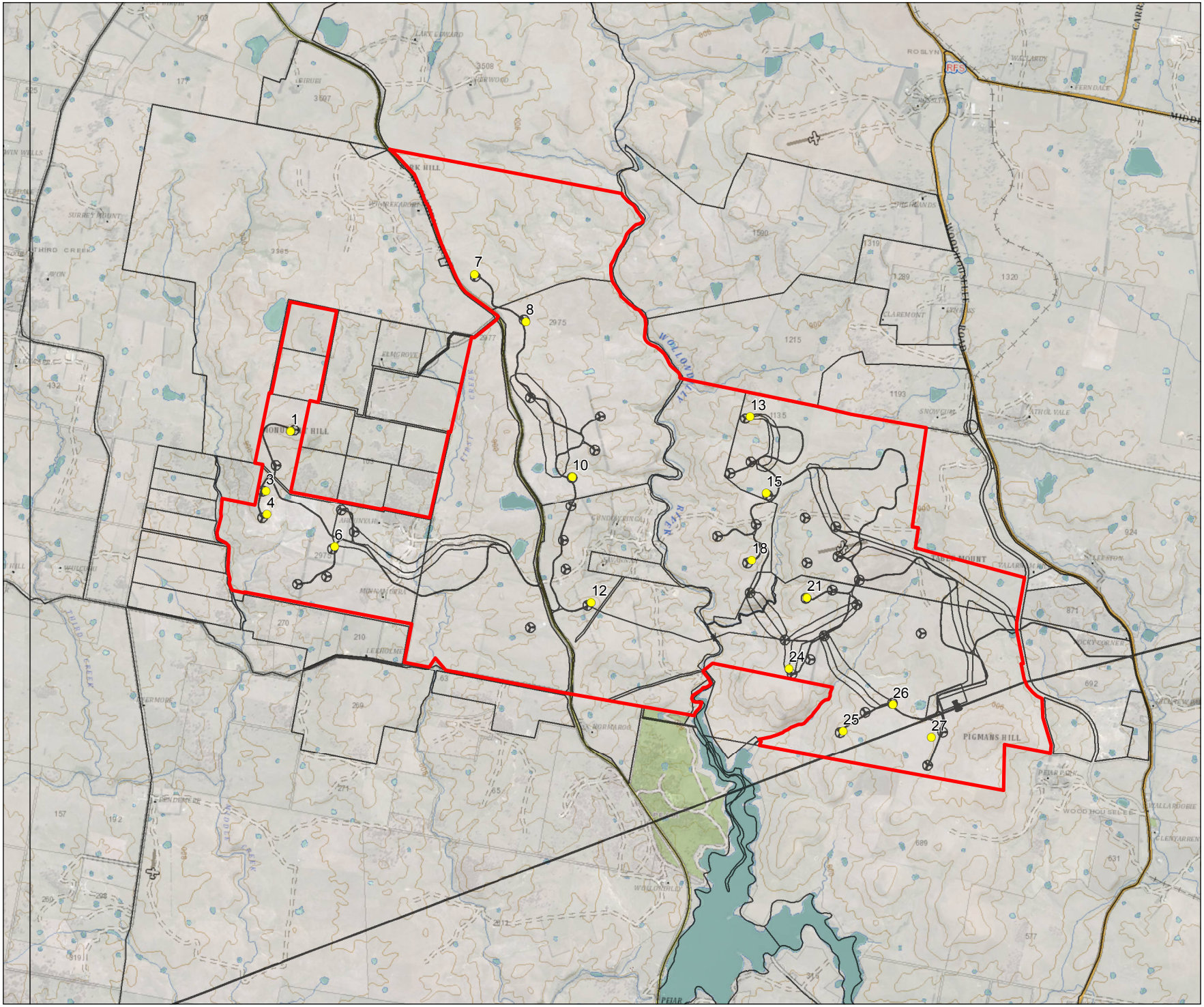

Figure 2: Crookwell 2 turbine searches

Project: Crookwell 2 and 3 Windfarm
Client: Crookwell Development Pty Ltd
Date: 4/04/2019

- Site Boundary - Crookwell 2
- Development layout
- Turbines searched

N

Metres
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Table 2: Species used in searcher efficiency trials at C2WF

Turbine	Carcass	Size class
	Winter (long grass)	
27	Brown Falcon	Large
	White-striped Freetail Bat	Bat
	Grey Fantail	Small
26	Brown Falcon	Large
	White-striped Freetail Bat	Bat
	Common Myna	Medium
25	Eastern Barn Owl	Large
	White-striped Freetail Bat	Bat
	Grey Fantail	Small
6	Common Myna	Medium
	White-striped Freetail Bat	Bat
	Fairy Martin	Small
15	White-striped Freetail Bat	Bat
	White-striped Freetail Bat	Bat
	Nankeen Kestrel	Medium
24	Common Myna	Medium
	Common Myna	Medium
	White-striped Freetail Bat	Bat
12	Common Myna	Medium
	White-striped Freetail Bat	Bat

3.1.2 Scavenger trials

The effect of carcasses being removed by scavengers prior to being detected by the observer was quantified through scavenger trials. The effect is expressed as the average duration of carcasses in the field prior to being removed by scavengers.

Trials were conducted concurrently with formal monthly searches beginning on 14th August 2019 and concluding on 25th October 2019. A total of 40 carcasses were placed at eight pre-selected turbines and distributed randomly as per the searcher efficiency trial. Remote-sensor cameras were set-up a short distance from the carcasses (< 5 metres) to document the elapsed time until scavenging took place and to identify the predator responsible.

The details of the trials are listed in Appendix 3.

3.2 Results

3.2.1 Carcass search results

A total of 47 bird and bat remains — comprising 28 bird and 19 bat remains — were discovered beneath turbines on C2WF during the first year of monitoring in 2019. This figure includes two incidental records comprising one bird and one bat remains.

Two additional bird carcasses — one Brown Falcon and one Nankeen Kestrel — were found prior to monitoring commencing in 2018 and as such are not included within the total sum of remains found in 2019 monitoring.

The results of formal bird and bat carcass searches at C2WF in 2019 are summarised in Table 3. The table shows the number of carcasses and feather spots found during formal searches, and incidentally. The monthly spread of carcass findings is shown in Figure 3.

Table 3: Summary of carcass search results for bird and bats at C2WF in 2019.

Search type	Season	Month	Bird	Bat	Feather spot	Total
Formal searches	Summer	January	2	5	2	9
		February	1	1	2	4
	Autumn	March	1	5		6
		April	4		1	5
		May		1	1	2
	Winter	June			1	1
		July	2		1	2
		August			1	1
	Spring	September	1	1		3
		October	3	5		7
		November	1		2	3
	Summer	December			1	1
Totals of formal searches			15	18	12	45
Incidental finds	Autumn	Mar-19	1	1		2
Total incidental finds			1	1	0	2
Combined total finds			16	19	12	47

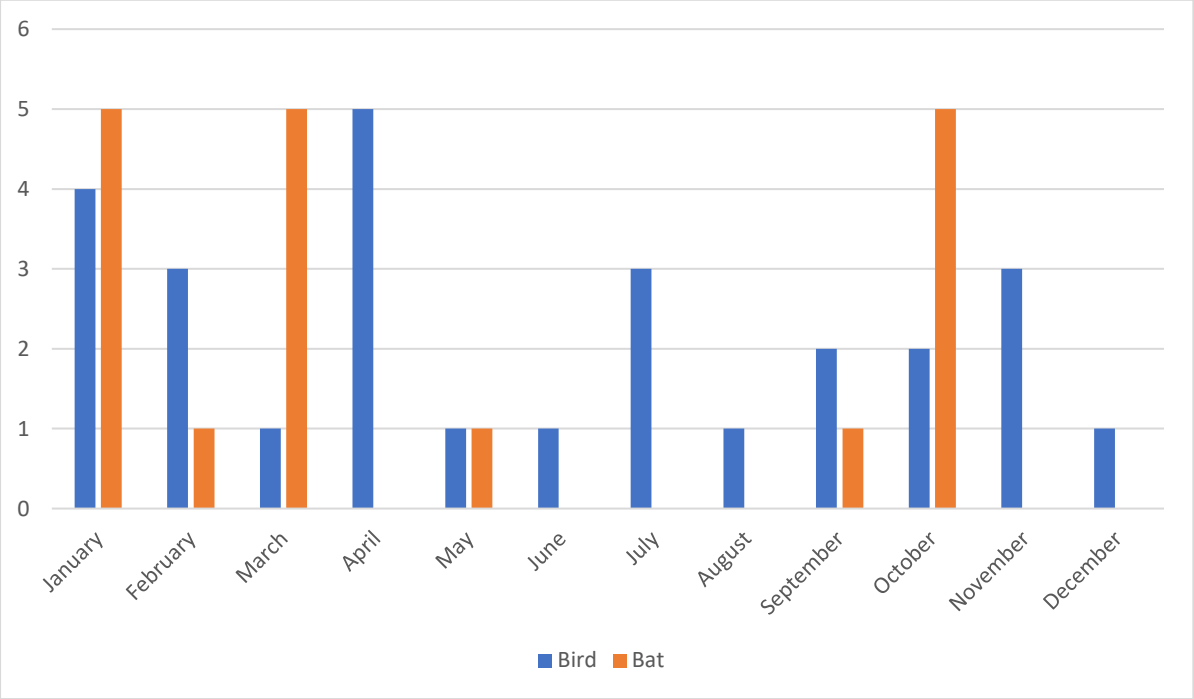

Figure 3: Number of carcasses found in each month during the first year of monitoring

3.2.2 *Birds*

A total of 28 bird strikes were recorded within the C2WF site during its first 12 months of operation. Forming the bulk of this total, 27 carcasses were discovered during formal monthly searches, comprising 15 partial or intact carcasses and 12 feather-spots. As is standard practice, it has been assumed that feather-spots discovered beneath turbines are the result of an initial turbine

collision, with scavenging predators such as Red Fox or ravens later consuming the carcass and leaving feather remains. Between one to five bird remains were recorded each month.

One bird carcass was found incidentally and intact by wind farm staff outside of the scheduled monthly surveys.

Detected bird mortality at C2WF is summarised in Table 4 below, with species listed in ranked order of the number of carcasses found. Detailed information on each bird carcass, feather-spot and incidental record during 2019 can be found in Appendix 1.

Table 4: Summary of detected bird mortality across the C2WF during 2019.

Note: Totals below include one incidental find of a Nankeen Kestrel outside of formal searches.

Bird Species	Percentage of total bird collisions	Percentage of all bird and bat collisions	Total
Australian Magpie	14.3	8.5	4
Wedge-tailed Eagle	14.3	8.5	4
Nankeen Kestrel	10.7	6.4	3
Brown Falcon	10.7	6.4	3
Grey Fantail	10.7	6.4	3
Raven sp.	10.7	6.4	3
Galah	7.1	4.3	2
Australian Wood Duck	3.6	2.1	1
Black Falcon	3.6	2.1	1
Common Starling	3.6	2.1	1
Eurasian Skylark	3.6	2.1	1
Fairy Martin	3.6	2.1	1
Laughing Kookaburra	3.6	2.1	1
Subtotal	100	59.5	28

The Wedge-tailed Eagle and Australian Magpie were the most commonly found birds under turbines during the 2019 monitoring period.

The Wedge-tailed Eagle was a species identified as at risk of blade-strike. It made up just over 14 percent of bird collisions with four individuals detected beneath turbines. Three carcasses were found to be of adult birds, whilst the most recent discovery in November was of a juvenile bird. Interestingly, these four instances of mortality for this species were at just two turbines, 4 and 24, with each striking two birds each. The entire wind farm site provides suitable habitat for Wedge-tailed Eagle, with the undulating topography on-site producing updraft winds suitable for soaring flight. Three Wedge-tailed Eagle nests have been detected on-site this year. Whilst the species was commonly observed flying across the wind farm throughout the year, no breeding activity was recorded.

One Black Falcon, listed as 'Vulnerable' in New South Wales (BC Act), was found in July. With this species not sighted during bird utilisation surveys conducted on the wind farm before carcass searches began, the collision risk for this species was considered to be low. In the lead up to this event, an elevated rate of sightings for this species was detected during 2019, with the species

seen in low numbers both on the wind farm and in surrounding areas. The species has not been sighted at the C2WF since October 2019.

During the first 12 months of operation, the Brown Falcon represented almost 11 percent of bird collisions. Suitable habitat, in the form of open pasture and fragmented woodland, occurs across the site, allowing this species to occur throughout the wind farm. This is reflected in the mortality results, with the location of collisions evenly distributed across the site. Though not the most commonly recorded species during targeted raptor surveys conducted on-site, this species is commonly associated with blade strike mortality throughout its range (Nature Advisory; unpublished data), and as such was expected to collide with turbines.

Nankeen Kestrel, a commonly encountered species across farmland habitats, was identified beneath turbines on three occasions and made up almost 11 percent of bird collisions detected on-site. This species was the most frequently encountered raptor on-site during targeted raptor surveys, with a total of 15 observations (8 of which occurred at RSA height). Blade strike of this species was anticipated, given their common flight behaviour at RSA height and observed collisions at other wind farms within their large range (Nature Advisory; unpublished data).

Three Grey Fantail were discovered beneath turbines 7 (1 individual) and 8 (2 individuals) in April 2019. This species is most frequently sighted flying below RSA height (< 30m above ground), and is not commonly sighted or considered to occupy RSA height (30 – 160 metres). BUS surveys conducted on-site in November 2017 and February 2019 recorded Grey Fantail flying at impact sites on 16 different occasions, all of which were found to be at heights below RSA. Notwithstanding this, during migration the species may fly higher, in which case it would be vulnerable to turbine collision.

The remainder of species subject to blade strike were those commonly found in farm landscapes and associated woodland habitats. These species were; Raven species, Galah, Australian Wood Duck, Common Starling, Eurasian Skylark, Fairy Martin and Laughing Kookaburra. These species, to varying extents, disperse across open country to other woodland habitats, increasing their risk of collision. Australian Magpie (4 individuals), Raven species (3 individuals) and Galah (2 individuals) formed the bulk of the remaining casualties, which is expected given that these frequently fly at RSA height and are among the most abundant bird species on the wind farm site.

A total of 12 feather-spots were detected during 2019 from eight different species (Table 4), including waterfowl and raptors.

No obvious pattern was evident in carcass distribution among turbines or habitat types. The wind farm site is made up of similar habitat types and turbines are located within open farmland habitats and adjacent to varying-sized fragments of woodland. This even distribution of records and species suggest that collision-related bird mortality risk is evenly spread across the site.

3.2.3 Bats

A total of 19 bat carcasses (including one incidental record) were detected during 2019 (Table 5). No bat carcasses were found from June to September, with the colder conditions experienced during these months triggering annual torpor and/or migration away from the region, resulting in reduced bat activity. Appendix 2 provides detailed information on each bat carcass recorded during 2019.

Table 5: Summary of bat carcass records across C2WF during 2019.

Bat Species	Number found during formal counts	Number found incidentally	Total
White-striped Freetail Bat	11	1	**12**
Gould's Wattled Bat	4	0	**4**
Chocolate Wattled Bat	2	0	**2**
Bat sp.	1	0	**1**
Total	**18**	**1**	**19**

The White-striped Freetail Bat was the most commonly found bat carcass at C2WF during 2019, with 12 individuals killed by blade-strike. Mortality attributed to this species accounted for 63 percent of bat collisions recorded during formal searches (Table 6). Recorded carcasses of this species were evenly distributed across the wind farm, which is expected given their ability to travel large distances and their broad habitat choice. The higher rate of mortality for this is expected, given their regular occurrence at RSA height and frequent finds at other wind farms in south–eastern Australia (Nature Advisory, unpublished data). This species was listed as a species of concern in the C2WF BBAMP, for these reasons, despite its status as a common species.

Four Gould's Wattled Bat carcasses were detected during formal searches, all within the eastern block of turbines (specifically turbines 15, 24 and 27). Gould's Wattled Bat had the second highest mortality rate among three identified species, making up 21 percent of all detected bat collisions (Table 6). Impacts to this species resulting from blade-strike are not unusual, with similar rates of impact reported at other wind farm locations across south-eastern Australia (Nature Advisory; unpublished data).

Two Chocolate Wattled Bat carcasses were found, representing 10.5 percent of all detected bat collisions (Table 6). Interestingly, both instances of mortality for this species occurred in the far west of the wind farm at turbines 3 and 6.

One bat carcass could not be identified to species level, as only the skeletal wing structure remained.

There was no obvious pattern in the distribution of bat carcasses among turbines, turbine groups, or between habitat types in 2019, with the number of Gould's and Chocolate Wattled Bats being too small to draw conclusions. Habitat on the wind farm site is dominated by grazing pasture, with sparsely scattered areas of woodland and planted tree rows. The vast majority of turbines are located within open farmland habitats, with a small number situated adjacent to woodland.

Table 6: Extent of mortality for each species in context to bats and overall collisions at C2WF during 2019

Bat Species	Percentage of total bat collisions (19)	Percentage of all bird and bat collisions (47)	Total
White-striped Freetail Bat	63.2	25.5	**12**
Gould's Wattled Bat	21.1	8.5	**4**
Chocolate Wattled Bat	10.5	4.3	**2**
Bat sp.	5.3	2.1	**1**
Subtotal	**100**	**40.4**	**19**

3.2.4 Searcher efficiency

Beau Meney, a zoologist from Nature Advisory, executed the searches for this monitoring period and therefore undertook the searcher efficiency trial in July 2019 coinciding with the short grass season. The searcher efficiency results are shown in Table 7 below.

Table 7: Searcher efficiency trial results

Turbine	Carcass	Size class	Detected
July 2019 - Winter (short grass)			
27	Brown Falcon	Large	✓
27	White-striped Freetail Bat	Bat	✓
27	Grey Fantail	Small	X
26	Brown Falcon	Large	X
26	White-striped Freetail Bat	Bat	X
26	Common Myna	Medium	✓
25	Eastern Barn Owl	Large	✓
25	White-striped Freetail Bat	Bat	X
25	Grey Fantail	Small	✓
6	Common Myna	Medium	✓
6	White-striped Freetail Bat	Bat	✓
6	Fairy Martin	Small	✓
15	White-striped Freetail Bat	Bat	✓
15	White-striped Freetail Bat	Bat	X
15	Nankeen Kestrel	Medium	✓
24	Common Myna	Medium	✓
24	Common Myna	Medium	X
24	White-striped Freetail Bat	Bat	✓
12	Common Myna	Medium	✓
12	White-striped Freetail Bat	Bat	✓

Notes: ✓ = Found; X = missed.

The average efficiency was 70 percent detectability rate. Three bat carcasses, two small birds, and one large bird were missed by the observer (Tables 8 & 9).

Table 8: Average searcher efficiency at C2WF for the two different size classes

Carcass size class	Carcasses found	Carcasses placed	Average efficiency
Bats	6	8	75%
Medium to large bids	8	12	67%

3.2.5 Scavenger trials

The results of the scavenger trial are presented in Table 9 and the raw data is in Appendix 3.

The average number of days the bird and bat carcasses are left in the field before they are scavenged is six days. Due to their small size bats are usually taken earlier, in this trial they were in the field with an average of three days. Birds were in the field on average 9 days before they are scavenged. Red Fox and ravens have been identified as the dominant scavengers at C2WF (Appendix 3).

Table 9: Results of the scavenger trail undertaken at C2WF

Time period	Carcass type	Number of carcasses	Number of days in the field	Average days in the field
Short grass/spring	Bat	10	30	3
	Med-large Bird	14	123	8.79
	Total	24	153	6.38

4 Monitoring 'at risk' groups

4.1 Introduction

Experience from other wind farms indicates that ongoing bird utilisation surveys (BUS) provide varying levels of information. A baseline was generated in the pre-construction surveys in 2017 on bird utilisation of the C2WF site. A review of this information combined with information from other sources has been collated in the risk assessment and is considered to provide an adequate pre-construction baseline to compare future changes.

More specific and targeted monitoring of "at risk" groups as presented below, and monitoring (linked to impact triggers) has provided more useful information within an adaptive management framework for addressing the bird and bat impacts of the wind farm.

The key "at risk" groups have been identified through the initial risk assessment and includes the following.

- Wedge-tailed Eagles (WTE) - A moderate risk to WTE was assessed (BL&A 2018a). Accordingly, it is important that mitigation measures are implemented, where practicable, to reduce WTE being attracted to the vicinity of the turbines and that further information is compiled on the WTE population on the wind farm site and the flight behaviours that could present a risk to WTE.
- Other raptors
- White-throated Needletail

The onsite occurrence of the above "at risk" species will be monitored during the bird utilisation surveys for the first two years of operation. Any mortality of these species will be identified through monthly carcass searches to be undertaken during the first two years of operation.

Raptor and White-throated Needletail observations have been recorded throughout the operational phase of the C2WF when an ecologist has been on site on a monthly basis. Incidental observations of all raptors were recorded and flight paths marked on a map.

A Black Falcon (listed as vulnerable in NSW under the BC Act) was found dead under a turbine on 22nd July 2019. This triggered an immediate response which included point count raptor surveys that were undertaken over a three to four-day periods on four occasions from beginning of September up until mid-November 2019. This response was initiated to determine the status of Black Falcon at C2WF.

No White-throated Needletail were observed at C2WF during the first year of operation and are so are not discussed further in this chapter.

4.2 Methods

4.2.1 Incidental observations

During the first year of monthly monitoring all raptor flights that were observed were recorded. Information recorded included:

- Date location and duration of observation period;
- Time and duration of flight;
- No. and age of birds;
- Flight height above ground (range);

- Flight behaviour;
- Flight behaviour observed included soaring, directional flight (flapping), circling, gliding and diving; and
- Other occasional behaviours included feeding, territorial displays, fighting and perching.

Flight paths were plotted as accurately as possible on large-scale aerial photographs of the site.

4.2.2 Point-count surveys

Fixed point raptor surveys were undertaken over four periods at C2WF by qualified ecologists skilled in Australian raptor species identification from Nature Advisory on the following dates.

- 3rd – 6th September 2019 Jackson Clerke
- 30th September – 2nd October 2019 Guille Mayor
- 21st – 23rd October 2019 and Eamon O'Meara
- 11th – 14th November 2019. Justin Sullivan

The fixed points were located at the same 16 turbines selected for the monthly carcass searches (Figure 2). The raptor surveys were undertaken separately from carcass searches, in which the observer positions themselves at a vantage point close to each selected turbine, giving them the best panoramic view of the surrounding environment. From this position, the surrounding area was scanned with binoculars for 20 minutes.

Particular consideration is given to Black Falcon due to an impact trigger occurring at the wind farm. All raptor sightings were noted along with associated behaviour and flight heights. Dates, times and flight paths were recorded for all sightings and flight paths recorded.

4.3 Results

Nine species of raptor have been observed flying at the C2WF site during the 2019 monitoring period and are listed below.

- Black Falcon
- Brown Falcon
- Brown Goshawk
- Little Eagle
- Nankeen Kestrel
- Peregrine Falcon
- Swamp Harrier
- Wedge-tailed Eagle
- Whistling Kite.

A total of 91 movements have been observed were recorded from the C2WF site during the monitoring period. The observations were made incidentally while traversing around the site, during raptor point-count surveys and during the bird utilisation survey (BUS). The raw data for the raptor observations can be viewed in Appendix 4. A summary of the observations are presented in Table 10 and the flight paths have been plotted on maps in Figures 4 & 5.

The Wedge-tailed Eagle and Nankeen Kestrel was the most commonly recorded raptor species at C2WF site. A total of 29 movements of Wedge-tailed eagle and 28 movements of Nankeen kestrel were observed (Table 11). These species are common and widespread across south-eastern Australia. The Wedge-tailed eagle was observed flying along ridges, valleys and across open country. Typical behaviour of Wedge-tailed Eagle was soaring at height using thermals and also gliding, flapping and territorial display. Three Wedge-tailed Eagle nests have been located at the

site though none of these nesting sites were used during the 2019 breeding season. A pair of Wedge-tailed Eagle usually have several nests within their territory that they rotate using from year to year. The Nankeen Kestrel was usually observed foraging across the site feeding on invertebrates and mice. The Brown Falcon is another common and widespread raptor commonly occurring across farmland throughout south-eastern Australia. There were 11 movements of Brown Falcon documented during the monitoring period.

Table 10: Summary of raptor flights observed at C2WF

Species	Number of flights
	Incidental Flights
Black Falcon	6
Brown Falcon	1
Little Eagle	1
Nankeen Kestrel	4
Wedge-tailed Eagle	14
	Point-count survey
Brown Falcon	7
Brown Goshawk	2
Nankeen Kestrel	23
Peregrine Falcon	2
Wedge-tailed Eagle	13
	BUS
Brown Falcon	3
Brown Goshawk	3
Nankeen Kestrel	1
Peregrine Falcon	1
Swamp Harrier	1
Wedge-tailed Eagle	2
Whistling Kite	7
	Totals
Black Falcon	6
Brown Falcon	11
Brown Goshawk	5
Little Eagle	1
Nankeen Kestrel	28
Peregrine Falcon	3
Swamp Harrier	1
Wedge-tailed Eagle	29
Whistling Kite	7

Black Falcon and Little Eagle are listed as vulnerable under the BC Act. Only one movement of Little Eagle was recorded and was likely moving through the area. The Little is unlikely to be impacted by the wind farm. Unfortunately, there was one strike of Black Falcon in July 2019. Due to this species being a listed threatened species this triggered a response and formal raptor surveys were initiated to determine the status of this species at the C2WF site.

The Black Falcon was observed sporadically from July to October 2019 and was only recorded incidentally while traversing around the site and never recorded during the point-count raptor surveys. The point-count surveys ceased in November as the Black Falcon was not recorded during the previous two consecutive surveys and was thought to have abandoned the area.

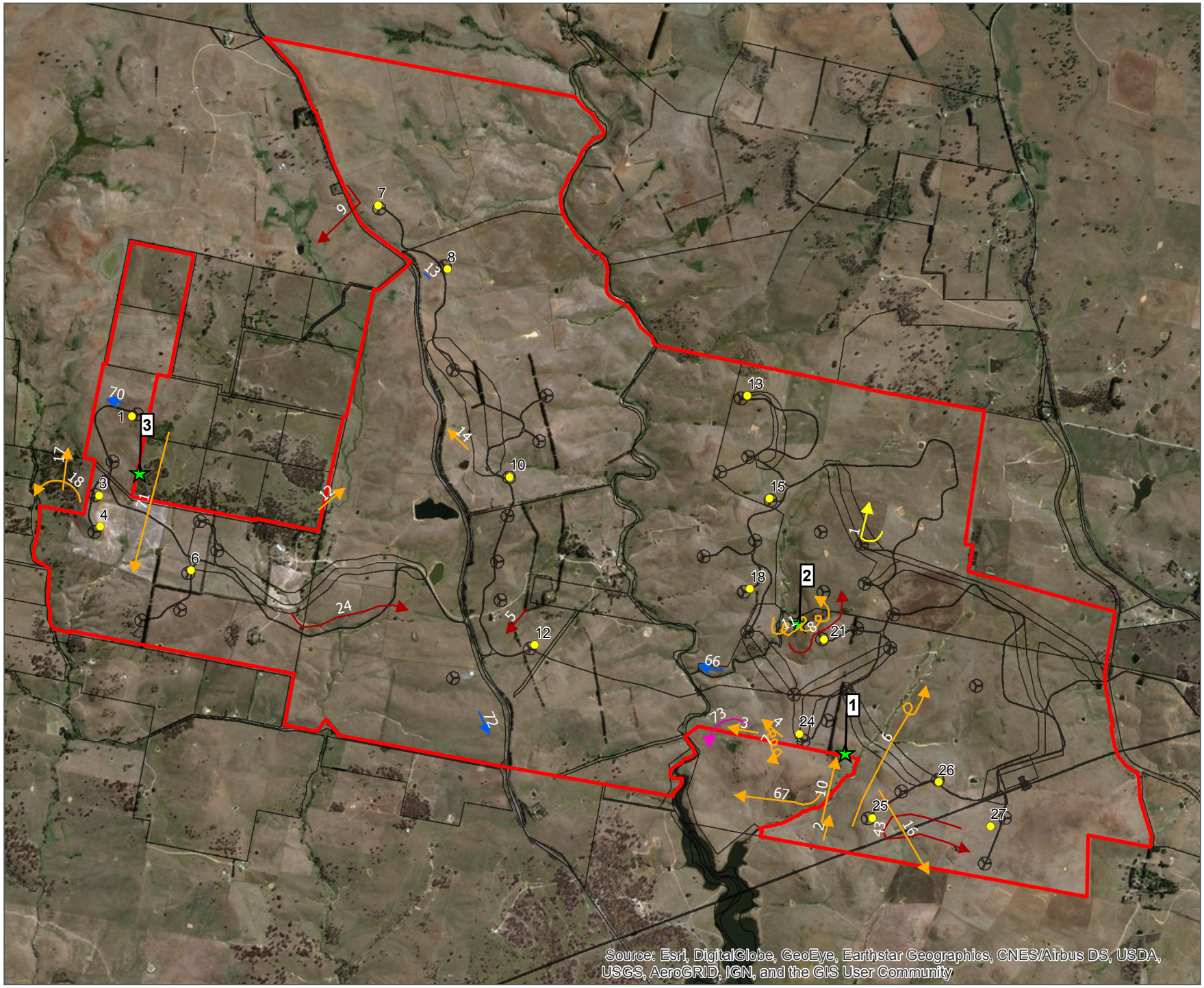

Figure 4: Incidental Raptor flights recorded at C2WF

Project: Crookwell Wind Farm
Client: Crookwell Development Pty Ltd
Date: 06/02/2020

- Site Boundary
- Development layout
- Turbines searched
- Wedge-tailed Eagle nests

Incidental Raptor Flights

- Black Falcon
- Brown Falcon
- Little Eagle
- Nankeen Kestrel
- Wedge-tailed Eagle

N

Metres
0 400

Nature Advisory
PO Box 337, Camberwell, VIC 3124, Australia
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03 9815 2111 - info@natureadvisory.com.au

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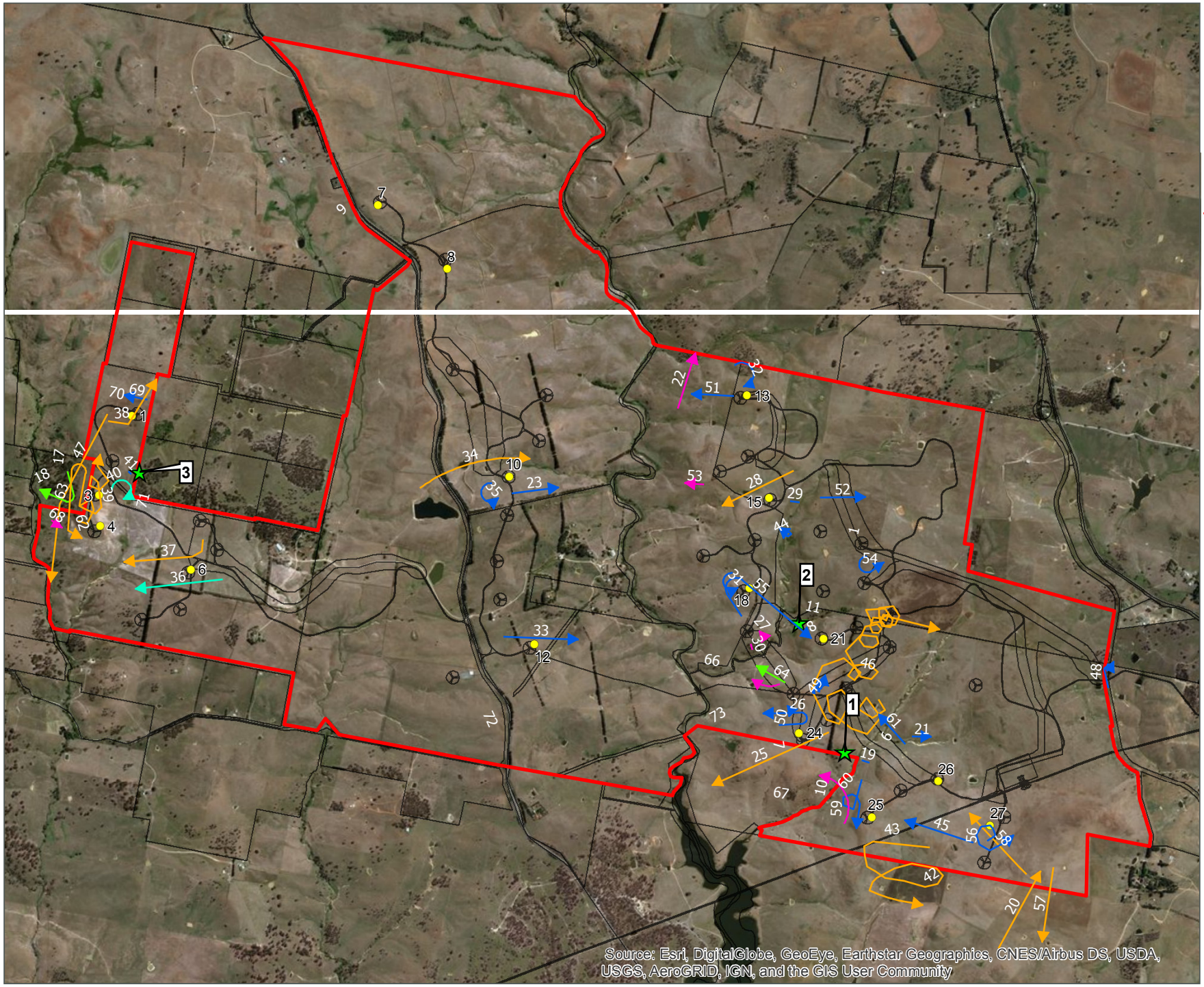

Figure 5: Raptor flight paths recorded during point-count surveys at C2WF

Project: Crookwell Wind Farm
Client: Crookwell Development Pty Ltd
Date: 06/02/2020

- Site Boundary
- Development layout
- Turbines searched
- Wedge-tailed Eagle nests

Point-Count Raptor Flights

- Brown Falcon
- Brown Goshawk
- Nankeen Kestrel
- Peregrine Falcon
- Wedge-tailed Eagle

N

Metres
0 400

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5 Bird Utilisation Survey

5.1 Introduction

The bird utilisation survey (BUS) was undertaken consistent with the requirements for a "Level One" bird risk assessment in accordance with 'Wind Farms and Birds - Interim Standards for Risk Assessment' issued by the Australian Wind Energy Association (AusWEA 2005). This approach has been endorsed in the Association's latest Best Practice Guidelines (Clean Energy Council 2018).

Bird utilisation surveys were undertaken as part of this investigation as follows:

- Late summer utilisation survey: 18th – 22nd February 2019;

The bird utilisation survey was undertaken by a team from Nature Advisory, comprising Khalid Al-Dabbagh (Senior Zoologist), Peter Lansley (Senior Zoologist), Justin Sullivan (Senior Ecologist) and Alan Brennan (Senior Ecologist and Project Manager).

5.2 Methods

5.2.1 Fixed-site bird count method

The fixed-point bird count method used to collect bird utilisation data involved an observer stationed at a survey site for 15 minutes. The adequacy of using 15 minutes as an interval to record the presence of birds during bird utilisation surveys was investigated in an earlier study at another wind farm site (BL&A unpublished data). This showed that 82 to 100 percent (average 88 percent) of species actually seen in one hour of surveying were seen in the initial 15 minutes of observation. Based on this result, the period of 15 minutes used in the formal bird utilisation surveys was considered adequate to generate representative data on the bird species in the area during replicate surveys.

During this period, all birds observed within 200 metres were recorded. The species, the number of birds and the height of the bird when first observed were documented. For species of concern (threatened species, waterbirds and raptors), the minimum and maximum heights were recorded.

For the purpose of this report, flight height relative to the rotor swept area (RSA) height is presented as described below. These heights were based on the actual turbine heights that were constructed, and were different from those used during the pre-construction phase.

- **A =** Below RSA (< 30 metres above ground)
- **B =** At RSA (30 – 160 metres above ground)
- **C =** Above RSA (> 160 metres above ground).

In the BUS, heights were measured at 10 m intervals between 0 and 40 metres and at 20 metre intervals above 40 metres and up to 160 metres. This allowed for more precise description of bird flight heights.

5.2.2 Locations of survey sites

Seven fixed survey sites were established at five impact sites and two reference sites. Impact sites were located near and among turbine locations. Reference sites were located on edges of the wind farm boundaries in areas of similar habitat and at least 500 metres away from the proposed turbines.

The survey sites were distributed as evenly as possible (subject to access constraints) across the proposed wind farm site to maximise coverage in areas where wind turbines would be located (Figure 6). Impact sites were positioned on elevated ground where possible, allowing a clear view in all directions.

The reference sites were established on public land for ease of access and were located in areas covered by some remnant native vegetation and/or natural wetlands to provide clear picture of birds at the wind farm site.

5.2.1 Timing of the surveys

The bird utilisation survey was undertaken in February 2019.

February 2019 BUS

The February 2019 BUS lasted five days and was undertaken during the period 18th – 22nd February 2019. The timing covers a suitable period for surveying birds as their populations are probably at their maximum abundance following the summer recruitment and most of the summer visitors to the wind farm area are probably still present.

During the surveys, eight counts were made at each survey site. Counts were made at different times of the day to allow for time-of-day differences in bird movements and activity. Table 11 indicates when each site was counted on each survey day. This schedule ensured that all sites were visited at all times of day so that no time-of-day biases affected the pooled count data.

Table 11: February 2019 BUS count times

Date/ time	8:00-8:30	8:30-9:00	9:00-9:30	9:30-10:15	10:15-11:00	11:00-11:30	11:30-12:00
18-Feb							
19-Feb	3	1	5	4	R2	1	2
20-Feb	2	R2	3	1	4	5	R1
21-Feb	R2	1	2	3	5	R1	4
22-Feb	R1	5	4				
Date	**12:00-12:30**	**13:00-13:30**	**13:30-14:00**	**14:00-14:45**	**14:45-15:30**	**15:30-16:00**	**16:00-17:00**
18-Feb	R1	5	4	R2	1	2	3
19-Feb	3	R1	5	4	2, R2	1	2, 3
20-Feb	R2	3	2	1, R2	4	5	R1
21-Feb	1	1, 2	R2	3	R1	4	5
22-Feb							

Note: See Figure 6 for BUS survey site locations. The prefix 'R' refers to reference sites.

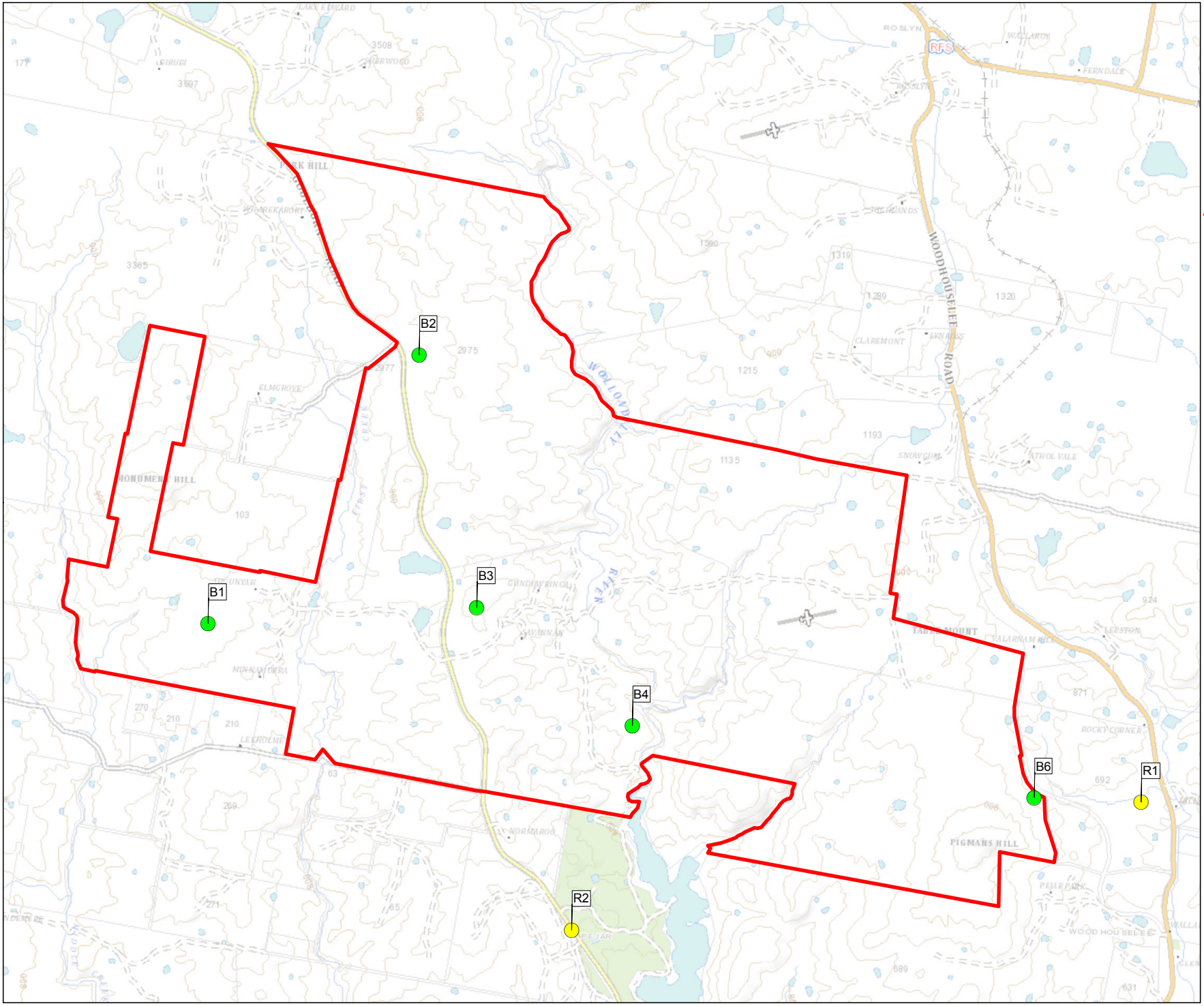

Figure 6: Crookwell 2 BUS points

Project: Crookwell 2 and 3 Windfarm
Client: Crookwell Development Pty Ltd
Date: 29/03/2019

- Site Boundary - Crookwell 2
- BUS locations (Impact Sites)
- BUS locations (Reference Sites)

N

Metres
0 500 1,000

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5.2.2 Incidental observations

In addition to the observations during formalised, fixed-site counts, incidental observations of birds of concern (threatened species, raptors, and waterbirds) were made whilst travelling throughout the proposed wind farm site. Notes were also made on woodland birds observed in remnant woodlands and any early morning and evening roosting movements. Emphasis was placed on observing birds that were moving through the site at RSA height.

5.2.3 Limitations

The February 2019 BUS was undertaken during late summer. This was considered a suitable time to record most resident birds as well as most summer migrants. Transient migratory birds were less represented in the observation data, though this is also considered due to their chance use of the wind farm site while passing through the area.

The purpose of the surveys was to collect a range of data, including usage of the site by resident and migratory birds that may only occur at certain times of the year.

For these reasons, the utilisation rates and species relative abundances recorded during the current surveys are considered to be representative of the site for the time period covered as they take into consideration time-of-day in bird activity and species occurrence. They are therefore considered to provide an interim basis on which to assess the bird risks associated with the C2WF. Further post-construction BUS will elucidate seasonal variation and provide a more comprehensive comparison with post-construction bird utilisation.

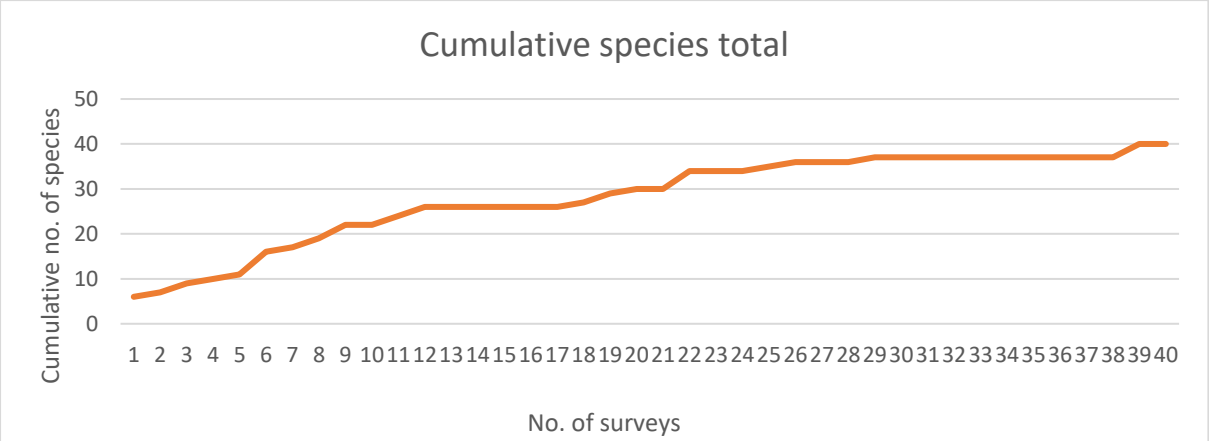
5.3 Results

5.3.1 Survey suitability

A cumulative species curve has been plotted for the February bird surveys to determine the suitability of the method. The cumulative species curve shows the number of different bird species observed over consecutive fixed-point bird counts conducted at the observation sites.

The species curve showing the results of the February 2019 BUS at the impact points is shown in Figure 7. The cumulative species curve indicates that the number of new bird species recorded levelled out after approximately 30 counts, after which only a small number of additional bird species were recorded. This result suggests that the survey provides a representative picture of the diversity of bird species flying over the wind farm site during the survey periods.

Figure 7: Cumulative number of bird species recorded during consecutive counts at impact points during the February 2019 survey at C2WF



5.3.2 Species composition

A total of 58 bird species were recorded on the wind farm site during the February 2019 bird survey both during formal surveys and incidentally. The raw data for the BUS from the impact points is presented in Appendix 6 and the raw data for the BUS from the reference sites is presented in Appendix 5.

The number of species actually counted during the February 2019 formal BUS counts reached 48 species, 40 of which were recorded at the impact sites (see Figure 7) and 35 of which were recorded at the reference sites. The number of species counted during the formal BUS counts equated to 83% of birds recorded at the wind farm site. Most of the other (17%) birds were not recorded in the formal BUS as they were either of rare occurrence or water birds restricted to the larger water bodies away from the turbine locations (e.g. Pejar Dam).

The species recorded constituted a combination of birds of open grasslands and stock grazing paddocks as well as woodland birds.

5.3.3 Species abundance

The species observed during the February 2019 BUS are detailed in Table 12 for the five impact sites and Table 13 14 for the two reference sites. Their abundance and height distribution are also noted in these tables.

Both tables include a list of the species observed during the BUS in each of the observation sites, as well as the number of individual birds per species recorded at each of the three height zones (below [<35 m], at [35–160 m] and above [>160 m] RSA height).

Impact sites

The following five most dominant bird species constituted 56.9% of all birds utilising the impact sites in the February 2017 survey. These were (in order of their dominance):

- Common Starling (30.4%);
- Australian Magpie (16.3%);
- Galah (7.6%);
- Red-rumped Parrot (4.4%); and
- Sulphur-crested Cockatoo (4.2%).

These five species are common farmland birds, including one introduced species (Common Starling). The large number of Common Starling records resulted from the fact that the species mostly move and feed in large flocks and when in or close to future turbine positions this behaviour inflates the count.

The other four species are also common farmland birds, mostly foraging in open grazing paddocks or crop and nesting in trees in nearby woodland or roadside shelter belts; they usually feed in smaller flocks than the Common Starling.

Reference sites

At the reference sites the five most common species recorded included (in order of abundance):

- Sulphur-crested Cockatoo (43.2% of all reference site birds);
- Galah (11.3%);
- Common Starling (11%);

- Australian Wood Duck (8%); and
- Australian Magpie (6.2%).

The five most commonly recorded species at the reference sites constituted 79.8% of all birds utilising the reference sites. The dominant species of birds recorded at the reference sites were similar to those recorded at the impact sites with the exception of the Australian Wood Duck. This was considered to be as both the reference sites were close to small farm dams that attracted the ducks regularly. However, more woodland species dominated in the reference sites as they were located closer to small woodland remnants.

Table 12: Number and height distribution of bird movements by species at the impact sites during the February 2019 survey

Species	Site 1			Site 2			Site 3			Site 4			Site 5			Totals			Grand Total	% impact
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C		
Australasian Grebe													5			5			5	0.5
Australian Magpie	51			45			14			20			37			167			167	16.3
Australian Pipit							3						4			7			7	0.7
Australian Raven	2			3			4			2			3			14			14	1.4
Australian Wood duck										5			15			20			20	2.0
Black-faced Cuckoo-shrike													1			1			1	0.1
Brown Falcon				1						1						2			2	0.2
Brown Goshawk	1							1								1	1		2	0.2
Buff-rumped Thornbill	14															14			14	1.4
Common Myna													1			1			1	0.1
Common Starling	63			98			39						111			311			311	30.4
Crested Pigeon							3			1						4			4	0.4
Crimson Rosella	8						7			2			1			18			18	1.8
Diamond Firetail													15			15			15	1.5
Dusky Woodswallow													10			10			10	1.0
Eastern Rosella	8						3						2			13			13	1.3
European Goldfinch				4									2			6			6	0.6
Galah	56			6			11						5			78			78	7.6
Great Cormorant																			0	0.0
Grey Butcherbird																			0	0.0
Grey Fantail													1			1			1	0.1
Grey Teal																			0	0.0
Laughing Kookaburra	1												2			3			3	0.3
Little Raven	3						20			3			1			27			27	2.6
Magpie-lark	9			5			6			3			9			32			32	3.1
Nankeen Kestrel																			0	0.0
Noisy Miner													6			6			6	0.6
Olive-backed Oriole																			0	0.0
Pacific Black Duck													7			7			7	0.7
Peregrine Falcon																			0	0.0
Pied Currawong							4									4			4	0.4
Raven sp.	21			11			2	2		6		4	6			26	2	4	32	3.1
Red Wattlebird							1									1			1	0.1
Red-rumped Parrot				4			6						35			45			45	4.4
Striated Pardalote													1			1			1	0.1
Striated Thornbill	8															8			8	0.8
Sulphur-crested Cockatoo	2						20			20			1			43			43	4.2
Superb Fairywren	1						3									4			4	0.4
Swamp Harrier				1												1			1	0.1
Tree Martin													43			43			43	4.2
Varied Sittella																			0	0.0
Wedge-tailed Eagle											2						2		2	0.2

Species	Site 1			Site 2			Site 3			Site 4			Site 5			Totals			Grand Total	% impact
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C		
Welcome Swallow							17						5			22			22	2.2
Whistling Kite		1	1											1			2	1	3	0.3
White-browed Woodswallow													3			3			3	0.3
White-faced Heron																			0	0.0
Willie Wagtail	3			2			5						13			23			23	2.2
Yellow-rumped Thornbill	1			15			4						4			24			24	2.3
Grand Total	**232**	**1**	**1**	**195**	**0**	**0**	**172**	**3**	**0**	**63**	**2**	**4**	**349**	**1**	**0**	**1011**	**7**	**5**	**1023**	**100**

Notes: A = Below RSA height (<35 metres); B = At RSA height (35–160 metres); C = above RSA heights (>160 metres).

Table 13: Number and height distribution of bird movements by species at the reference sites during the February 2019 survey

Species	Reference site 1		Reference site 2		Totals		Grand total	% imp
	A	B	A	B	A	B		
Australasian Grebe	4				4	0	4	0.9
Australian Magpie	27		13		27	0	27	6.2
Australian Pipit					0	0	0	0.0
Australian Raven	2		8		2	0	2	0.5
Australian Wood duck	35				35	0	35	8.0
Black-faced Cuckoo-Shrike			4		0	0	0	0.0
Brown Falcon		1			0	1	1	0.2
Brown Goshawk			1		0	0	0	0.0
Buff-rumped Thornbill					0	0	0	0.0
Common Myna					0	0	0	0.0
Common Starling	36	12	81		36	12	48	11.0
Crested Pigeon	7				7	0	7	1.6
Crimson Rosella	4		5		4	0	4	0.9
Diamond Firetail					0	0	0	0.0
Dusky Woodswallow	6				6	0	6	1.4
Eastern Rosella	3		17		3	0	3	0.7
European Goldfinch					0	0	0	0.0
Galah	49		3		49	0	49	11.3
Great Cormorant		1			0	1	1	0.2
Grey Butcherbird			1		0	0	0	0.0
Grey Fantail	5				5	0	5	1.1
Grey Teal	19				19	0	19	4.4
Laughing Kookaburra					0	0	0	0.0
Little Raven					0	0	0	0.0
Magpie-lark	5		3		5	0	5	1.1
Nankeen Kestrel				1	1	1	2	0.5
Noisy Miner			66		0	0	0	0.0
Olive-backed Oriole	1				1	0	1	0.2
Pacific Black Duck					0	0	0	0.0
Peregrine Falcon				1	1	1	2	0.5
Pied Currawong			8		0	0	0	0.0
Raven sp.					0	0	0	0.0
Red Wattlebird	3		8		3	0	3	0.7
Red-rumped Parrot					0	0	0	0.0
Striated Pardalote			4		0	0	0	0.0
Striated Thornbill	1				1	0	1	0.2
Sulphur-crested Cockatoo	188				188	0	188	43.2
Superb Fairywren			1		0	0	0	0.0
Swamp Harrier					0	0	0	0.0

Species	Reference site 1		Reference site 2		Totals		Grand total	% imp
	A	B	A	B	A	B		
Tree Martin					0	0	0	0.0
Varied Sittella	4				4	0	4	0.9
Wedge-tailed Eagle					0	0	0	0.0
Welcome Swallow	1				1	0	1	0.2
Whistling Kite			2	2	2	2	4	0.9
White-browed Woodswallow					0	0	0	0.0
White-faced Heron	1		1		0	0	0	0.0
Willie Wagtail	3				3	0	3	0.7
Yellow-rumped Thornbill	10				10	0	10	2.3
Grand Total	**414**	**14**	**226**	**4**	**417**	**18**	**435**	**100.0**

Notes: A = Below RSA height (<35 metres); B = At RSA height (35–160 metres); C = above RSA heights (160 metres); Note that no bird was recorded flying over 160 m in this survey so there is no C column in the table.

5.3.4 Number of bird observations

The distribution of bird numbers recorded among the survey sites is shown in Table 14.

Table 14: Number of birds recorded at each survey site during February 2017 survey

Observation Sites	Impact sites			Grand Total	% importance	Density No./ha/hour
	A	B	C			
1	232	1	1	234	22.9	9.3
2	195			195	19.1	7.8
3	172	3		175	17.1	7.0
4	63	2	4	69	6.7	2.7
5	349	1		350	34.2	13.9
Total	**1,011**	**7**	**5**	**1,023**	**100**	
Reference Sites						
R1	414	14		428	65.0	17.0
R2	226	4		230	35.0	9.1
Total	**640**	**18**		**658**	**100**	
Grand Total	**1,651**	**25**	**5**	**1,681**		

Notes: A = Below RSA height (<35 metres); B = At RSA height (35–160 metres); C = above RSA heights (160 metres).

The total number of birds counted at the impact sites varied between a minimum total of 63 birds at impact site 4 to a maximum total of 349 birds at site 5. The higher number at some of the survey sites was mainly due to the presence of larger numbers of bush birds in the woodland remnants surrounding the observation site or the occasional large flock of Common Starling and Sulphur-crested Cockatoo over the counting area during the fixed-point bird count.

The mix of bird species recorded at each survey site reflected the nature and type of habitat in the count area. At sites with patches of native vegetation, such as remnant woodlands, more bush birds were encountered compared with sites with open grazing paddocks and few or no trees.

The density of birds was different between the sites of the survey. The highest bird density at the impact sites was at survey site 5 and the lowest at site 4 (Figure 8). Bird density (number of birds/ha/hour) was comparatively high at sites with wooded areas included in the count area (Impact sites 1, 5), and lower at sites of more open grazing grassland (Impact sites 2, 3, 4). The difference between the averages of the two habitat types was not significant (some overlap of the standard error bars), suggesting that in the February 2019 BUS, differences in bird densities between the open grassland and remnant vegetation habitats were not as great as previous surveys had indicated (BL&A 2018b).

The trend in bird abundance at the reference sites was similar to that of the impact sites with wooded areas surrounding them as both reference sites were located close to wooded areas (Figure 8). Both reference sites had relatively high bird densities.

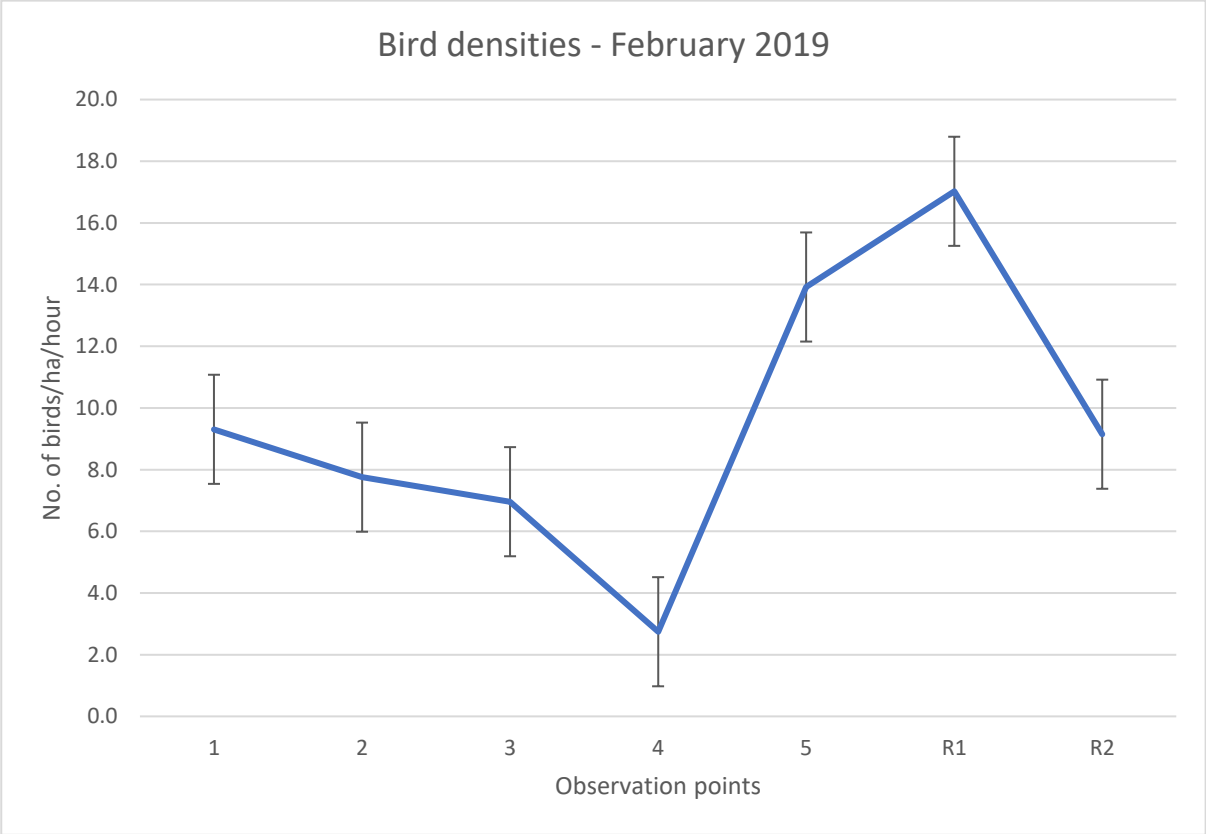


Figure 8: Bird density (birds/ha/hour) at the impact and reference sites (Average ± SE) during the February 2019 survey

5.3.5 *Flight heights*

Bird heights were classified as below (< 35 metres), at (35–160 metres), and above (> 160 metres) RSA height. The number of birds recorded at the different flight heights are presented in Figure 9.

The distribution of flight heights was similar between the surveying sites with the majority of birds recorded flying below RSA height. Overall, 93% of birds were recorded below RSA height, 7% at RSA height and no flights above RSA height.

The height distribution confirms that most birds were recorded below RSA height and are therefore exposed to a low risk of collision with operational wind turbines.

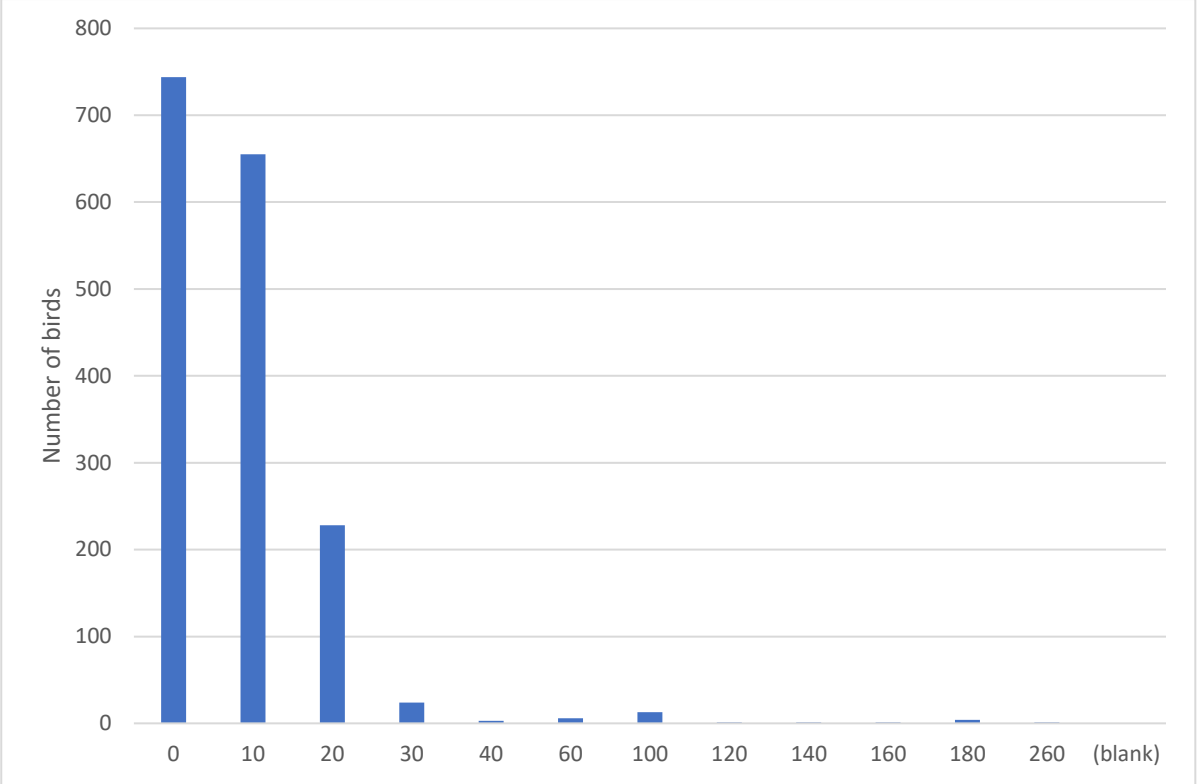


Figure 9: Height distribution of birds in the February 2019 BUS

Of the species recorded utilising the wind farm site, only four species were seen flying at RSA height at the impact sites (Table 15), these were:

- Raven species;
- Wedge-tailed Eagle;
- Whistling Kite; and
- Brown Goshawk.

These four species accounted for 100% of the total birds observed at RSA height at impact survey sites. It is unusual for such low numbers of species and individuals to be recorded at RSA height during a BUS. This finding may be indicative of better foraging areas for raptors nearby, such as at the reference sites where a greater variety and abundance of birds flew at RSA height (see below).

Overall, of all bird flights observed during the February 2019 BUS, only 0.7% (7/1023 flights) were at RSA height at the surveyed impact sites (Table 15) and include the species listed below.

- Brown Falcon;
- Common Starling;
- Great Cormorant;
- Nankeen Kestrel;
- Peregrine Falcon; and
- Whistling Kite.

Table 15At the reference sites, six species of bird were observed flying at RSA height. These were:

- Brown Falcon;

- Common Starling;
- Great Cormorant;
- Nankeen Kestrel;
- Peregrine Falcon; and
- Whistling Kite.

Table 15: Species flying at rotor swept height (RSA) at the impact sites during the February 2019 survey

Species	Totals			Grand Total	% RSA birds	% RSA of all RSA flight birds	% RSA of flights of all birds
	A	B	C				
Raven sp.	26	2	4	32	6.3	28.6	0.2
Wedge-tailed Eagle	0	2	0	2	100	28.6	0.2
Whistling Kite	0	2	1	3	66.7	28.6	0.2
Brown Goshawk	1	1	0	2	50	14.3	0.1
Grand total (All birds ^)	1011	7	5	1023	0.7	100	0.7

Notes: A= below RSA height (<35 m), B = at RSA height (35 -160 m), and C= above RSA height (>160 m). ^Note =All birds recorded in BUS (not just RSA birds).

5.3.6 Raptors

Five raptor species were recorded during the surveys, comprising 10 observations in total. The presence of these raptors varied between the survey sites (Table 12) though generally they were recorded in low numbers compared with other species (Table 16).

Whistling Kite was the most abundant raptor species at C2WF, ranging widely across the wind farm. More than one individual Brown Falcon, Brown Goshawk and Wedge-tailed Eagle were also observed. However, all raptors were seen in very low numbers during February 2019. Raptors comprised the majority of birds flying at RSA height, making up 71% (5 of 7) of all birds flying at RSA height (Table 16).

Wedge-tailed Eagles usually soar high, and often above RSA heights. Of the two recorded occurrences of this species over the wind farm site during formal BUS counts, all (100%) flights were at RSA height; however, the overall importance of the eagles among other RSA birds was 28.6% of all birds flying at RSA height (Table 16). Number of birds flying at RSA height overall were very low in February 2019 and comprised only raptors and ravens.

The number of raptors was low in relation to the total number of birds recorded during the BUS. Raptors formed approximately 0.5% of all birds recorded at the wind farm at all heights (Table 16). Based on the low utilisation rate by raptor species at the impact survey sites, risks to these species are considered to be low.

The Wedge-tailed Eagle is considered as a bird of special interest and its numbers should be monitored closely. During the February 2019 survey only two eagles were recorded flying over the wind farm site. This number is very low and amounts to 0.003 birds per hectare per hour. This figure is very low compared to densities recorded at close by operational wind farms. C2WF is likely to be part of the feeding territory of one family of eagles.

5.3.7 Waterbirds

Three waterbird species were recorded during the BUS surveys, comprising 32 observations in total (Table 17). Of these, approximately 63% were the Australian Wood Duck.

The Australian Wood Duck is a very common farmland waterbird that usually roosts along the edges of farm dams and forages in farm dams and open paddocks next to dams during day and night. They are gregarious birds, known to move and forage in flocks. Flocks of this species were observed at several farm dams across the C2WF. This species was not observed flying at RSA heights though small flocks may on occasion fly at RSA height, particularly at night time.

The remaining waterbirds recorded at impact sites were common species, including Pacific Black Duck and Australasian Grebe (Table 16).

The C2WF site contained many small farm dams close to the future wind turbine locations, but these dams generally lacked aquatic vegetation and had bare edges trampled by stock. There were also some larger dams with some aquatic vegetation located away from the future wind turbines. A large lake was located beyond the nearby Pejar Dam. These water bodies attracted a good number of water birds such as Eurasian Coots, Black Swan, Silver Gulls, as well as various cormorants, moorhen and ducks. None of the common birds using these waterbodies were seen flying over the wind farm and were mainly restricted in their movements to the waterbodies.

Table 16: Raptor and waterbird species recorded at the impact survey sites during the February 2019 survey

Species	Number of birds at:			Total	% RSA birds	% RSA of all RSA birds	% RSA of all birds
	A	B	C				
Raptors							
Whistling Kite	0	2	1	3	66.7	28.6	0.2
Brown Falcon	2	0	0	2	0.0	0.0	0.0
Brown Goshawk	1	1	0	2	50.0	14.3	0.1
Wedge-tailed Eagle	0	2	0	2	100.0	28.6	0.2
Swamp Harrier	1	0	0	1	0.0	0.0	0.0
Total raptors	**4**	**5**	**1**	**10**	**50.0**	**71.4**	**0.5**
Waterbirds							
Australian Wood duck	20	0	0	20	0.0	0.0	0.0
Pacific Black Duck	7	0	0	7	0.0	0.0	0.0
Australasian Grebe	5	0	0	5	0.0	0.0	0.0
Total waterbirds	**32**	**0**	**0**	**32**	**0.0**	**0.0**	**0.0**
Total all birds	**1011**	**7**	**5**	**1023**	**0.7**	**100.0**	**0.7**

Notes: Feb 2019 surveys: 'All RSA birds' = 7, 'All birds' = 1023.

5.3.8 Listed species

Most birds found to utilise the wind farm site were common birds. Of the species recorded during the February 2019 BUS, two species (Diamond Firetail and Dusky Woodswallow) were listed as vulnerable under the BC Act. These two species were recorded at impact site 5 which included some remnant woodland within the counting area. The Dusky Woodswallow, along with another listed species in NSW the Varied Sittella were also recorded nearby at the reference sites.

Conclusions resulting from the February 2019 BUS surveys are provided together in Section 6.1.3.

Listed species continued to be encountered on-site at C2WF during formal bird and bat mortality searches, with Black Falcon, Little Eagle, Diamond Firetail and Dusky Woodswallow all recorded during 2019.

5.4 Comparison Summary of February 2017 and February 2019 survey results

Overall, the results of the February 2019 survey were in many respects similar to those of the February 2017 survey. However, the more recent survey recorded less species and less birds at lower densities. It also recorded a lower percentage of birds at RSA height but more raptor species and more threatened species. Table 17 below provides a comparison of the main survey results between the two surveys. The reasons for this may be related to the widespread and severe drought that has persisted in the area since 2017. Further analysis of these data will be undertaken for the second annual report (for the year 2020).

Table 17: Comparison of February 2017 and February 2019 BUS results

Bird Utilisation Survey (BUS)	February 2017	February 2019
No. of bird species recorded at the windfarm	78	58
No. of bird species recorded during the formal BUS (as a % of all birds recorded)	55 (70%)	48 (83%)
Total no. of bird counts (individuals) at impact sites	2567	1023
Range of bird density at impact sites (No. of birds/ha/hour)	6.9 - 18.5	2.7-13.9
% of all birds counted at RSA height (including reference sites)	7%	1.5%
% of bird observations at RSA height at impact sites only	5.1%	0.7%
No. of raptor species recorded at the wind farm	4	7
No. of raptor species recorded during the formal BUS	4	7
% of raptor observations at RSA height (impact sites only)	46%	50%
% of raptors recorded at RSA height/all birds recorded (impact sites only)	<1%	<1%
No. of threatened birds recorded at the wind farm	1	3
No. of threatened birds recorded during the formal BUS	1	2

6 Summary, implications and adaptive management

Post-construction bird and bat carcass searches for the first year of the operation of C2WF were undertaken in accordance with the approved BBMP (BL&A 2018a).

6.1 Birds

6.1.1 Overall carcass search results

Between January 2019 and December 2019 where 27 bird remains were found during formal searches and one found incidentally. The most commonly occurring species recorded under turbines were the Australian Magpie, Wedge-tailed Eagle, Brown Falcon, Grey Fantail, Nankeen Kestrel, raven sp. and Galah.

The Australian Magpie and Galah were in the top three most abundant species at the wind farm during the February bird utilisation survey and similarly the Wedge-tailed Eagle, Brown Falcon and Nankeen Kestrel were the top three most abundant raptors at the wind farm site from the raptor observations that were recorded. The Little Raven and Forest Raven are also common occurring birds in farmland and often fly at Rotor swept area heights. The unusual finding was three Grey Fantail during the April carcasses searches where three birds were found under two turbines. This species usually flies below the rotor swept area. It is likely that the Grey Fantail may have been migrating north at the time of collision.

The bird species found during the carcass searches constitute a very small proportion of the bird species recorded on the wind farm. Many of the woodland birds do not regularly fly at RSA height and therefore do not feature in the carcass search results (with the exception of the Grey Fantail). There was a slight peak in the number of bird carcass found in April 2019 due to the Grey Fantail collisions.

One threatened species — Black Falcon — was recorded as a casualty at the wind farm. Black Falcon is listed as vulnerable under the NSW *Biodiversity Conservation Act 2016*. This finding triggered a response in accordance with the BBAMP and targeted raptor surveys were promptly initiated to determine the status of the species at the C2WF site. After consultation with the Biodiversity and Conservation team at the Department of Planning, Industry and Environment point count surveys were undertaken from vantage points across the site. Black Falcon was observed sporadically from July to October 2019 and was only recorded incidentally while traversing around the site and never recorded during the point-count raptor surveys. The point-count surveys ceased in November as the Black Falcon was not recorded during the previous two consecutive surveys and was thought to no longer be in the area.

6.1.2 At risk species

Three species or groups of birds were identified in the BBAMP as being at risk from the wind farm. These include the following.

- Wedge-tailed Eagle
- Other raptors
- White-throated Needletail

There have been no White-throated Needletail carcasses detected under turbines nor were any recorded at the site during 2019, hence it is considered highly unlikely that this species has been impacted on by the wind farm. However, there have been carcasses of Wedge-tailed Eagle and other raptors found under turbines. This is discussed below.

A total of four Wedge-tailed Eagle, three Brown Falcon (plus two prior to the monitoring period commencing), three Nankeen Kestrel and one Black Falcon (listed as threatened under the BC Act) have

been recorded as casualties at the wind farm to date. To gain a better understanding of how these species are using the site, ongoing monitoring has been undertaken. Wedge-tailed Eagle nests have been identified and monitored in the breeding season for occupancy. Flight paths have been mapped to gain a better understanding of turbines at most risk of strike. It is considered likely that raptor collisions are due mainly to their soaring habits and preference to the type of habitat (windy with uplifting air currents) at the wind farm.

6.1.3 Conclusions from 2019 bird utilisation surveys

The conclusions from the February 2019 BUS at the C2WF are presented below:

- The study area consists largely of cleared ridges and plateaux supporting an abundance of common, predominantly farmland birds;
- The study area supports a low proportion of raptors compared to the number of all other birds that were recorded using the site. Raptors represented less than 1% of all birds recorded at impact sites during both the February 2017 and February 2019 BUS;
- The study area supports a low proportion of waterbirds compared to the number of all other birds that were recorded using the site. Waterbirds represented 2% and 3% of all birds recorded at impact sites during the February and November BUS surveys respectively;
- Bird abundance and diversity tended to be higher at BUS sites surrounded by remnant woodlands or scattered trees compared to sites lacking trees;
- The proportion of birds recorded at RSA height (at impact sites) was low — 5% in February 2017 and less than 1% in February 2019;
- The proportion of raptors recorded at RSA height against all birds recorded (at impact sites) was very low — 0.5% for both the 2017 and 2019 February surveys; and
- A total of three threatened birds were recorded across the two surveys. All three are woodland birds and were mostly recorded in trees or on the ground — largely below RSA height.

6.1.4 Implications and adaptive management

The number of carcasses found at Crookwell 2 Wind Farm is comparable to other wind farms in south-eastern Australia. Raptors were among some of the more common species found under turbines including one Black Falcon. Continued incidental monitoring of raptors, including recording species, flight heights and behaviour, and plotting flight paths, is to continue during the 2020 monitoring period.

6.2 Bats

6.2.1 Overall carcass results

Overall 19 bat carcasses were found during the 2019 monitoring period at Crookwell 2 Wind Farm. This includes one carcass that was found incidentally by wind farm personnel. None of the bat carcasses found under turbines were listed as threatened under the BC Act or the commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

No bat carcasses were found between April and August 2019; the colder months when bat activity is comparatively low or absent as most bats are in a torpor state which is similar to hibernating or have migrated from the area. January, March and October were peak periods for bat collisions being detected with being collected each month.

The commonly-occurring White-striped Freetail Bat was the most commonly found bat species and is discussed below.

6.2.2 At risk species

One bat species was identified in the BBAMP as being at risk from collision with turbines — White-striped Freetail Bat.

A total of 12 White-striped Freetail Bat were found in the first year of monitoring including one bat found incidentally. This number is considered to be within the normal range of White-striped Freetail Bat casualties found under turbines at operating wind farms. The White-striped Freetail Bat is widespread on the wind farm site based on the bat survey results and often flies at RSA heights, which puts it at risk of collision with turbines.

6.2.3 Implications and adaptive management

Impacts on bat species are considered to be negligible as the number of dead bats found during the mortality monitoring program was low. It is considered unlikely that the project is having a significant impact on any bat species' population. The monitoring program will continue throughout 2020.

7 References

AusWEA (Australian Wind Energy Association) 2005. Wind Farms and Birds: Interim Standards for Risk Assessment. Report prepared by Brett Lane and Associates and AIRA Professional Services; Report No. 2003.35 (2.2), July 2005.

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Clean Energy Council 2018. Best Practice Guidelines for Implementation of Wind Energy Projects in Australia. Clean Energy Council, Australia.

Hull, C L & Muir, S, 2010, Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo method, Austr. J. Env. Management 17:77-87.

Appendix 1: Bird mortality data obtained during the first year of monitoring in 2019.

Season	Date	Common name	Threatened Status	Report (R)/ Feather spot (FS)/ Incidental (INC)	Turbine number	Distance from turbine (m)	Bearing from turbine
Spring	29/10/2018	Brown Falcon	-	INC18.10.1	7	35	S
Summer	20/12/2018	Brown Falcon	-	INC18.12.1	25	102	
Summer	16/01/2019	Eurasian Skylark	-	FS19.1.1	7	40	S
Summer	17/01/2019	Galah	-	FS19.1.2	10	20	N
Summer	12/02/2019	Fairy Martin	-	R19.2.2	8	53	N
Summer	12/02/2019	Galah	-	FS19.2.3	10	47	NW
Summer	12/02/2019	Raven sp.	-	FS19.2.4	1	91	SE
Autumn	14/03/2019	Raven sp.	-	R19.3.4	6	93	N
Autumn	5/03/2019	Nankeen Kestrel	-	INC19.3.7	3	20	N/A
Autumn	9/04/2019	Grey Fantail	-	R19.4.1	8	39	S
Autumn	9/04/2019	Brown Falcon	-	R19.4.2	4	65	SE
Autumn	11/04/2019	Common Starling	-	FS19.4.3	7	30	E
Autumn	11/04/2019	Grey Fantail	-	R19.4.4	7	56	SW
Autumn	11/04/2019	Grey Fantail	-	R19.4.5	8	57	W
Autumn	14/05/2019	Brown Falcon	-	FS19.5.2	12	94	SE
Winter	13/06/2019	Brown Falcon	-	FS19.6.1	15	42	W
Winter	16/07/2019	Black Falcon	Vulnerable (NSW)	R19.7.3	18	0	
Winter	16/07/2019	Raven sp.	-	FS19.7.1	1	85	S
Winter	15/08/2019	Australian Wood Duck	-	FS19.8.1	10	39	W
Spring	9/09/2019	Australian Magpie	-	R19.9.1	18	2	S
Spring	1/10/2019	Australian Magpie	-	R19.9.2	27	60	W
Spring	23/10/2019	Australian Magpie	-	R19.10.3	12	80	S

Season	Date	Common name	Threatened Status	Report (R)/ Feather spot (FS)/ Incidental (INC)	Turbine number	Distance from turbine (m)	Bearing from turbine
Spring	24/10/2019	Laughing Kookaburra	-	R19.10.6	6	41	NW
Spring	13/11/2019	Nankeen Kestrel	-	FS19.11.2	27	114	N
Spring	15/11/2019	Australian Magpie	-	FS19.11.3	27	55	NW
Summer	11/12/2019	Nankeen Kestrel	-	FS19.12.1	18	62	N

Appendix 2: Bat mortality data obtained during the first year of monitoring at C2WF.

Month	Date	Common Name	Species	Threatened status	Report Number	Turbine number	Distance from turbine (m)	Bearing from turbine (°)
January	19/01/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.1.4	15	90	E
January	19/01/2019	Gould's Wattled Bat	*Chalinolobus gouldii*	-	R19.1.5	24	10	E
January	19/01/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.1.8	12	7	N
January	19/01/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.1.9	12	20	N
January	19/01/2019	Gould's Wattled Bat	*Chalinolobus gouldii*	-	R19.1.6	24	20	E/SE
February	11/02/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.2.1	7	3	NW
Autumn	5/03/2019	White-striped Freetail Bat	*Austronomis australis*	-	INC19.3.8	27	8	N
March	13/03/2019	Unknown bat sp.	*N/A*	-	R19.3.1	10	34	E
March	13/03/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.3.2	12	32	E
March	14/03/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.3.3	6	27	N
March	15/03/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.3.5	24	13	NE
March	16/03/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.3.6	21	61	S
May	13/05/2019	Gould's Wattled Bat	*Chalinolobus gouldii*	-	R19.5.1	27	70	E
September	1/10/2019	Gould's Wattled Bat	*Chalinolobus gouldii*	-	R19.9.3	15	71	SW
October	22/10/2019	Chocolate Wattled Bat	*Chalinolobus morio*	-	R19.10.1	6	27	E
October	22/10/2019	Chocolate Wattled Bat	*Chalinolobus morio*	-	R19.10.2	3	0	S
October	23/10/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.10.4	27	41	NW
October	23/10/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.10.5	27	36	NW
October	24/10/2019	White-striped Freetail Bat	*Austronomis australis*	-	R19.10.7	27	30	W

Appendix 3 Scavenger trial data obtained during the first year of monitoring at C2WF.

Season	Species	Carcass size	Placement Date	Scavenged date	Scavenged time	Days in the field	Turbine	Scavenger
Winter	Brown Falcon	Large	14/08/2019	27/08/2019	2:55am	13	27	Red Fox
Winter	Nankeen Kestrel	Medium	14/08/2019	21/08/2019	3:16am	7	6	Red Fox
Winter	White-striped Freetail Bat	Bat	14/08/2019	17/08/2019	5:25pm	3	8	Australian Raven
Winter	White-striped Freetail Bat	Bat	14/08/2019	14/08/2019	11:38am	0	24	Australian Raven
Spring	Common Myna	Medium	6/09/2019	12/09/2019	5:40am	6	6	Red Fox
Spring	Common Starling	Medium	1/10/2019	1/10/2019	9:01pm	1	21	Red Fox
Spring	Common Starling	Medium	1/10/2019	2/10/2019	11:54pm	2	13	Red Fox
Spring	Common Starling	Medium	1/10/2019	2/10/2019	9:09pm	2	25	Red Fox
Spring	Australian Magpie	Large	5/09/2019	13/09/2019	9:13am	8	27	Australian Raven
Spring	Gould's Wattled Bat	Bat	5/09/2019	5/09/2019	2:34pm	1	24	Australian Raven
Spring	Common Myna	Medium	7/09/2019	11/09/2019	3:41pm	4	8	Australian Raven
Spring	Grey Fantail	Small	5/09/2019	30/09/2019	12:31am	25	13	Red Fox
Spring	White-striped Freetail Bat	Bat	5/09/2019	9/09/2019	9:09am	4	25	Australian Raven
Spring	Gould's Wattled Bat	Bat	5/09/2019	15/09/2019	3:48am	10	18	Unknown
Spring	Common Starling	Medium	2/10/2019	9/10/2019	4:13am	7	6	Red Fox
Spring	Common Myna	Medium	30/09/2019	16/10/2019	7:18pm	16	8	Red Fox
Spring	White-striped Freetail Bat	Bat	1/10/2019	7/10/2019	4:13am	6	25	Unknown
Spring	Common Starling	Medium	2/10/2019	17/10/2019	2:22am	15	27	Red Fox
Spring	White-striped Freetail Bat	Bat	23/10/2019	25/10/2019	12:31am	2	27	Red Fox
Spring	Brown Falcon	Large	5/09/2019	21/09/2019	8:37pm	16	25	Red Fox
Spring	White-striped Freetail Bat	Bat	22/10/2019	25/10/2019	12:58am	3	8	Red Fox
Spring	White-striped Freetail Bat	Bat	22/10/2019	23/10/2019	N/A	1	6	Unknown

Season	Species	Carcass size	Placement Date	Scavenged date	Scavenged time	Days in the field	Turbine	Scavenger
Spring	Laughing Kookaburra	Large	24/10/2019	25/10/2019	N/A	1	6	Unknown
Spring	White-striped Freetail Bat	Bat	24/10/2019	24/10/2019	9:49pm	0	25	Red Fox

Appendix 4: Raptor observation at C2WF during 2019 monitoring period

Map Ref	Species	Date	Incidental/ point count	Start time	Finish time	Number of birds	Age	Flight height	Min height	Max height	Flight direction	Flight behaviour	Notes	Observer
1	Little Eagle	15/03/2019	Incidental	13:49	13:50	1	Adult	80				Flapping	One adult, mobbed by several magpies. Nearly hit by blades as a result. As close as 10 metres from strike area.	Beau Meney
2	Wedge-tailed Eagle	11/06/2019	Incidental	15:06	15:08	2	Adults		30	100	North-east	Gliding, soaring		Beau Meney
3	Wedge-tailed Eagle	13/06/2019	Incidental	10:35	10:36	1			50	100	East	Soaring		Beau Meney
4	Wedge-tailed Eagle	13/06/2019	Incidental	10:35	10:37	1		150	150	150	North	Gliding		Beau Meney
5	Black Falcon	13/06/2019	Incidental	15:05	15:06	1	Adult	30				Flapping	One individual seen flying to the north of turbine 12 and heading south-west. Individual seen again along Crookwell Road when leaving site.	Beau Meney
6	Wedge-tailed Eagle	16/07/2019	Incidental											Beau Meney
7	Wedge-tailed Eagle	17/07/2019	Incidental											Beau Meney
8	Black Falcon	17/07/2019	Incidental	9:39	9:41	2	Adult	RSA height	90			Flapping	Pair seen flying northward at Rsa height, in close proximity turbines 23 and 21.	Beau Meney
9	Black Falcon	18/07/2019	Incidental	16:17	16:17	1	Adult	5	5	70	West	Flapping	One individual sighted being harrassed magpies and flying west over Crookwell Road.	Beau Meney
10	Wedge-tailed Eagle		Incidental											Beau Meney
11	Wedge-tailed Eagle		Incidental											Beau Meney
12	Wedge-tailed Eagle	13/08/2019	Incidental	11:14	11:15	1		200			North	Gliding	Flew north approximately 1km.	Beau Meney
13	Nankeen Kestrel	13/08/2019	Incidental	12:35	12:38	1	Adult	15		15	West	Hovering	Flew west approximately 185m.	Beau Meney
14	Wedge-tailed Eagle	13/08/2019	Incidental	12:45	12:47	1		400			West	Gliding, soaring		Beau Meney
15	Black Falcon	13/08/2019	Incidental	14:28	14:28	1		5				Foraging	Hunting.	Beau Meney
16	Wedge-tailed Eagle	14/08/2019	Incidental	15:05	15:07	1	Adult	90			South-east	Gliding	Flying between T25 and T28.	Beau Meney
17	Wedge-tailed Eagle	15/08/2019	Incidental	11:27	11:30	2	Adult/sub-adult	70	70	500		Courtship display, gliding	West of T2, flying above RSA height, 400-500m high.	Beau Meney
18	Wedge-tailed Eagle	15/08/2019	Incidental	11:33	11:35	1	Adult		100	250		Soaring		Beau Meney
19	Nankeen Kestrel	3/09/2019	Point Count T25	13:10		1		RSA height				Foraging	1 Nankeen Kestrel foraging 500m north of T25 at RSA height.	Jackson Clerke
20	Wedge-tailed Eagle	3/09/2019	Point Count T25	13:10		1		RSA height			North	Gliding	1 Wedge-taile Eagle moving north 2kms South-East of T25 at RSA height.	Jackson Clerke
21	Nankeen Kestrel	4/09/2019	Point Count T26	9:35		1		Below RSA height				Foraging	1 Nankeen Kestrel foraging 250m N of T26 below RSA.	Jackson Clerke
22	Brown Falcon	4/09/2019	Point Count T13	15:01		1		Below RSA height			North	Flapping	1 Brown Falcon 300m West of T13 moving north below RSA.	Jackson Clerke

Map Ref	Species	Date	Incidental/ point count	Start time	Finish time	Number of birds	Age	Flight height	Min height	Max height	Flight direction	Flight behaviour	Notes	Observer
23	Nankeen Kestrel	6/09/2019	Point Count T10	9:39		1		Below RSA height			East	Flapping	1 Nankeen Kestrel moving East 50 South of T10 below RSA.	Jackson Clerke
24	Black Falcon	6/09/2019	Incidental	12:30		1		20			East	Flapping	1 Black Falcon moving east along WF track harrassed by starlings.	Jackson Clerke
25	Wedge-tailed Eagle	30/09/2019	Point Count T24	14:00		2			150	350	South-west	Gliding, courtship display	2 WTE at approx above T24 at 350 and 150 m height. One moved South-west and one performed courtship displays.	Guille Mayor
26	Nankeen Kestrel	30/09/2019	Point Count T24	14:00		1		30				Foraging	1 Nankeen Kestrel foraging at 30m.	Guille Mayor
27	Brown Falcon	30/09/2019	Point Count T21	14:30		2		10				Courting	2 brown Flacon seen copulating in a tree near turbine.	Guille Mayor
28	Wedge-tailed Eagle	30/09/2019	Point Count T15	15:00		1		400			South-west	Soaring	1 WTE soaring at appro 400m height moving South-west.	Guille Mayor
29	Nankeen Kestrel	30/09/2019	Point Count T15	15:00		1		30				Foraging	1 Nankeen Kestrel foraging at 30m height.	Guille Mayor
30	Brown Falcon	30/09/2019	Point Count T18	15:45		2							2 Brown Falcon seen at a potential nesting site 250m from turbine.	Guille Mayor
31	Nankeen Kestrel	30/09/2019	Point Count T18	15:45		1		20				Foraging	1 Nankeen Kestrel foraging at 20m height.	Guille Mayor
32	Nankeen Kestrel	30/09/2019	Point Count T13	16:30		3		10				Foraging	3 Nankeen Kestrel foraging close to ground.	Guille Mayor
33	Nankeen Kestrel	1/10/2019	Point Count T12	9:30		2		50			East	Flapping	2 Nankeen Kestrels moving E at 50m height.	Guille Mayor
34	Wedge-tailed Eagle	1/10/2019	Point Count T10	10:00		1		300			East	Soaring		Guille Mayor
35	Nankeen Kestrel	1/10/2019	Point Count T10	10:00		1		50				Foraging		Guille Mayor
36	Brown Goshawk	1/10/2019	Point Count T6	12:30		1		500			West	Flapping		Guille Mayor
37	Wedge-tailed Eagle	1/10/2019	Point Count T6	12:30		2		400			West	Soaring		Guille Mayor
38	Wedge-tailed Eagle	1/10/2019	Point Count T1	13:00		2		250			North-west	Gliding		Guille Mayor
39	Wedge-tailed Eagle	1/10/2019	Point Count T3	14:00		2		200			North	Soaring		Guille Mayor
40	Brown Goshawk	1/10/2019	Point Count T3	14:00		1		50				Soaring		Guille Mayor
41	Nankeen Kestrel	1/10/2019	Point Count T3	14:00		1		50				Mobbing	1 Nankeen Kestrel at 50m height, harassing the Goshawk.	Guille Mayor
42	Wedge-tailed Eagle	2/10/2019	Point Count T26	9:00		2		600				Soaring		Guille Mayor
43	Black Falcon	2/10/2019	Incidental			1	Adult					Hovering	Hovering against wind and diving for birds on the ground, 50m west of turbine 28.	Guille Mayor
44	Nankeen Kestrel	21/10/2019	Point Count	14:50	14:52	1			10	50		Foraging		Eamon O'Meara
45	Nankeen Kestrel	21/10/2019	Point Count	17:16	17:16	1			20	50		Flapping		Eamon O'Meara
46	Wedge-tailed Eagle	22/10/2019	Point Count	13:20	13:29	2			50	500		Soaring		Eamon O'Meara
47	Wedge-tailed Eagle	22/10/2019	Point Count	15:19	15:20	1			60	100		Gliding		Eamon O'Meara
48	Nankeen Kestrel	22/10/2019	Point Count	16:40	16:41	1			15	50		Foraging		Eamon O'Meara

Map Ref	Species	Date	Incidental/ point count	Start time	Finish time	Number of birds	Age	Flight height	Min height	Max height	Flight direction	Flight behaviour	Notes	Observer
49	Nankeen Kestrel	22/10/2019	Point Count	17:37	17:40	2			0	50		Foraging		Eamon O'Meara
50	Nankeen Kestrel	22/10/2019	Point Count	17:42	17:42	2			0	25		Foraging		Eamon O'Meara
51	Nankeen Kestrel	11/11/2019	Point Count 13	13:58	14:01	1			15	30	West	Foraging	1 x Nankeen Kestrel observed foraging at 15-30m above ground, 50m west of T13. Flew to west.	Justin Sullivan
52	Nankeen Kestrel	11/11/2019	Point Count 15	14:21	14:21	1					East	Foraging	1 x Nankeen Kestrel observed foraging 300m east of T15. Flew to east.	Justin Sullivan
53	Brown Falcon	11/11/2019	Point Count 15	14:22	14:22	2			0	10		Mobbing	2 x Brown Falcon observed diving at Ravens at ground level, 400m south west of T15.	Justin Sullivan
54	Nankeen Kestrel	11/11/2019	Point Count 15	14:34	14:36	3							3 x Nankeen Kestrels foraging/circling 20-50m above ground, 50m north west of T20.	Justin Sullivan
55	Nankeen Kestrel	11/11/2019	Point Count 18	15:02	15:19	1			0	20	North	Foraging	1 x Nankeen Kestrel observed foraging at 0-20m above the ground. Bird moved from south of T18 to 100m north west of T18, to 50m west of T21.	Justin Sullivan
56	Nankeen Kestrel	11/11/2019	Point Count 27	16:09		1			10	100	North	Soaring	1 x Nankeen Kestrel observed soaring between 10 and 100m above the ground, flying north of T28.	Justin Sullivan
57	Wedge-tailed Eagle	11/11/2019	Point Count 27	16:16		1		250			South	Gliding	Wedge-tailed Eagles gliding at approx 250m above ground, south west of T28. Glided south.	Justin Sullivan
58	Wedge-tailed Eagle	11/11/2019	Point Count 27	16:16		1		250			North-west	Gliding	Wedge-tailed Eagles gliding at approx 250m above ground, south west of T28, glided to the north west.	Justin Sullivan
59	Brown Falcon	11/11/2019	Point Count 25	16:37	16:56	2		20				Foraging	2 x Brown Falcon observed foraging at 20m above the ground, along the ridge 100m west of T25.	Justin Sullivan
60	Nankeen Kestrel	11/11/2019	Point Count 25	16:39	16:45	2		20				Foraging	2 x Nankeen Kestrel observed foraging at 20m above the ground, 50m west of T25. One swooped at a Brown Falcon.	Justin Sullivan
61	Nankeen Kestrel	11/11/2019	Point Count 26	17:13		1		30				Foraging	1 x Nankeen Kestrel observed flying at 30m above ground, 400m north west of T26, then dropped behind ridge.	Justin Sullivan
62	Wedge-tailed Eagle	13/11/2019	Point Count 3	8:49	9:09	2			50	200	North/south	Gliding	2 x Wedge-tailed Eagle gliding 50-200m high west of T3, then observed flying north-south along vegetated gully. At one point came within 40m of T4.	Justin Sullivan
63	Peregrine Falcon	13/11/2019	Point Count 3	9:08	9:08	1					West	Mobbing	1 x Peregrine Falcon observed swooping at Wedge-tailed Eagle, then flying west.	Justin Sullivan
64	Peregrine Falcon	13/11/2019	Point Count 24	10:59	10:59	1		100			North-west	Flapping	1 x Peregrine Falcon observed at 100m above ground, 200m north west of T23. Flew north west.	Justin Sullivan
65	Brown Falcon	13/11/2019	Point Count 24	11:02	11:02	2			0	10		Flapping	2 x Brown Falcons observed at 0 to 10 m above ground, 300m north west of T23. One bird flew and perched on small tree.	Justin Sullivan
66	Nankeen Kestrel	13/11/2019	Incidental	11:20	11:20	1		15			West	Hovering, flapping	1 x Nankeen Kestrel observed at 15m above ground, flying over riparian planting area, west of T23. Hovered over-head and flew west.	Justin Sullivan
67	Wedge-tailed Eagle	13/11/2019	Incidental	11:45	11:47	3	2 adults, 1 juvenile		11	150	West	Soaring	3 x Wedge-tailed Eagle observed soaring at 100-150m above ground, west of T25. Flying above gully.	Justin Sullivan
68	Brown Falcon	14/11/2019	Point Count 4	7:37	7:37	1		10				Perched	1 x Brown Falcon observed perched in tree in gully, 250m west of T4.	Justin Sullivan
69	Nankeen Kestrel	14/11/2019	Point Count 1	8:01	8:01	1			0	20		Foraging	1 x Nankeen Kestrel observed at 0-20m above ground, foraging 100m north of T1. At one point, seen diving to ground for prey.	Justin Sullivan
70	Nankeen Kestrel	14/11/2019	Incidental	8:27	8:27	1		100			North-west	Flapping	1 x Brown Falcon observed at 100m above ground, flying north west of T1.	Justin Sullivan

Map Ref	Species	Date	Incidental/ point count	Start time	Finish time	Number of birds	Age	Flight height	Min height	Max height	Flight direction	Flight behaviour	Notes	Observer
71	Wedge-tailed Eagle	14/11/2019	Incidental	8:28	8:33	2		180				Soaring	2 x Wedge-tailed Eagle observed at 180m above ground, soaring 200 west of T1-T4 (soaring along gully).	Justin Sullivan
72	Nankeen Kestrel	14/11/2019	Incidental	9:40	9:40	1		20				Foraging	1 x Nankeen Kestrel observed south of main wind farm access road on Crookwell Road.	Justin Sullivan
73	Brown Falcon	14/11/2019	Incidental	11:19	11:19	1		120				Flapping	1 x Brown Falcon observed at 120m high being swooped by approx 15 Australia Magpies, 500m west of T24.	Justin Sullivan

Appendix 5: Raw data for February 2019 BUS at impact sites at C2WF

Site	1										2								3									4										5									Grand Total
Height class	A								B	C	A								A								B	A							B	C	A								B	
Species/replicate	1	2	3	4	5	6	7	8	2	2	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	3	8	1	2	3	4	5	6	7	8	5	6	1	2	3	4	5	6	7	8	8	
Australasian Grebe																																										3		2				5
Australian Magpie	6	1	7	13	8	12	2	2			6	6	2	5	9	7	6	4		1			4	4	4	1			1	2	1	8	2	3		3				3	1	2	23	2	3	3		167
Australian Pipit																				1			1		1															2	2							7
Australian Raven				2												1	2		1					2		1						2										2	1			14
Australian Wood duck																													5												15						20
Black-faced Cuckoo-shrike																																												1			1
Brown Falcon																	1																1													2
Brown Goshawk		1																									1																			2
Buff-rumped Thornbill	8		4		2																																									14
Common Myna																																												1			1
Common Starling	3	8		47				5				21	5	49	4		18	1		22			17																	4	6	16	7	30		40	8		311
Crested Pigeon																				2					1									1													4
Crimson Rosella			2	3		1		2												2			2	1	2							2										1					18
Diamond Firetail																																											5		1	6	3		15
Dusky Woodswallow																																							4		2			3	1			10
Eastern Rosella				2	2		2	2												3																									2		13
European Goldfinch																		4																								1	1					6
Galah		32			22		2								4		2			10					1																		5					78
Grey Fantail																																							1									1
Laughing Kookaburra				1																																						1		1			3
Little Raven		3																							17	3				1					2									1			27
Magpie-lark	1				2	2		4				2			2			1		1	1		1		2	1					2			1						1	2		2	2		2		32
Noisy Miner																																										2			4		6
Pacific Black Duck																																										5		2				7
Pied Currawong																							2		2																							4
Raven sp.		1									2							9								2		2		1				5				4		3	1	1				1		32
Red Wattlebird																							1																									1
Red-rumped Parrot														4									6																	2	8	3	5	5	3	3	6		45
Striated Pardalote																																													1			1
Striated Thornbill					8																																											8
Sulphur-crested Cockatoo				2																	1			12	2	5						2		18								1					43
Superb Fairywren		1																						2	1																							4
Swamp Harrier															1																																	1
Tree Martin																																								26	2	3			8		4		43
Wedge-tailed Eagle																																					2										2
Welcome Swallow																					10	1	3	2		1																3			2		22
Whistling Kite									1	1																																					1	3
White-browed Woodswallow																																										3						3
Willie Wagtail	1	1						1					1					1					2	1	1	1														1	1	3	2	1	3	1	1		23
Yellow-rumped Thornbill								1				4	2			6		3						4																4								24
Grand Total	19	48	13	70	44	15	6	17	1	1	8	33	10	58	20	14	29	23	1	42	12	1	39	28	34	15	1	2	1	9	1	16	3	27	1	5	2	4	38	30	54	37	63	31	56	40	1	1023

Appendix 6: Raw data for February 2019 BUS at reference sites at C2WF

Reference site	R1										R2										Grand Total
Height Class	A								B		A								B		
Species/replicate	1	2	3	4	5	6	7	8	6	8	1	2	3	4	5	6	7	8	6	8	
Australasian Grebe	3				1																4
Australian Magpie	1	4	2	5	3	3	2	7			1	1	3	4	1	1	2				40
Australian Raven				1				1				2	1	1	1	1	2				10
Australian Wood duck		8		8	8	11															35
Black-faced Cuckoo-shrike															2		2				4
Brown Falcon									1												1
Brown Goshawk													1								1
Common Starling		22	13					1	12		10		1	1	41	12	16				129
Crested Pigeon	1	2		2	2																7
Crimson Rosella						4								2	1		2				9
Dusky Woodswallow		2						4													6
Eastern Rosella		1					2				2	2	4	5			4				20
Galah		23		2	23			1									3				52
Great Cormorant										1											1
Grey Butcherbird														1							1
Grey Fantail	1		1			2	1														5
Grey Teal		7			8		4														19
Magpie-lark				2	2			1					1	1				1			8
Nankeen Kestrel																			1		1
Noisy Miner											2	8	5	15	8	16	6	6			66
Olive-backed Oriole		1																			1
Peregrine Falcon																				1	1
Pied Currawong											2		2	2		1	1				8
Red Wattlebird				1		1		1						2	3	2		1			11
Striated Pardalote											2							2			4
Striated Thornbill					1																1
Sulphur-crested Cockatoo		65		3	2	5		113													188
Superb Fairywren																	1				1
Varied Sittella						4															4
Welcome Swallow								1													1
Whistling Kite												1					1		1	1	4
White-faced Heron	1													1							2
Willie Wagtail		1	2																		3
Yellow-rumped Thornbill	2		6			1	1														10
Grand Total	9	136	24	24	50	31	10	130	13	1	19	14	18	35	57	33	40	10	2	2	658