CROOKWELL 2 WIND FARM

BIRD AND BAT ADAPTIVE MANAGEMENT PROGRAM

RISK ASSESSMENT

Crookwell Development Pty Ltd

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1. INTRODUCTION

BL&A was engaged by Crookwell Development Pty Ltd to undertake a risk assessment of the Bird and Bat Adaptive Management Program (BBAMP) for the Crookwell 2 Wind Farm (C2WF). The C2WF project is located approximately 14km south-east of the Crookwell township and 28km north-west of Goulburn in the southern tablelands of New South Wales.

The NSW Office of Environment and Heritage (OEH) requested that an updated risk assessment be completed in a letter to Crookwell Development Pty Ltd dated 14 November 2016.

The conditions of approval requires a risk analysis that demonstrates that the selected turbine sites, including allowance for micro-siting, will not result in a significant impact on birds and bats listed as migratory or threatened, or other species of concern, namely raptors (e.g. Wedge-tailed Eagle) and water birds.

This risk assessment has therefore been prepared by BL&A for Crookwell Development Pty Ltd, as a basis for focussing the monitoring and investigations that will form part of the BBAMP on identified, significant risks.

Wind farms can impact on birds and bats via two potential pathways, as listed below.

- Direct impacts such as collision of birds and bats with operating wind turbine towers or blades at rotor swept area (RSA) heights
- Indirect impacts such as disturbance effects that exclude birds and bats from habitat and/or barrier effects that limit bird and bat movements between essential resources, such as foraging and roosting areas.

The risk assessment has followed the procedure for risk assessment of AS/NZS ISO 31000 2009. The assessment has been undertaken as described below.

- Bird and bat species or groups of concern have been short-listed based on their likelihood of occurrence at the site
- Two impact pathways have been assessed: a) direct collision with turbines; and b) indirect effects (including both disturbance and barrier effects)
- Impact likelihood criteria have been developed and applied to each impact pathway for each species or group of concern
- Impact consequence criteria have been developed and applied to each impact pathway for each species or group of concern
- The risk level for each species or group of concern from the two impact pathways has been determined consistent with a risk matrix.

As some groups, such as bats, many raptors and waterbirds, behave in similar ways, their risk profile is the same and species within these groups are not assessed separately. Any species in these groups are considered to be subject to the level of risk assessed for their group.

This risk assessment was undertaken by a team from Brett Lane & Associates Pty Ltd including; Peter Lansley (Senior Zoologist), Alan Brennan (Senior Ecologist and Project Manager) and Brett Lane (Principal Consultant).

2. SOURCES OF INFORMATION AND SPECIES OF CONCERN

2.1. Sources of Information

To ascertain the species of concern that may occur on the C2WF site, the following sources were used.

- The NSW Bionet Atlas Search tool (OEH 2017a), using an approximate 30 by 30 kilometre search region using the following co-ordinates (North: 34.40 West: 149.42 East: 149.75 South: 34.68, decimal degrees) centred over the proposed C2WF site (searched 16 March 2017)
- NSW Bionet species records data from map sheet 8828, Goulburn (OEH 2017b). This covers the area 34° 30' to 35° 00' S, 149° 30' to 150° 00' E, including the entire wind farm footprint in the north-western corner of the map sheet. Searched 14 March 2017.
- The EPBC Act Protected Matters Search Tool (PMST) using a search region with an area with a radius of ten kilometres from the approximate centre point of the study area using coordinates: latitude 34˚ 32' 34" S and longitude 149˚ 34' 57" E (Department of the Environment and Energy 2017). Searched 14 March 2017.
- Previous ecological reports e.g. URS (2004a, 2004b) and BL&A (2015).
- TSC Act threatened species schedules (NSW Scientific Committee 2016).

2.2. Species of concern

Species of concern include the following.

- Species listed as threatened on legislation or according to an authoritative source (e.g. state environment department list)
- Species known to be particularly prone to collision with operating turbines or sensitive to disturbance and
- Species for which a concentration of population significance occurs on the site and that behaves in a way that might put it at risk from the wind farm.

From the forgoing information sources, a list of species with potential to occur in the search region was generated. Of these, a short-list of species of concern was then generated based on the likelihood of occurrence on the C2WF site itself given the habitat present on the site, distribution of species and previous wildlife records and surveys undertaken at the site (see Comments field).

The original site assessments (URS 2004a,b; BL&A 2015) identified threatened and listed migratory species likely to occur on the site, some of which were detected during on-site fauna survey work. Although this has been taken into consideration, a number of additional species and groups, including non-threatened species/groups, have been identified through the current review that were not originally considered. Similarly some species or groups reviewed earlier are no longer considered at risk in the C2WF region, based on updated data. The rationale for the inclusion of the shortlisted species and groups can be found in Section 4. The short-listed species and groups are listed below:

EPBC Act Listed Migratory Species

- White-throated Needletail

EPBC Act listed threatened birds

- Regent Honeyeater (Critically endangered)
- Swift Parrot (Critically endangered).

TSC Act listed threatened birds

- Barking Owl (Vulnerable)
- Diamond Firetail (Vulnerable)
- Dusky Woodswallow (Vulnerable)
- Flame Robin (Vulnerable)
- Gang-gang Cockatoo (Vulnerable)
- Little Eagle (Vulnerable)
- Scarlet Robin (Vulnerable)
- Speckled Warbler (Vulnerable)
- Varied Sittella (Vulnerable)

TSC Act listed threatened bats

- Eastern Bent-wing Bat (Vulnerable)
- Eastern Falsistrelle (Vulnerable)

Non–listed species

- White-striped Freetail Bat
- Wedge–tailed Eagle
- Other raptors
- Waterbirds

3. RISK ASSESSMENT PROCESS

The risk assessment process was based on the Risk Evaluation Matrix Model used to measure the overall risk of a potential impact event. In this case the potential impact event involves birds or bats striking wind turbine blades or being deterred from using part of the wind farm site due to disturbance or because of a barrier effect. The risk assessment process considers the *likelihood* of that event, and, should it occur, its *consequences*. This model is currently used across a wide range of industry sectors, in particular for assessing environmental risk.

The Risk Evaluation Matrix Model also complies with the ISO31000 Risk Assessment Standard (Rollason *et al* 2010).

The assessment requires criteria to be developed for likelihood and consequence. These criteria are provided in Table 1 and Table 2.

Table 1: Likelihood criteria for a risk event to occur

Likelihood	Description
Certain	Very probable that the risk event could occur in any year (>95%)
Almost Certain	More probable than not that the risk event could occur in any year (>50%)
Likely	Equally probable that the risk event could or could not occur in any year (50%)
Unlikely	Less probable than not that the risk event could occur in any year (<50%)
Rare	Improbable that the risk event could occur in any year. (<5%). The risk event is only theoretically possible, or would require exceptional circumstances to occur.

Table 2: Consequence Criteria

Negligible	*Low*	*Moderate*	*High*	*Severe*
Occasional individuals lost but no reduction in local or regional population viability.	Repeated loss of small numbers of individuals but no reduction in local or regional population viability.	Moderate loss in numbers of individuals, leading to minor reduction in localised or regional population viability for between one and five years.	Major loss in numbers of individuals, leading to reduction in regional or state population viability for between five and ten years.	Extreme loss in numbers of individuals, leading to reduction in regional or state population viability for a period of at least 10 years

Table 3 shows the risk levels used and how they are determined from the assessed likelihood and consequence levels.

Table 3: Risk matrix defining risk level based on likelihood and consequence

Likelihood	Consequence				
	Negligible	*Low*	*Moderate*	*High*	*Severe*
Certain	Negligible	Low	High	Severe	Severe
Almost Certain	Negligible	Low	Moderate	High	Severe
Likely	Negligible	Low	Moderate	High	High
Unlikely	Negligible	Negligible	Low	Moderate	High
Rare	Negligible	Negligible	Negligible	Low	Low

4. RISK ASSESSMENT RESULTS AND CONCLUSIONS

4.1. Risk assessment results

Table 4 provides the results of the likelihood and consequence assessment based on the inputs from the aforementioned sources and includes the information listed below as part of the risk assessment process.

- Environmental value to be protected
- Reasons for inclusion
- Threatened species status
- Hazard or source event
- Consequence score and likelihood scores
- Risk rating and
- Comments relating to risk rating scores.

Table 4 includes a summary of the previous findings for each considered species or group and their relevance to the assessment.

The risk associated with wind turbine collision and indirect effects at the C2WF for most birds and bats was rated as **negligible**. The exceptions are described below.

Given the occurrence of collisions involving Wedge-tailed Eagle at many wind farms but a low incidence of disturbance, risks to this species arise from likely collisions but not from indirect disturbance. Given the foregoing and the presence of eagles at most wind farms, including their successful breeding within 200 metres of operating turbines (BL&A, unpubl. data), the risk to the Wedge-tailed Eagle was therefore considered to be **moderate**.

Based on experience with other wind farms in eastern Australia collision with common occurring raptor species is likely. Common occurring raptor species that are likely to collide with turbines at the C2WF site include Australian Hobby, Black-shouldered Kite, Nankeen Kestrel, Brown Falcon, Collared Sparrowhawk and Brown Goshawk. These species appear not to be deterred by the presence of operating wind turbines and occur regularly at other wind farms in NSW. Overall the risk from collision with turbines to 'other raptors' is considered to be **low** as these species are widespread and have a common status which makes regional population impacts unlikely.

The White-throated Needletail flies regularly at turbine height and flocks would pass over the C2WF site during the summer months. Collisions have been recorded at wind farms elsewhere in NSW and Australia. The risk to this species from the C2WF is considered to be **low** as the species is widespread and numerous in eastern and south-eastern Australia.

Two threatened bat species have been recorded in the C2WF search region and two additional species are predicted to occur (DoTEE 2017) or have been recorded in the wider surrounding region (OEH 2017b). Only one of these species, however, was considered to be at risk of collision with turbines. The Eastern Bentwing-bat has a maternity cave at Wee Jasper located approximately 100 kilometres south-west of C2WF. This species disperses up to 300 kilometres from

maternity caves on migration to their wintering caves. However, this bat species was not recorded in targeted surveyed in 2017. This bat may therefore frequent the site at times of migration. The Eastern Bentwing-bat population is considered to be at a **negligible** risk from collision with turbines. The other listed species recorded in the region, Eastern False Pipistrelle, is considered to be at negligible risk since it is a forest species and expected to fly across the predominantly cleared areas of C2WF only rarely.

Given the occurrence of collisions involving the common and widespread White-striped Freetail Bat at many wind farms but a low incidence of disturbance, risks to this non-listed species arise from likely collisions but not from indirect disturbance. The risk to White-striped Freetail Bat was therefore considered to be **low**.

One bat species, the Yellow-bellied Sheathtail-bat, has been recorded at C2WF and is rated as having an **unlikely** risk from collision with turbines due to the single call recorded and the low likelihood of regularly occurring in the project area.

Table 4: Bird and Bat Risk Assessment

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
Birds							
Australian Painted Snipe *Rostratula australis*	Species or species habitat may occur within area	Endangered - EPBC Act & TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Shallow terrestrial freshwater habitats with fringing aquatic vegetation, such as sedges, rushes and reeds, and may also utilise dams with suitable vegetative cover (Marchant and Higgins 1993). The lack of suitable wetland habitats in and around C2WF indicates that this species is unlikely to be affected by the presence of wind turbines in the area.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Barking Owl *Ninox connivens*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend into closed forest and more open areas. Species has declined in southern Australia and now occurs in a wide but sparse distribution in NSW (OEH 2017c) including only one record from the search region (OEH 2017a). It is unlikely that this species commonly flies at RSA height, however, should turbine strike occur to individuals flying within the turbine blade height, it is highly likely that only a very small number of birds would be affected.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Black-faced Monarch *Monarcha melanopsis*	Species or species habitat likely to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in spring and summer in rainforest and wet forest in coastal lowlands of Cape York Peninsula and along the coastal fall of the Great Dividing Range in Queensland, New South Wales and eastern Victoria. Sometimes occur in dry sclerophyll forest and woodland of the inland slopes. Spends winter in New Guinea (Higgins et al. 2006). Not expected to collide with turbines since it is a forest species normally restricted to foraging and nesting in trees.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Curlew Sandpiper *Calidris ferruginea*	Species or species habitat may occur within area	Critically endangered – EPBC Act Endangered - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in northern hemisphere and occurs in Australia mostly from spring to autumn in open shallow wetlands, including intertidal zones (Higgins and Davies 1996). A lack of suitable habitat in the C2WF area indicates it would be unlikely to experience mortality as a result of collision with a turbine.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Diamond Firetail *Stagonopleura guttatus*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Rare	Negligible	Occur in south-eastern Australia south of the tropics (Higgins et al. 2006), including all regions of New South Wales (Morris et al. 1981). Inhabits mainly woodlands and also occurs in dry forests, along watercourses and in farmland areas (Morris et al. 1981; Higgins et al. 2006). Has been recorded regularly inhabiting farmland around wind turbines in southern NSW where it has never been observed flying at RSA height or colliding with turbines (BL&A, unpubl. data). It is therefore considered at very low risk.
			Indirect disturbance, including barrier effects.	Unlikely	Rare	Negligible	
Dusky Woodswallow *Artamus cyanopterus*	Species recorded from the wind farm region OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Endemic to southern and eastern Australia in dry open sclerophyll forests and woodlands, usually dominated by eucalypts. Often found on the edges or in clearings of forest and woodland and sometimes recorded in shrubland, heathland and modified landscapes (Higgins *et al.* 2006). This species may occasionally fly at RSA height but usually flies within the canopy. Collisions are considered to be unlikely.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Eastern Curlew *Numenius madagascariensis*	Species or species habitat may occur within area	Critically endangered – EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in the northern hemisphere. When in Australia, inhabits sheltered coasts, especially estuaries, embayment, harbours, inlets and coastal lagoons with large intertidal mudflats or sandflats, often with beds of sea grass; occasionally on open inland wetlands (Higgins and Davies 1996). Unlikely to be affected by C2WF due to a lack of suitable habitat in the region.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Flame Robin *Petroica phoenicea*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Rare	Negligible	Negligible	Breeds mostly in forests and woodlands of the high country of south-eastern Australia and Tasmania, dispersing to more open habitats in the autumn and winter when they often occur in farmland at low altitudes (Higgins & Peter 2002). There is potential for this species to occur at C2WF however it spends the majority of its time on or near the ground and is considered unlikely to fly at RSA heights.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
Fork-tailed Swift *Apus pacificus*	Species or species habitat likely to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Aerial migrant from north-east Asia, occurring in southern Australia from October to April. Potentially at risk from collisions with turbines since it forages ar RSA height and above. This species has rarely if ever been recorded as a casualty of wind turbines in Australia. The number of potential collisions, compared with the overall population of this common species (Higgins 1999), suggest impacts on its population would be minimal.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Gang-gang Cockatoo *Callocephalon fimbriatum*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Restricted to Victoria and New South Wales north to around Newcastle, along the coast and ranges (Barrett et al. 2003). In summer generally in tall mountain forests and woodlands including subalpine snow gum woodlands and occasionally in temperate rainforests and regenerating forests. In winter occur at lower altitudes in drier, more open Eucalyptus woodland (Higgins 1999). There is potential for this species to visit the C2WF during winter in woodland habitats and may fly at RSA height occasionally however the frequency of mortality is not expected to be high enough to impact on its regional population.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Latham's Snipe *Gallinago hardwickii*	Species or species habitat may occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Occurs in wide variety of permanent and ephemeral wetlands; it prefers open freshwater wetlands with dense cover nearby, such as the edges of rivers and creeks, bogs, swamps, waterholes, etc. It has been known to use wetlands with a variety of cover, including tussock grasslands, lignum, sedges, reeds and rushes, woodlands and sclerophyll forests and known to occur in some areas over 1000 metres altitude (e.g. in montane bogs, Morris et al. 1981). This species may fly at RSA height through the lack of suitable habitat in the C2WF region and the lack of casualties at Australian wind farms to date suggests its population is at low risk from operating wind farms.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Little Eagle *Hieraaetus morphnoides*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Distributed throughout the Australian mainland except in the most densely forested parts of the Great Dividing Range (Marchant and Higgins 1993). In the 1990s, the Little Eagle was estimated globally as numbering tens of thousands to as many as 100 000 birds (Ferguson-Lees & Christie 2001), but in recent decades, the Little Eagle is believed to have undergone a moderate reduction in population size in NSW (NSW Scientific Committee 2010a). The species has not yet been recorded colliding with wind turbines and occurs in NSW at very low population densities so regular collision is unlikely.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Little Lorikeet *Glossopsitta pusilla*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Occur along the eastern seaboard of Australia in open forests and woodlands as well as urban areas where suitable foraging trees exist. This common species may fly at RSA height and therefore be susceptible to collision, however there are few records in the vicinity of C2WF (OEH 2017a,b) and it is expected to suffer minimal impact from the wind farm.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
other raptors	Species recorded from the wind farm region (OEH 2017a)	not listed	Collision with operating wind turbines.	Likely	Low	Low	Turbine strikes by commonly occurring raptors, such as Australian Hobby, Black-shouldered Kite, Brown Falcon, Nankeen Kestrel, Collared Sparrowhawk and Brown Goshawk are likely, based on experience at other wind farms in south-eastern Australia. The widespread and common status of these species makes population impacts unlikely. These species appear not to be deterred by the presence of operating wind turbines and occur regularly at other wind farms in NSW.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Painted Honeyeater *Grantiella picta*	Species or species habitat likely to occur within area	Vulnerable – EPBC Act & TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Inhabits dry open forest and woodlands and mainly feeds on the fruits of mistletoe. Strongly associated with mistletoe around the margins of open forests and woodlands (Higgins et al. 2001). The paucity of records in the region (OEH 2017a, OEH 2017b) suggests it is unlikely to be greatly affected by turbines of C2WF.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Powerful Owl *Ninox strenua*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Occurs in mainland south-eastern Australia in forests and woodlands along the coast Great Divide, and parts of the inland slopes (Higgins 1999). A paucity of suitable wooded habitat at C2WF indicates it would rarely fly across the wind farm so its susceptibility to collision is expected to be low.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
Regent Honeyeater *Anthochaera phrygia*	Species or species habitat likely to occur within area	Critically endangered EPBC Act and TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Inhabits dry box-ironbark eucalypt forests near rivers and creeks on inland slopes of the Great Dividing Range. It could also occur in small remnant patches or in mature trees in farmland or partly cleared agricultural land (Higgins *et al*. 2001). This species usually flies within the tree canopy and would rarely visit the C2WF site.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Rufous Fantail *Rhipidura rufifrons*	Species or species habitat likely to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Rare	Negligible	Negligible	Breeds in spring and summer in rainforest, wet sclerophyll forest and gullies from Cape York Peninsula south along the Great Dividing Range to Victoria. Occur less commonly in drier forest and on the inland slopes. Spends winter in Queensland and southern New Guinea (Higgins et al. 2006). This species prefers shady areas and dense foliage, so is considered unlikely to be at risk from collisions with turbines.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Satin Flycatcher *Myiagra cyanoleuca*	Species or species habitat known to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in spring and summer in dry and wet forest in Tasmania, Victoria and New South Wales along the Great Dividing Range. May also breed in Queensland in Wet Tropics and the south-east. Spends winter in New Guinea and islands to its east (Higgins et al. 2006). Since it is a tree dweller, it is not expected to be at risk from colliding with turbines.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Scarlet Robin *Petroica boodang*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Rare	Negligible	Negligible	Lives in open forests and woodlands. During winter, it visits more open habitats, such as grasslands, and can be seen in farmland and urban parks and gardens at this time (Higgins & Peter 2002). This species does not fly at RSA height.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Speckled Warbler *Chthonicola sagittatus*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Rare	Negligible	Negligible	Inhabits dry eucalypt forests and woodlands, especially those with box-ironbark eucalypt associations. It is also found in River Red Gum woodlands (Higgins and Peter 2002). This species mainly forages on the ground or the lower woodland strata and is not known to fly at RSA height, hence, it would not be impacted by C2WF
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Superb Parrot *Polytelis swansonii*	Species or species habitat may occur within area	Vulnerable – EPBC Act & TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Occurs in riparian River Red Gum forests and adjacent areas of box eucalypt vegetation from the Murrumbidgee and Murray Rivers northwards to the Namoi Valley. Breed in hollow branches or trunks of tall eucalypts within 9 km of feeding areas. Mostly feed in box woodlands and wooded farmlands; less often in riparian forests (Higgins 1999). There are four records from the C2WF region, all from well south of Crookwell in the Gunning and Bredalbane areas (OEH 2017a). It would therefore appear unlikely to be impacted by collision with C2WF turbines.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Swift Parrot *Lathamus discolor*	Species or species habitat may occur within area	Critically endangered - EPBC Act Endangered – TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Prefers a narrow range of eucalypts in NSW, including White Box, Mugga Ironbark, Grey Box and Yellow Gum as well as River Red Gum when this species supports abundant 'lerp'. Breeds in Tasmania and migrates to the mainland of Australia for the autumn, winter and early spring months. At this time it mostly lives north of the Great Dividing Range in Victoria (Emison *et al.* 1987; Higgins 1999; Kennedy and Tzaros 2005). In some years most birds disperse north into New South Wales, along the inland slopes and the south and central coasts. Potential to occur at C2WF however there are no records from the surrounding search region which indicates it would be a rare occurrence and therefore unlikely to be impacted.
			Indirect disturbance, including barrier effects.	Unlikely	Low	Negligible	
Varied Sittella *Daphoenositta chrysoptera*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Active species inhabiting most of mainland Australia in eucalypt forests and woodlands. It forages in groups, flying into the tree canopy and working down the branches and the trunk, probing through the bark in search of insects (Pizzey & Knight 2003).Distribution in NSW is nearly continuous from the coast to the far west (Morris et al. 1981; Barrett et al. 2003). Its population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades (OEH 2017Ac). The Varied Sittella is unlikely to fly at RSA height and hence likely to experience minimal impacts from C2WF.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
Waterbirds	Species recorded from the wind farm region (OEH 2017a)	not listed	Collision with operating wind turbines.	Unlikely	Low	Negligible	Habitats on the C2WF site for waterbirds are limited to small farm dams, although the larger Pejar Reservoir is close to the southern boundary. No large concentrations of waterbirds occur nearby. Experience at other wind farms in NSW indicates few waterbirds collide with turbines, even near large waterbird concentrations (e.g. Lake George), where birds confine most of their activities to the wetlands and don't move across farmland frequently.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Wedge-tailed Eagle *Aquila audax*	Species recorded from the wind farm region (OEH 2017a)	not listed	Collision with operating wind turbines.	Almost certain	Moderate	Moderate	The Wedge-tailed Eagle is the species most exposed to collision risk due to its common status and habit of soaring and circling at RSA height while foraging. Several birds of this species have been struck at other wind farms in NSW. Disturbance is not an issue, with the eagle breeding successfully as close as 200 metres from operating wind turbines. The regular incidence of collisions has the potential to affect the regional population.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
White-throated Needletail *Hirundapus caudacutus*	Species or species habitat likely to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Likely	Low	Low	Breeds in north-east Asia and migrates to Australia in the austral spring and summer. Forages aerially and is known to follow storm systems and fronts. Occasional mortality has been recorded on other wind farms in its range. It typically flies at and above RSA height. Loss of a small number of individuals each year is not considered to be of significance as the species is numerous in Australia (Higgins 1999), although no recent estimates of population are available.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Yellow Wagtail *Motacilla flava*	Species or species habitat may occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in the northern hemisphere and occurs as a summer visitor mostly to tropical and subtropical areas of Australia in short grass or muddy areas often near water (Higgins et al. 2006). In New South Wales it is occasional in the summer first recorded in 1979 and mostly at the lower Hunter estuary (Morris et al. 1981; Higgins et al. 2006). Its general rarity in southern Australia, coupled with a paucity of suitable habitat at C2WF suggests it is unlikely to collide with turbines at C2WF and suffer any consequent loss in its overall population.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Bats							
Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Not recorded in targeted survey. Roosts in caves during the day, dispersing over a range of forest, woodland and grassland habitats at night. This species could collide with turbines as it is known to fly at RSA height (Churchill 2008). It is possible that small numbers of this species may frequent the C2WF site or cross the area during migration between maternity and wintering caves.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Occur in south-eastern Australia along the coast and Great Divide from around Brisbane to Mt Gambier; also Tasmania. Prefers moist forested habitats with trees taller than 20 metres. Roosts in tree hollows but has also been found roosting in buildings or under loose bark. Flies within or just below the canopy in gaps, along tracks, and also in open areas (Churchill 1998, 2008). Since this species tends to avoid small forested remnants (Churchill 2008), its risk from the C2WF which is mainly open country with a few small remnant treed areas, is expected to be insignificant.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Grey-headed Flying-fox *Pteropus poliocephalus*	Foraging, feeding or related behaviour may occur within area	Vulnerable - EPBC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Occur in mainland south-eastern Australia. The national population is fluid, moving along the east coast dependent on food resources. Widespread throughout range in summer, contracting to coastal lowlands north of the Hunter Valley and occasionally found on the south coast and north-west slopes of NSW in winter, associated with winter flowering eucalypts and Spotted Gum *Corymbia maculata*. Much nightly movement to foraging sites from daytime camps, usually within 15km of their day roost site. The single record from the wider region, in Goulburn in January 2017 (OEH 2017b), suggests the species may reach C2WF rarely, and therefore it is at minimal risk from population impacts.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Large-eared Pied Bat *Chalinolobus dwyeri*	Species or species habitat may occur within area	Vulnerable - EPBC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Occur from Rockhampton, Queensland to Bungonia, NSW, from the coast to the inland slopes in a variety of forest and woodland. Often occur in areas of extensive cliffs and caves, their preferred roosting habitat (Churchill 2008; OEH 2017a). Mapping and one regional record (from Marulan; OEH 2017b,c) suggest that the species would be at the edge of its range in the Crookwell area and be minimally affected by C2WF.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*	At southern end of range. One possible call. (Richards 2008)	Vulnerable TSC Act	Collision with operating wind turbines	Unlikely	Low	Negligible	It was only recorded at with one possible call. It would be considered to be very rare in the project area, which may be related to an apparent requirement for viable populations to only (in this region) be found in very large forest remnants. Turbine strike is unlikely if the bat is present
			Indirect disturbance, including barrier effects	Unlikely	Negligible	Negligible	
White-striped Freetail Bat *Tadarida australis*	Species recorded from the wind farm region (OEH 2017a)	not listed	Collision with operating wind turbines.	Likely	Low	Low	Occurs in a wide range of habitats, including forest, woodland, shrubland, grassland and urban areas (Churchill 1998, 2008). This species is known to fly 50 metres or so above the ground which puts it at risk of collision and it has been recorded colliding with turbines in other areas of NSW (BL&A, unpubl. data). It is abundant and widespread and potential collisions at the C2WF site are considered unlikely to have a significant impact to the regional population.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	

Notes: TSC Act = Threatened Species Conservation Act 1995; EPBC Act = Environment and Protection of Biodiversity and Conservation Act 1999

4.2. Conclusions

The surveys of the C2WF and surrounding wind farm sites to date, combined with the knowledge generated at operating wind farms elsewhere in Australia (BL&A unpubl. data), indicate that collision rates are typically very low. This risk assessment indicates that no significant population-wide impacts are anticipated for species or groups of concern.

This assessment found that the following species or groups may experience some, non-negligible risk to their populations from colliding with turbines at C2WF:

- Wedge-tailed Eagle – **moderate** risk
- Other raptors – **low** risk
- White-throated Needletail – **low** risk
- Eastern Bent-wing Bat – **low** risk
- White-striped Freetail Bat – **low** risk

Many of the NSW threatened species (TSC Act) screened in this risk assessment are not at risk from the C2WF. Woodland birds and bats do not regularly fly at RSA height and therefore do not encounter turbines very often.

This risk assessment indicates that a small proportion of the species and groups of concern (three out of 28 bird species or species groups and two out of five bats) have more than a negligible risk of being affected by collision with operating turbines once the C2WF is constructed. No birds or bats are at risk from indirect effects, such as disturbance or barrier effects. The BBAMP for the C2WF will therefore focus on monitoring the impacts of the project on Wedge-tailed Eagle, other raptors, White-throated Needletail, Eastern Bent-wing Bat and White-striped Freetail Bat.

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