


CROOKWELL 2 WIND FARM
OPERATIONAL FLORA AND FAUNA
MANAGEMENT PLAN

Crookwell Development Pty Ltd

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CONTENTS

1. INTRODUCTION3
 1.1. Background.....3
 1.2. Site Description3
 1.3. Information Sources.....4
 1.4. Additional information.....4
 2. REQUIREMENTS OF THE OFFMP5
 2.1. Compliance Summary5
 2.2. OFFMP Objectives6
 3. MITIGATION MEASURES TO REDUCE RISK to FLORA AND FAUNA.....8
 3.1. Habitat Management Procedures8
 3.1.1. Vegetation communities and important flora and fauna habitat8
 3.1.2. Impacts on native vegetation, pasture and planted wind breaks..... 13
 3.1.3. Native vegetation to be protected and protection measures 13
 3.1.4. Rehabilitation of removed/disturbed vegetation..... 13
 3.2. Operational stage measures to minimise bird and bat disturbance 15
 3.2.1. Carcass removal 15
 3.2.2. Management of lambing..... 16
 3.2.3. Pest control, including rabbits;..... 16
 3.2.4. Management of stock (grain) feeding..... 17
 3.2.5. Lighting on turbines and buildings..... 17
 3.2.6. Supplementary Mitigation Measures 17
 4. REPORTING REQUIREMENTS 24
 5. MANAGEMENT ACTIONS AND PERFORMANCE CRITERIA..... 25
 6. REFERENCES..... 28

TABLES

Table 1: Sections within the OFFMP that respond to Condition of Consent 836
 Table 2: Additional potential supplementary mitigation measures 19
 Table 3: Specific management objectives, activities, timing and performance criteria 25

FIGURES

Figure 1: Wind farm layout and native vegetation9
 Figure 2: Native Vegetation Zone 1 10
 Figure 3: Native Vegetation Zone 2 10
 Figure 4: Native Vegetation Zone 3 10

1. INTRODUCTION

1.1. Background

Development consent was originally granted in June 2005 for the Crookwell 2 Wind Farm (C2WF) with up to 46 wind turbines and associated infrastructure (DA 176-8-2004-i) – a wind farm located across a 2,088-hectare area centred 14km south-east of Crookwell township in the Southern Tablelands of New South Wales (Figure 1).

In 2008, approval was sought (Mod-1) to modify the development consent by substituting larger turbines for those previously approved, relocating 20 of the 46 turbines and providing an alternate access road via Woodhouselee Road. This modification to the development consent was subsequently approved in July 2009. Given subsequent further developments in wind turbine technology, Crookwell Development Pty Ltd – the proponent for the C2WF – sought approval to modify the Mod-1 development consent by further increasing the size of the proposed wind turbines. The revised proposal (Mod-2) also includes a reduction in the total number of turbines from 46 to 32, along with re-alignment of the access tracks and cabling to service the remaining turbines.

The C2WF project has been granted development consent for its Mod-2 application on 31st October 2017. As part of the approval process for the proposed Mod-2, an Operational Flora and Fauna Management Plan (OFFMP) sub plan must be developed in accordance with Condition 83 of the Development Consent. Crookwell Development Pty Ltd commissioned Brett Lane & Associates Pty Ltd (BL&A) to develop this OFFMP in February 2018.

1.2. Site Description

C2WF 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, this vegetation lacks a diverse understorey and indigenous ground cover and introduced pasture grasses have come to dominate the ground cover.

Exotic grassland (improved pasture) dominates the study area, with small patches of native vegetation on and adjacent to the site. Large patches of woodland habitat occurred mostly outside the wind farm boundary. A few smaller patches were scattered throughout the site, mostly in the north and west. Much of the area has been subject to past clearing. Consequently, many of the trees present are of a comparatively young age or are of a species that have fewer hollows suitable for hollow-dependent fauna, such as possums, gliders and large owls.

The avifauna of the site is typical of this part of NSW, with canopy-dwelling honeyeaters and insectivores dominating. Low bird diversity and abundance reflected the lack of extensive treed habitat within and surrounding the wind farm site. The slopes of some of the steeper ridges still support a relatively intact tree canopy that would provide foraging habitat for insectivorous bats.

No major waterbird habitat occurs on the wind farm site or in the locality. As water storages, Pejar Dam, Lake Pejar and Lake Edward do not provide suitable habitat for a wide diversity or high abundance of waterbirds and shorebirds that typically require gentle sloping shorelines, substantial areas of fringing vegetation and mudflats for feeding (URS 2004).

Habitat quality for birds and bats is considered to be low in the largely cleared parts of the site, moderate in most wooded areas and moderate to high in the wooded slopes in the southern and north-western parts of the site.

1.3. Information Sources

Several information sources were taken into account when preparing this OFFMP. These are listed below:

- Bird and Bat Adaptive Management Plan (BBAMP) for Crookwell 2 Wind Farm (BL&A 2018);
- Biodiversity Report for the Modification-2 Application (BL&A 2015); and
- Flora and Fauna Management Subplan – Construction Environmental Management Plan Crookwell 2 Wind Farm Project (Union Fenosa 2005)

1.4. Additional information

This OFFMP was prepared by a team from Brett Lane & Associates Pty Ltd including; Jackson Clerke (Zoologist), Brett Macdonald (Senior Ecologist), Alan Brennan (Senior Ecologist and Project Manager) and Brett Lane (Principal Consultant).

2. REQUIREMENTS OF THE OFFMP

The specific requirements of the OFFMP are presented below as extracted from the approval conditions.

Condition (83)

An Operation Flora and Fauna Management Sub Plan must be prepared as part of the OEMP. The Sub Plan must be prepared in consultation with the Department and OEH and include:

(a) plans showing:

- *terrestrial vegetation communities; important flora and fauna habitat areas; areas to be protected; and areas to be planted;*

(b) methods to manage impacts on flora and fauna species (terrestrial and aquatic) and their habitats which may be directly or indirectly affected by the development. These must include:

- *habitat management procedures including rehabilitation requirements and active replanting of windrows;*
- *operation stage measures to minimise bird and bat disturbance, in particular reducing the incidence of bird/bat strike. Management measures that must be considered for areas near the turbines include:*
 - i. *minimising the availability of raptor perches;*
 - ii. *modifying structures to prevent perching;*
 - iii. *management of lambing;*
 - iv. *swift carcass removal;*
 - v. *pest control, including rabbits;*
 - vi. *management of stock (grain) feeding;*
 - vii. *filling in of small dams that might attract insects and birds;*
 - viii. *use of deterrents (eg. flags, marker balls);*
 - ix. *minimising external lighting;*
 - x. *turbine management, that might include the turning off of turbines that are predicted to cause unacceptable bird/bat mortality at identified times;*
 - xi. *measures identified from research undertaken at other wind farms to reduce the incidence of bird/bat strike;*

(c) performance criteria against which to measure the success of the methods; and a programme for reporting on the effectiveness of management measures against the identified performance criteria. Management methods must be reviewed where found to be ineffective.

2.1. Compliance Summary

Table 1 sets out which sections of this OFFMP addresses the specific requirements of Condition 83 of the 2017 Mod-2 approval.

Table 1: Sections within the OFFMP that respond to Condition of Consent 83

Condition number	Abbreviated condition details	OFFMP Section/s
83 (a)	<i>Plans showing: terrestrial vegetation communities; important flora and fauna habitat areas; areas to be protected; and areas to be planted</i>	3.1.1
83 (b)	<i>Habitat management procedures including rehabilitation requirements and active replanting of windrows</i>	3.1 & 3.2
	<i>Operation stage measures to minimise bird and bat disturbance, in particular reducing the incidence of bird/bat strike...</i>	
83 (c)	<i>Performance criteria against which to measure the success of the methods; and a programme for reporting on the effectiveness of management measures against the identified performance criteria. Management methods must be reviewed where found to be ineffective.</i>	5

2.2. OFFMP Objectives

The overall aim of this OFFMP is to provide methods to manage the impacts on flora and fauna species (terrestrial and aquatic) and their habitats which may be directly or indirectly affected by the development of the C2WF and provide performance criteria against which to measure the success of the methods.

This is achieved by establishing monitoring and management procedures consistent with the methods outlined by the Australian Wind Energy Association (AusWEA 2005) and endorsed in the Clean Energy Council’s Best Practice Guidelines (CEC 2013).

The specific objectives of this OFFMP, derived from the conditions of approval, are set out below.

- Provide plans showing important areas of flora and fauna habitat areas to be protected or revegetated;
- Provide methods to for active management of habitat, including revegetation and rehabilitation;
- To detail and address specific and potential mitigation measures and related implementation strategies to reduce impacts on birds and bats;
- To document an agreed performance criterion that outlines the measures of success of the mitigation measures implemented and allows for review where these are found to be ineffective; and
- To identify matters to be addressed in periodic reports on the outcomes of the application of the mitigation measures against the performance criterion and their success.

This OFFMP is based on the experience gained from the preparation and implementation of approved management plans to monitor and mitigate the impacts of wind farm operation on flora and fauna at numerous wind farms in New South Wales and Victoria. At the time of writing, BL&A has prepared and/or implemented approved management plans

for White Rock, Cullerin, Gullen Range, Taralga, Capital I and Woodlawn wind farms in NSW (BL&A 2011a & c, 2014, 2016), and Bald Hills, Macarthur, Berrybank, Crowlands, Hawkesdale, Lal Lal, Mt Gellibrand, Mt Mercer, Mortlake South and Ryan's Corner wind farms in Victoria (BL&A 2009, 2011b, 2012a-f, 2013a-c).

The approach developed for mitigating impacts on flora and fauna in this OFFMP has been refined from experience gained from the development and implementation of mitigation measures outlined in other wind farm management plans, such as those listed above, and feedback from regulators and approval authorities. This OFFMP has incorporated learning and experience from past plans and incorporates the latest approaches to mitigating wind farm impacts on flora and fauna.

This management program uses an adaptive management approach. Therefore, management measures can be amended to ensure more effective management and mitigation are implemented in response to impacts on flora and fauna from the wind farm.

This plan is being prepared in consultation with the department and OEH as per the conditions of consent.

3. MITIGATION MEASURES TO REDUCE RISK TO FLORA AND FAUNA

Mitigation involves the prevention, avoidance and/or reduction of the risk of an impact on flora and fauna from the operation of C2WF occurring or continuing to occur.

An impact could be an event such as; the loss of identified important flora and fauna habitat, the loss of a listed species, or in relation to birds and bats; the event of an impact trigger. An ‘*impact trigger*’ is defined in Section 0 of the C2WF BBAMP (BL&A 2018) as a threshold of impact on birds or bats that triggers an investigation and/or management response.

This section outlines measures that will be undertaken during operation of the wind farm to prevent or reduce the potential for an impact to occur, and addresses condition of approval 83 (a-c).

Any future novel or new mitigation measures that are identified to be of potential benefit for birds and bats at the C2WF should be incorporated into the plan as part of adaptive management, in consultation with the OEH.

3.1. Habitat Management Procedures

This section provides information on and locations of vegetation communities, important flora and fauna habitat areas and describes habitat management procedures, including rehabilitation requirements and active replanting of windrows.

3.1.1. *Vegetation communities and important flora and fauna habitat*

As described above, the occurrence of native vegetation within and adjacent wind farm infrastructure is very limited, as the vast majority of the area currently supports pasture heavily dominated by introduced graminoid and forb species (so called ‘improved pasture’).

Three areas of native vegetation were recorded within, or within 20 metres of, wind farm infrastructure. These are presented below in Figures 1 to 4. None of these areas of native vegetation are of conservation concern and they are unlikely to provide habitat for any listed threatened (important) flora or fauna species, given their highly modified and degraded state.

Other native vegetation comprised scattered indigenous canopy trees (eucalypt species), which are also depicted in Figures 1 to 4. These scattered trees are also not of conservation concern and they are unlikely to provide habitat for any listed threatened (important) flora or fauna species, given their isolation from areas of treed habitat.

Four wind breaks comprising planted non-indigenous trees and shrubs were recorded within wind farm infrastructure (Figures 1 to 4), which are unlikely to provide habitat for any listed threatened (important) flora or fauna species.

The remainder of vegetation within an adjacent wind farm infrastructure comprised improved pasture heavily dominated by introduced graminoid and forb species, which is very unlikely to provide habitat for any listed threatened (important) flora or fauna species.

Figure 1: Wind farm layout and native vegetation

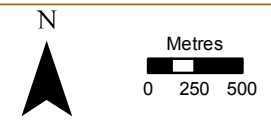
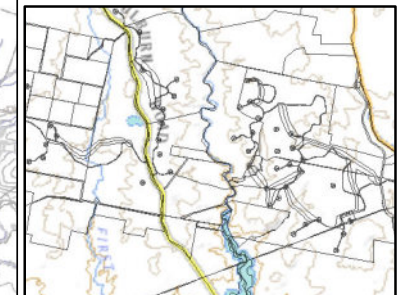
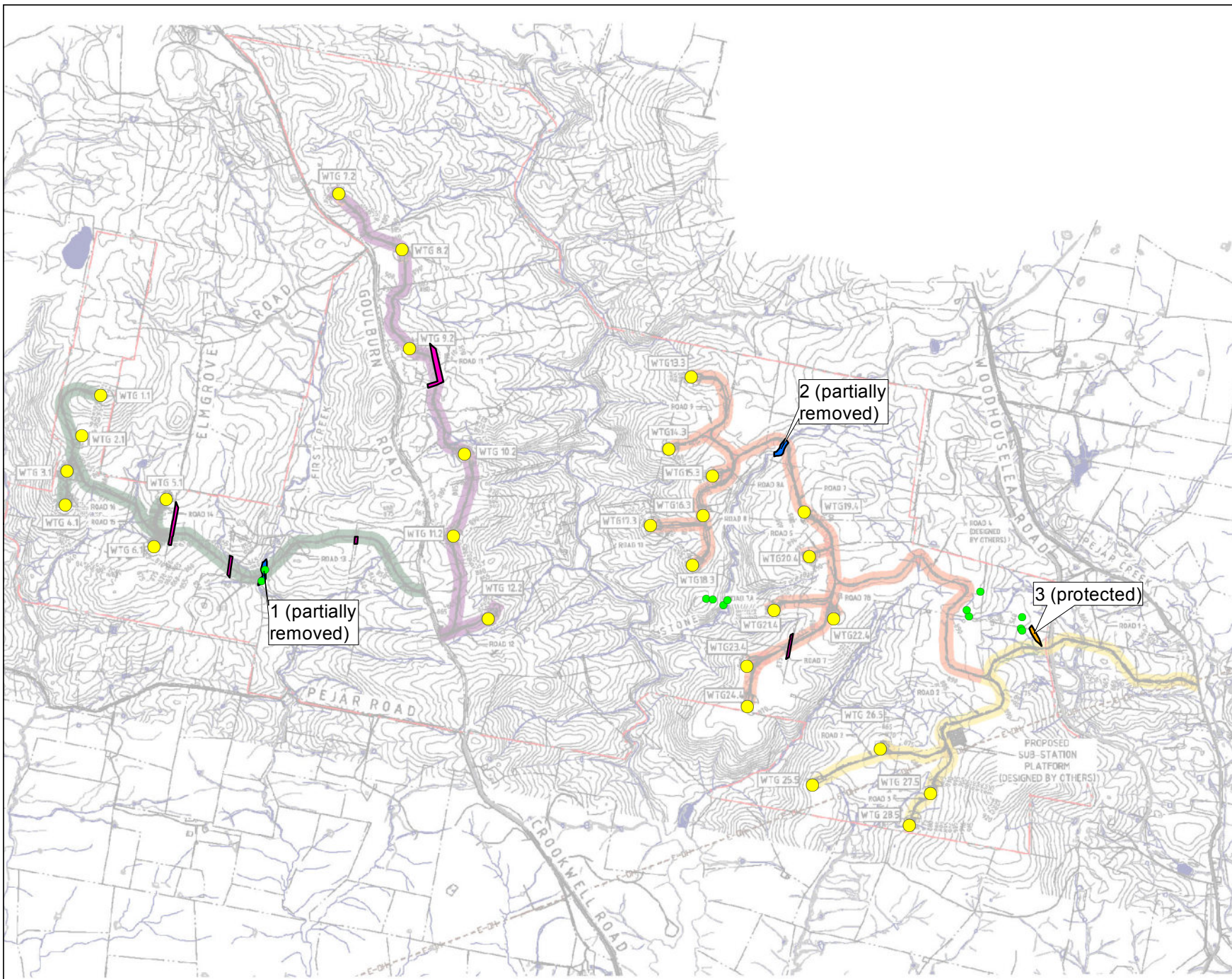
Project: Crookwell 2 Windfarm
Client: Union Fenosa Wind Australia Pty Ltd
Date: 23/03/2018

Legend

- Turbines
- Scattered trees (avoid if possible)

Community

- █ Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands
- █ Gully Reedland/Sedgeland
- █ Planted non indigenous trees



DESCRIPTION	ISSUED	VERD	APPD	DATE	CLIENT	ARCHITECT	PROJECT
INFORMATION	RG	PS	PS	15.03.18		BMD	NORTHROP CROOKWELL 2 WIND FARM

Figure 2: Native Vegetation Zone 1

Project: Crookwell 2 Windfarm

Client: Union Fenosa Wind Australia Pty Ltd

Date: 3/08/2018

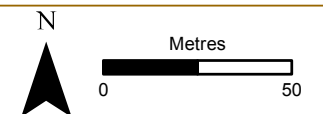
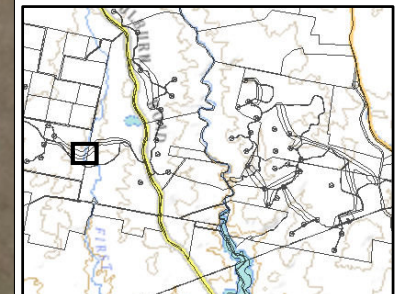
Legend

● Scattered trees

Community

■ Gully Reedland/Sedgeland

■ Planted non indigenous trees



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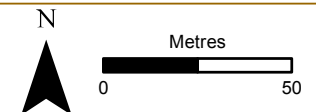
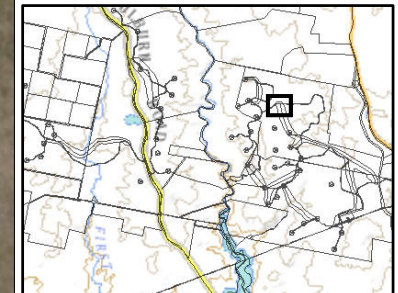
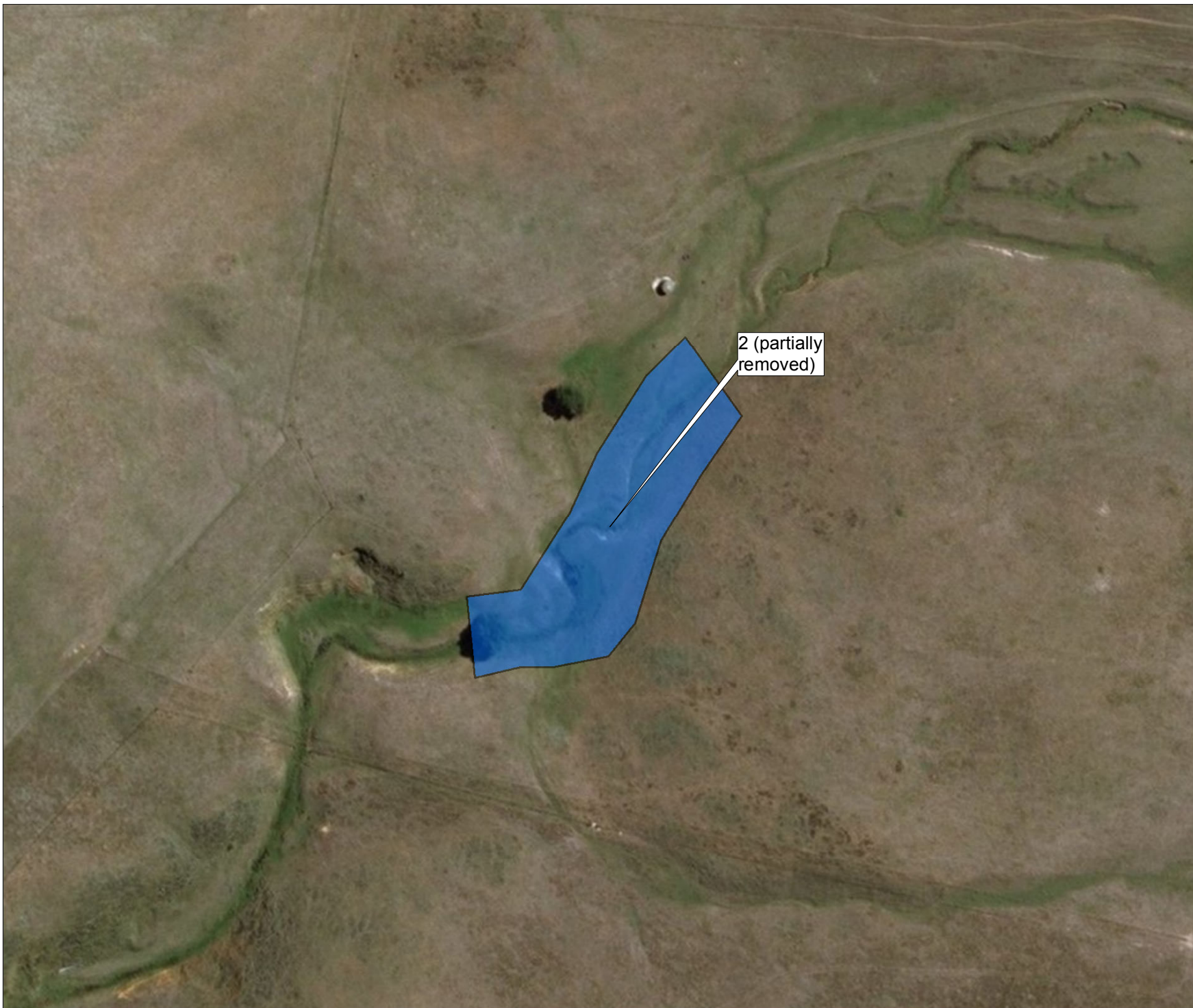
Figure 3: Native Vegetation Zone 2

Project: Crookwell 2 Windfarm
Client: Union Fenosa Wind Australia Pty Ltd
Date: 3/08/2018

Legend

Community

 Gully Reedland/Sedgeland



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Figure 4: Native Vegetation Zone 3

Project: Crookwell 2 Windfarm

Client: Union Fenosa Wind Australia Pty Ltd

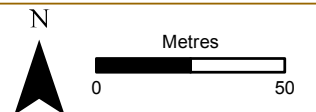
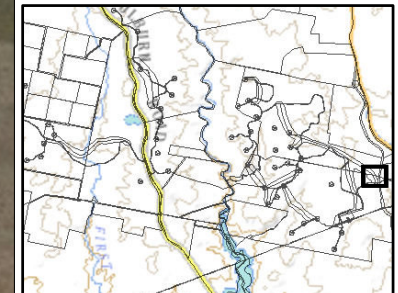
Date: 3/08/2018

Legend

● Scattered trees (avoid if possible)

Community

Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands



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3.1.2. Impacts on native vegetation, pasture and planted wind breaks

Impacts on native vegetation were limited to vegetation zones 1 and 2, which have been dissected by wind farm infrastructure (access road and underground cabling) and have been subject to partial removal and associated disturbance adjacent the infrastructure footprint, as too have the four planted wind breaks. An extensive area of improved pasture has also been removed/disturbed to facilitate construction of all wind farm infrastructure.

3.1.3. Native vegetation to be protected and protection measures

Vegetation Zone 3 (Figure 2) will be protected from wind farm post construction phase impacts. Measures to ensure protection of this vegetation will include the following.

This area of native vegetation is located within 20 metres of wind farm infrastructure and therefore prone to inadvertent damage. Protection will therefore involve the establishment of a Vegetation Protection Zone (VPZ) surrounding the vegetation, comprising sturdy post and wire fencing, which will be clearly visible to operators. This will be achieved using bright coloured para webbing and attached signage clearly depicting the area as a construction 'no go zone'. The boundary of the VPZ will be no less than one metre from the boundary of the vegetation zone (the tree canopy drip line).

Areas of vegetation zones 1 and 2 (Figure 2) outside the construction footprint will also require protection from inadvertent damage. These will be protected in the same manner as Vegetation Zone 3.

Where practicable, scattered trees will also be protected from wind farm post construction impacts. Measures to ensure protection of these trees will include the establishment of Tree Protection Zones (TPZ's) around each tree, which will be constructed as per the above method for the VPZ, although the boundaries of the TPZ's will be twice the canopy dimensions, measured from the drip line of the tree canopy for each tree.

Mitigation methods to ensure the protection of native vegetation during the post construction phase of the project are described in the following sections.

3.1.4. Rehabilitation of removed/disturbed vegetation

Revegetation

The extent of removal of native vegetation (vegetation zones 1 and 2), planted wind breaks and pasture, as a result of construction of the wind farm, i.e. in disturbed areas around turbines, access tracks and underground cabling routes, will be determined (mapped and described) during an initial monitoring exercise at commencement of the operational phase of the wind farm. This will be undertaken by an independent ecologist and involve mapping the extent of vegetation removal using a combination of aerial photography interpretation and a hand-held GPS unit. This baseline information will inform where revegetation is to be undertaken.

Once areas requiring revegetation have been determined, the following revegetation works are to be undertaken.

Native vegetation

Any areas of native vegetation temporarily disturbed during the construction and operational phases of the project are to be revegetated with indigenous species of plants, to their former condition, where practicable. This will involve restoring native vegetation in

vegetation zones 1 and 2 using tube-stock seedlings. Species selection will be consistent with that of the vegetation community removed and adjacent undisturbed vegetation.

Revegetation works will be undertaken by a bushland contractor with experience in bushland restoration in the wind farm region and commence at the beginning of the operational phase of the wind farm.

Follow-up planting will be undertaken where seedlings have not survived. The survival target for seedlings will be at least 75% survival in the first two years of the post construction of the wind farm.

Improved pasture

All areas of improved pasture temporarily disturbed during the construction or operational phases of the project will be restored to at least their former condition, where practicable.

Pasture restoration will be undertaken by a qualified pasture restoration practitioner with proven experience in restoring agricultural pastures. The methods employed will be determined by the practitioner and restoration is to commence at the beginning of the operational phase of the wind farm.

Pasture restoration performance targets will be determined through consultation with the relevant landowners.

Planted wind breaks

Removal of sections of planted wind breaks to facilitate construction of the wind farm will be compensated for by planting ‘extensions’ on the affected wind breaks, at least as large as the sections removed and of similar species composition.

The location of these compensatory plantings and performance targets will be determined through consultation with the relevant landowners.

Monitoring and reporting

Monitoring progress of the revegetation program will be undertaken by an independent ecologist each mid-spring and late autumn for the first two years of the post construction phase of the wind farm.

Progress of the revegetation program will be reported by an independent ecologist in the two annual reports for this plan (See Section 4).

Weed Control

Operational phase vegetation management will ensure that high threat weeds such as Blackberry do not become established in the development footprint and that similar weeds do not invade adjacent areas of native vegetation. After the completion of all wind farm construction works the following weed control program will be implemented. The weed control program will be coordinated with the revegetation program.

Extent of area to be monitored and baseline weed infestation monitoring

The extent of the development footprint which will be subject to monitoring for high threat weeds will be determined (mapped) during an initial monitoring exercise at commencement of the operational phase of the wind farm. This will be undertaken by an independent ecologist and involve determining the extent of disturbance as a result of construction of the wind farm, i.e. in disturbed areas around turbines, access tracks and

underground cabling routes. During this exercise, high threat weed infestations within the determined disturbance footprint will be mapped and described.

Areas of high threat weed infestation will be mapped using a combination of aerial photography interpretation and a hand-held GPS unit. This baseline information will be made available to the appointed weed control contractor to inform where control is to occur.

Weed control

Where required, spring and early summer weed control is to be undertaken by an experienced bush regenerator in areas where high threat weed infestations were identified during the baseline weed infestation monitoring exercise.

Weed control is to be undertaken throughout the first two years of the post construction phase of the wind farm.

Control is to be undertaken using the most appropriate method for the species concerned and in a sensitive manner, whereby off-target mortality is kept to a minimum.

The aim of the weed control program is to eliminate all high-threat weed infestations attributable to the construction and operation of the wind farm. A high-threat weed infestation will be considered eliminated when the cover of the high threat weed cover has been reduced to less than 1% for woody weeds or less than 5% for non-woody weeds.

Ongoing weed monitoring and reporting

Ongoing weed monitoring will be undertaken by an independent ecologist (i.e. someone not associated with the weed control contractor) each spring/early summer for the first two years of the post construction phase of the wind farm.

Ongoing weed monitoring will be undertaken as per the method used for baseline weed infestation monitoring above.

Progress of the weed control program will be reported by an independent ecologist in the two annual reports for this plan (See Section 4).

Contractors

All management works described above are to be undertaken by a bushland contractor with experience in bushland restoration in the wind farm region. Monitoring and reporting are to be undertaken by an independent qualified ecologist.

3.2. Operational stage measures to minimise bird and bat disturbance

Land-use and stock management below and around turbines can influence the presence and behaviour of native birds on site.

The following section aims specifically to reduce risks posed to the birds and bats through collision with turbines. A number of management measures are considered below, which address Condition 83 (b) and will be employed in order to reduce risk to bird and bat fauna.

3.2.1. Carcass removal

Some raptors forage for carrion (dead and decaying flesh of an animal) and also on small mammals, rabbits, etc. In order to reduce the risk of raptors colliding with turbines, a regular carrion removal program will be implemented during operations, to reduce the attractiveness of the site to raptors and therefore reduce the potential for fatal collisions.

by this group of birds. This program will focus on an area of a minimum of 200 metres around turbines, where safe, feasible and practical.

A designated suitable person will be appointed (such as a wind farm employee or landowner) to perform the function of Carrion Removal Coordinator who will undertake the activities described below.

- Monthly inspections of the wind farm site to search for any stock, introduced or native mammal and bird carcasses (to be recorded as incidental finds) that may attract raptors (e.g. kangaroos, pigs, goats, foxes, rabbits, dead stock). This search will be undertaken via vehicle and visual checks in addition to using binoculars to look for large carcasses within 200 metres of each turbine.
- Additional, opportunistic observations by operators during normal inspections and work routines and by landowners as they travel around their properties provides further opportunity to identify and report carcasses of stock or feral animals so that timely collection can be undertaken to remove them. This can be addressed by operator and landowner protocols.
- Any carcasses and/or remains found that are within 200 metres of turbines, will be collected and disposed of as soon as possible, in a manner that will avoid attracting raptors close to turbines.
- Consult with landowner or site or asset manager in relation to the appropriate disposal of collected carrion, to be located at least 200 metres away from the closest turbine.
- Wind energy facility maintenance staff and landowners will be required to notify the Carrion Removal Coordinator following identification of carrion on site in between monthly searches.
- Carcass occurrence and removal will be recorded in a “management log book” maintained by C2WF asset manager.
- An annual summary of carcass removal, based on the ‘management log’ will be provided in the annual monitoring reports.

The need for continuation of the carcass removal program and effort required will be assessed after one year of operation. In general, the criteria for continuation will be based on the frequency of carcass finds. For example, if carcass frequency is particularly low (e.g. one or two per quarter) outside of turbine search zones (i.e. not beneath turbines) the intense program may be discontinued or reduced considerably, subject to agreement from OEH. Alternatively, if peaks occur at specific times or locations where there are turbines with intervening periods of low numbers, the effort may be focussed on the peak periods and/or locations.

3.2.2. Management of lambing

During lambing season (usually late autumn / winter) young lambs are susceptible to death. Therefore, for properties that are part of the C2WF (i.e. properties that have turbines), lambing will be restricted to at least 200 metres away from turbines, to reduce the risk that raptors (Wedge-tailed Eagles in particular) are attracted close to the turbines.

3.2.3. Pest control, including rabbits;

An integrated rabbit control program (to reduce site attractiveness to Wedge-tailed Eagles) within 200 metres of turbines will be undertaken. Methods to control rabbits include

borrow destruction, poisoning and shooting. Such a rabbit control program will require cooperation and agreement from the landowner.

Any feral animal control on the wind farm site will involve the removal and appropriate disposal of resulting carcasses in a timely manner.

3.2.4. Management of stock (grain) feeding

In order to reduce collision risks to birds, for properties that are part of the C2WF (i.e. properties that have turbines), the practice of grain feeding of stock within 200 metres of turbines will be minimised as it could cause draw additional parrots and other birds to the site.

3.2.5. Lighting on turbines and buildings

It has long been known that sources of artificial light attract birds, as evidenced by night-migrating birds in North America and Europe. Lighting is probably the most important factor under human control that affects mortality rates of birds and bats colliding with all structures (Longcore, et al. 2008). Most bird mortality at communication towers for example, occurs in poor weather with low cloud in autumn and spring, i.e. during migration periods (Longcore, et al. 2008).

It is postulated that bright lights may temporarily blind birds, particularly those accustomed to flying at night or in low light conditions, causing them to fly toward the light source and collide with the structure (Gauthreaux and Belser 2006). They would appear prone to saturation of their retinas, causing temporary blindness when subjected to bright light (Beier 2006) and mortality of both birds and bats can result from collisions with lit structures. Birds can also become disoriented or ‘trapped’ in the field of light (Longcore et al. 2008).

Bats are also attracted to the increased numbers of insects that may congregate near bright light sources.

Measures to reduce the impact of lighting include using low pressure sodium or mercury lamps with UV filters to reduce brightness. The colour of lighting may also be important. Some studies have found that red lights resulted in a lower mortality than white lights (Longcore et al. 2008), but more recent research on oil rigs at sea suggests that blue or green lights may result in lower mortality than red or white lights (American Bird Conservancy 2014).

For the above reasons, building lighting will be baffled and directed to avoid excessive light spillage and security lighting will be baffled to direct it towards the area requiring lighting and not skyward.

3.2.6. Supplementary Mitigation Measures

In addition to the mitigation measures to be implemented above, there are a number of supplementary mitigation measures that will be considered under circumstance where an impact upon birds or bats is identified at the wind farm.

Supplementary mitigation measures will be implemented in consultation with OEH in the event that an impact trigger occurs. That is; a significant impact on birds or bats resulting from the operation of C2WF. The purpose of supplementary mitigation measures will be to prevent the impact from continuing to occur.

Section 6 of the C2WF BBAMP (BL&A 2016) details the definitions for an impact trigger and unacceptable impact for threatened and non-threatened species and the subsequent decision-making framework. In the event that an impact trigger occurs a rapid investigation into the cause of the impact is to be undertaken. Specific mitigation measures will be implemented depending on the nature, cause and significance of any impact recorded in response to results of investigations and the species concerned. This investigation will aim to identify particular risk behaviours that may have led to the impact and thus inform appropriate mitigation measures. Supplementary mitigation measures employed in this case will have an agreed upon performance criteria developed and timeframes to be assessed against.

Although it is unknown what supplementary mitigation measures may be required in response to a particular situation, some hypothetical examples are provided in Table 2.

Table 2: Additional potential supplementary mitigation measures

Hypothetical cause of impact	Mitigation Measure ¹	Likelihood of impact continuing following mitigation	Time to implementation
Foraging source identified that attracts threatened species and “at risk” species to impact areas	Consider the use of acoustics (i.e. loud music/irregular noise) to discourage birds from foraging in this location where such noise would not impact neighbours	Low	Implement as soon as possible.
	Encourage species into alternative areas outside of the wind farm boundary, where available, through the use of social attraction techniques offsite (decoys and audio playback systems)		Implement according to agreed plan
Farming practice attracts threatened species to risky areas (e.g. grain feeding of stock)	Investigate whether farming practice is a contributing factor and if so, subject to landowner agreement relocate farming further from turbines to reduce risk	Low	Immediately
Wind/rain/fog causing low visibility	If low visibility at the site is identified as an issue, carcass searches may be repeated during periods of low visibility to measure mortality rates. Temporary shutdown of those turbines found to cause the problem may be necessary during periods of extreme low visibility – to be implemented only in the event that threatened species are experiencing unacceptable impacts.	Low	Immediately low visibility is identified as the cause of unacceptable impacts on threatened species.

¹ Note that the mitigation measures in this table are examples of what may be possible. Ultimately, the chosen mitigation measure will be identified as part of the impact-trigger investigations described in C2WF BBAMP (BL&A 2016)

Hypothetical cause of impact	Mitigation Measure ¹	Likelihood of impact continuing following mitigation	Time to implementation
Attraction to lights on the wind farm site	Avoid high intensity lighting within the wind farm site (e.g. use of light hoods) or switch off lighting temporarily while species is on or near the wind farm site. Alternative measures include: <ul style="list-style-type: none"> • Synchronise any flashing lights, • Use red rather than white or yellow lights, or • Remove lights, where practicable • All lights switched off except when needed for service work 	Low	If lights can be switched off, this will occur immediately. Alternative measures will be implemented as soon as practicable after recording the impact trigger.
Nest site close to turbine	Discourage nesting close to turbines	Low	Prior to breeding season.

Mitigation measures specifically listed in Condition 83 (b) are addressed separately below. These are examples of potential issues not considered to-date but describe useful and tested responses from other wind farms in addressing the issues. Should these be implemented as a management response at C2WF the response of birds and bats to these measures will be recorded.

Minimising the availability of raptor perches

Minimising perching opportunities is not always feasible around turbines, as there can be scattered trees or even woodland surrounding some turbines. Removal of this habitat is likely to be more detrimental to bird and bat species than not.

In the event that perching nearby turbines is identified as a risk behaviour then monitoring of perching opportunities to 100m around the turbine will be undertaken. Should these locations be used in a manner that elevates collision risk, alternative perching, nesting and bat roosting sites can be provided at safe distances from collision risk zone (>500m). Alternatively, removing the perching opportunity can be considered where this will not cause excessive damage to habitat.

Manmade structures can be modified to prevent or discourage perching through guards if these are nearby to turbines.

OEH consultation must be undertaken prior to any such implementation of this mitigation measure.

Filling in small dams

Dams can serve as habitat for birds and bats. Birds may roost and forage on the dam while insects drawn to the water will in turn attract bats to forage. When situated near turbines this could result in increased risk of these animals colliding with turbines.

Filling in a dam as a mitigation measure could be quite disruptive to farming practices and as such should only be undertaken after investigation concludes the dam is a major contributor to impacts. In this case, subject to landowner agreement, a dam can be filled in and alternative stock watering arrangements established in order to prevent birds and bats from being attracted to the area.

This would be implemented as soon as possible after recording the impact trigger if the dam is the cause of the problem.

OEH consultation must be undertaken prior to any such implementation of this mitigation measure.

Use of deterrents

The use of deterrents to discourage bird and bat species from encountering turbines is one possible mitigation measure. Audible deterrents have been known to be employed at some industrial sites, such as airports and agricultural areas, to some effect and is referred to in Table 2.

Another issue for birds at wind farms is the issue of birds colliding with wires and infrastructure, rather than just the turbine blades themselves. Met mast guidewires and powerlines can become an issue for some species. In this case, flags and ball markers can be employed to make them more visible if this is identified as the cause of impact. It is recommended that where powerlines cross waterways that these be marked with flags or

marker balls as waterbirds may be susceptible to colliding with wire when arriving and departing this habitat.

There is little research currently available into the success of making turbine blades more visible. Visual cues, such as marking on turbines (passive cues), are thought to have limited effect as birds may become habituated to them (May et al. 2015). The effectiveness of cues is also likely to vary widely between species of birds. One experiment in America used ultraviolet light to increase the raptors awareness of approaching blades but showed little response (Hunt et al. 2015). Other cues can include; reflectors, scarecrows and markings but it is essential to take into account species specific sensory constraints (May et al. 2015).

These measures, and others, may be considered on a trial or experimental basis in the event that they are deemed appropriate supplementary mitigations through investigation of the impact. The results of such trials would prove very valuable for future conservation and mitigation efforts at other wind farms.

OEH consultation must be undertaken prior to any such implementation of this mitigation measure.

Turbine management

In the event that turbine shutdown as a mitigation approach for a specific species management objective is considered necessary by DPE, it will be based on specific advice from OEH and agreed with the proponent. Turbine shutdown should be considered as a last resort, once all mitigation options are exhausted. This information will include, but not be limited to:

- Ongoing acceptable impacts, including the level of risk to the species' regional and overall populations, where known;
- The findings of detailed investigations undertaken in response to the impact trigger, focussing on the species' use of the immediate area around affected turbines;
- Clear scope for on-going monitoring to identify triggers for turbine shut-down;
- Agreed triggers for turbine shutdown and restart; and
- Reporting and consultation arrangements.

Measures identified from research undertaken at other wind farms to reduce the incidence of bird/bat strike

Recent studies from other countries have investigated various methods for reducing impacts on birds and bats from wind farms. Most of these are research into the effectiveness and improvement of known methods, such as those cited above under use of deterrents. But there are also new methods developing which may be considered as they become available.

Research into visual deterrents involving advanced radar technology are being trialled in the U.S. (OSU 2017). These identify an approaching bird and trigger an active cue to deter it away from the turbine. This ensures birds to not become used to the deterrents and is thought to be much more effective (May et al. 2015). The main target of these trials are raptors in America and seek to utilise active cues such as; lasers, audible deterrents, lights and decoys, however the effectiveness of each cue would be dependent on the species targeted. The results of these trials are as yet unavailable.

Another study by Arnett et al. (2013a) utilised audible cues to deter bats from the rotor swept area of the turbines. Findings suggested broadband ultrasound broadcasts may reduce bat fatalities by discouraging bats from approaching sound sources. This worked by disrupting the bats echolocation ability which they naturally moved away from. Such approaches are currently limited by broadcast distance and the availability of technology. However, these devices, suitable for windfarms, may be available commercially within the next few years.

A study in Spain (de Lucas et al. 2012) into turbine shut-down mitigations reported a substantial reduction of Griffon Vulture fatalities (mean of 50.8%) at a wind farm due to shutdown of turbines identified as having the highest mortalities. This was done at times specific to the species behaviour but showed such measures can be effective with adequate understanding of the species targeted.

Another approach investigated was curtailing blade rotation at low wind speeds which resulted in reductions in bat fatalities. Various studies (Baerwald et al. 2009; Arnett et al. 2011; Arnett et al. 2013b) showed reductions in bat fatalities ranging from 50 to 87% when compared to normally operating turbines. Further study to identify times when bat collision risk is high could optimize timing of curtailment and minimize power loss (Weller and Baldwin 2012; Martin et al. 2017). Such methods could be trailed in cases where impacts to bats are significant.

These and other measures will be more thoroughly investigated should supplementary measures be required.

4. REPORTING REQUIREMENTS

In accordance with the Condition of Consent 83 (c), reports regarding management measures outlined in Section 5 of this OFFMP and implemented during the operational phase of the wind farm will be submitted to the Department and OEH. This will be done on an annual basis.

An annual report will be prepared within three months of the completion of the first and second years of operation of C2WF. The report will assess the effectiveness of the management methods applied to mitigate the impacts on flora and fauna from C2WF. This will be done using the performance criteria outlined in section 5.

The effectiveness of management measures regarding impacts on birds and bats will be informed by the ongoing results of the C2WF BBAMP (BL&A 2018) monitoring program. The results of monthly carcass monitoring, outlined in section 4 of the BBAMP (BL&A 2018), will inform of mortalities, potential areas where there may be higher incidence of bird and bat strikes and any significant impacts on birds and bats. This in turn will allow the investigation into the effectiveness of management measures.

Where management methods are found to be ineffective, these will be reviewed and refinements proposed and/or additional mitigation measures investigated to ensure effectiveness in managing impacts. This will be done as impacts are detected or if mitigation measures are found to be ineffective in annual reports. OEH will be consulted in this process.

In the event that a supplementary mitigation measure is required, for example; if an impact trigger has occurred and investigation has warranted additional management measures, then additional reporting may be required to assess the effectiveness of that measure. This process will be determined in consultation with OEH and be specific to the measures employed.

Matters to be addressed in the annual reports will include, but will not be limited to:

- A brief description of the management prescriptions implemented and identification of any modifications made to the original management practices;
- Review of the management prescriptions against the performance criteria;
- Identification of any unacceptable impacts including whether identified indirect impacts on flora and fauna of the site are of significance at a regional, state or national level, or if species of concern have been affected;
- A discussion of any prescriptions found to be ineffective;
- An outline of proposed refinements or additional supplementary management prescriptions;
- A summary of livestock carcass removal for the purposes of predator reduction;
- Details of any landowner feral animal control programs and their timing;
- Details of the native vegetation protection measures implemented and their success; and
- A summary of how impacted areas have been rehabilitated.

After the second annual report, the need for additional annual reports on mitigation methods will be reviewed in consultation with OEH.

5. MANAGEMENT ACTIONS AND PERFORMANCE CRITERIA

Table 3 summarises specific management objectives, activities, timing and performance criteria for the implementation of this OFFMP. It can be used for monitoring and reporting on the implementation of this plan.

Table 3: Specific management objectives, activities, timing and performance criteria

Management action	Management activities and controls	Timing	Performance criteria for measuring success of methods	Completed (yes/no)
Implement native vegetation protection measures	Undertake native vegetation protection measures as per Section 3.1.3	Commencement of Post-construction phase	Native vegetation protection measures in place as per that prescribed in Section 3.1.3	
Vegetation rehabilitation	Undertake revegetation works as per Section 3.1.4	Two years, beginning at commencement of Post-construction phase	Revegetation targets met as follows: <ul style="list-style-type: none"> Native vegetation - 75% survival in the first two years of the post construction of the wind farm Improved pasture and planted windrows – targets to be established through consultation with landowners 	
	Monitoring of progress of the revegetation program undertaken by an independent ecologist	Each mid-spring and late autumn for the first two years of the post construction phase of the wind farm		
	Undertake weed control program as per Section 3.1.4	Two years, beginning at commencement of Post-construction phase	High threat weed cover has been reduced to less than 1% for woody weeds or less than 5% for non-woody weeds	
	Monitoring of progress of the weed control program undertaken by an independent ecologist			
Mitigation measures to reduce risk	Carrion removal program - stock and kangaroo carcasses will be removed from within 200 metres of wind turbines on a monthly basis and be disposed of.	During operation	Carcasses removed	
			Activity recorded in management log book	
			Increase frequency of stock and kangaroo carcass removal and disposal if required	

Management action	Management activities and controls	Timing	Performance criteria for measuring success of methods	Completed (yes/no)
	Subject to landowner agreement, restrict lambing to paddocks at least 200m from turbines.		No increase in raptor mortality during lambing season	
	Stock will not be fed grain underneath turbines		No increase in bird mortality due to grain underneath turbines	
	Pest control program - Implement rabbit control on an ongoing basis		Monitor effectiveness of rabbit control and, where bird mortality is clearly related to rabbit numbers, increase the effectiveness of rabbit control	
	Habitat improvement or protection to encourage animals to use habitats away from turbines.		Protection of offset site located in woodland habitat.	
	Minimising external lighting. If required. There are only low levels of lighting on the wind farm during operation.		If mortality at turbines near light sources significantly exceeds that of activity at unlit turbines, type and duration of lighting will need to be reviewed, subject to security and OH&S limitations.	
	Remove permanent lights on buildings and sub-stations to avoid light spillage and visibility from above.			
	Baffle security lighting to avoid light spillage and visibility from above.			
	Use of deterrents – Where required, overhead powerlines will have marker balls and/or flags where they cross waterways			No incidental records of bird mortality from power line collision around waterways.
Supplementary measures - measures to be used if investigation warrants	In the event that the C2WF BBAMP (BL&A 2016) monitoring program detects a significant impact, or an impact trigger occurs, or OEH deems it necessary, supplementary mitigation measures such as those explored in section 3.2.6, will be investigated and employed if required.	As required	To be agreed upon with OEH in the event that supplementary mitigation measures are applied.	

Management action	Management activities and controls	Timing	Performance criteria for measuring success of methods	Completed (yes/no)
Annual Reports	Preparation of Annual Reports to be submitted to Secretary and OEH for the first two years of operation of the wind farm.	Operational phase—after years one and two.	Annual reports for the first two years delivered within three months of operation of the wind farm.	
			Annual reports to include (but not be limited to); mitigation measures implemented, review against criteria and recommendations for the following year.	
			Further annual reports upon agreement	

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