

**G ADDITIONAL RAPTOR SURVEY AND ASSESSMENT (NOVEMBER,  
2004)**

# **R E P O R T**

## **Crookwell II Wind Farm Additional Raptor Survey and Assessment**

*Prepared for*

**Crookwell II Wind Farm Joint Venture**

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URS Australia Pty Ltd were engaged by Wind Farm Joint Venture (WFJV) on the 24 September 2004 to carry out a follow-up field survey and assessment of the project area defined as the proposed Crookwell II Wind Farm, Crookwell, New South Wales. This survey provides an additional assessment of raptor presence and movements around the site. The need for this additional survey was identified in the EIS in Section 11.6.2.

This study was to generally investigate raptor and waterbird species with respect to:

- presence;
- abundance;
- distribution;
- behavioural traits; and
- potential impacts resulting of the operation of the proposed wind farm.

This study is the follow-up survey for these species, aimed at assessing seasonal variation in species population and composition, for comparison with the initial survey and assessment.

## 1.1 Methodology

The site of the Crookwell II wind farm was visited from 5-7 October 2004. Four observers spent a total of 9 observer days on the site and in the vicinity. The observers comprised two URS staff and two specialist sub consultants.

The weather was cool to mild, with winds varied from light to moderate. There were some showers on one afternoon.

All accessible areas of the site were visited, either on foot or in a vehicle. The survey included the Wollondilly River and its eastern tributary. Standard 2 hectare/20 minute bird surveys and searches for nests and roosts of raptors were conducted in the major pine breaks and woodland remnants. Farm dams on the site were visited several times as part of the survey. Pejar Dam and Lake Edwards (a small ephemeral lake located outside of the site boundary) were visited and waterbird sightings recorded.

Two observers spent 2 hours on hilltops on a fine morning, tracking the movements of birds in the northwest part of the site. Records were kept of numbers, distribution, height and movements of birds on the site. **Appendix 1** contains a list of birds seen and their habitats.

### 2.1 Raptors

Raptor numbers were not high during this survey, likely reflecting the poor existing habitat quality resulting from past extensive clearing of the site. Although it was breeding season at the time the survey, no active raptor nests were found on-site. Potential nest sites include a few paddock trees, and larger trees in the woodland remnants and pine breaks. One Australian Kestrel was observed sitting near a hollow in a dead tree that was potentially a roost, however this cannot be confirmed, as it was not observed entering the hollow.

Potential prey observed on the site included young lambs, occasional rabbits and hares, and low numbers of small birds.

Main raptor locations and movements are marked on **Figure 1**.

#### 2.1.1 Australian Kestrel

Australian Kestrels were seen singly or in pairs, mostly hovering over west-facing slopes near the top of hills. The clustering of the observations suggests that 1-2 pairs were present at the site.

Australian Kestrels were frequently observed west of Crookwell Road, hovering over pasture or near pine breaks and woodland (labelled as K on **Figure 1**). A pair was observed hovering below the top of Monument Hill in moderate winds. One Kestrel was observed several times northwest of the Minnamurra homestead in a dead tree containing hollows (the potential breeding site mentioned above). There were few hollows suitable for nesting in paddock trees or in woodland remnants, due to the species and age of the trees. All Kestrels observed were flying lower than 50 metres, and they were often seen hovering at 10-20 metres above the ground.

The absence of the Australian Kestrels to the east of Crookwell Road at this time of year is probably due to the lack of suitable nest trees.

#### 2.1.2 Brown Falcon

Brown Falcons were observed 9 times (labelled as BF on **Figure 1**). They were seen alone, or in groups of 2-3, mostly on the ground or flying close to the ground, especially during periods of high wind. It was estimated that there were 3-5 Brown Falcons on the site during the survey period.

No active nests were seen on the site, but the larger pine trees (18 metres in height) and some of the larger trees in the woodland remnants would be suitable nest sites. Brown Falcons use the stick nests of other species (other raptors, ravens, and magpies). Several suitable stick nests were seen in pine breaks and woodland trees, but there were no signs that they were being used by Brown Falcons.

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### **2.1.3 Wedge-tailed Eagle**

Wedge-tailed Eagles were not observed on the site, however there is some anecdotal evidence that the species is seen occasionally on the site. Two Wedge-tailed Eagles were observed soaring at a height of at least 200 metres, approximately 2-3 km west of the site.

There are few potential nest sites (tall trees) for Wedge-tailed Eagles on the wind farm site. No nests were observed during the survey. Most of the trees in the woodland remnants are less than 15 metres tall, and many of the taller paddock trees are in exposed positions, making these trees less suitable nesting sites. The 'Elmgrove' woodland contained some larger trees that may provide nesting habitat for Wedge-tailed Eagles as they are in a relatively sheltered area. Some were observed overflying the property from a distance as access to this area was not obtained.

### **2.1.4 Other raptor observations**

A Brown Goshawk was seen flying at canopy height over the woodland at the north-west end of Pejar Dam. Two Little Eagles and a White-bellied Sea-eagle were seen flying over Pejar Dam, at heights of 50-100 metres. No nests were found during surveys of the surrounding woodland, but one Little Eagle performed an undulating flight display, suggesting that it may be a paired male.

An immature Peregrine Falcon was flushed from a tree at the Wollondilly River, near the Gundowringa homestead (Gundowringa). No cliffs suitable for nesting were seen on the site, but this species will also nest in trees. A discarded rabbit or hare carcass was observed and was likely to have been a Peregrine Falcon kill, located north-west of Minnamurra.

Potential raptor food sources in the form of dead lambs and ewes were observed north-west of Minnamurra. These carcasses were attracting some birds, such as Magpies, although no raptors were observed feeding on them. Small numbers of rabbits and hares were observed across the site, and 2 foxes were observed at Elmgrove.

## **2.2 Waterbirds**

The water level in the farm dams was low, Lake Pejar was dry and Lake Edwards was almost dry. Waterbird numbers were relatively low on the wind farm site. Small numbers of common species such as Grey Teal, Eurasian Coots, Pacific Black Ducks and Black Swans were present on farm dams across the site. Less common species such as a Musk Duck, a Sharp-tailed Sandpiper and Hardheads were occasionally seen on dams. The farm dams had little aquatic or riparian vegetation, and breeding habitat for waterbirds was restricted to small reed-fringed pools on the Wollondilly River.

Observations on different days showed that small numbers of waterbirds were moving to and from the farm dams, probably during the night. No waterbirds were seen to make spontaneous movements during the day. When disturbed, they flew at low levels to nearby dams or returned to the area from which they were flushed. Waterbirds disturbed from the river usually flew upstream at heights below 30 metres.

Larger numbers of waterbirds were recorded on Pejar Dam. The lack of fringing vegetation or extensive mudflats limits the number and type of birds that can use this dam. The presence of Pink-eared Ducks, Pelicans and a flock of Great Crested Grebes on the Pejar Dam, that does not provide their nesting requirements, is probably due to the drying of inland habitats during the drought. The dam may support higher numbers of common species when it contains more water.

**2.3 General Observations from Monument Hill**

Bird movements were recorded for a 2 hour period (0840-1040 hours) on 7 October 2004, within a 2km radius of Monument Hill (the results are presented in **Table 1**). The weather during the two hour period was fine and mild, with light winds. Woodlands occur to the east (Elmgrove) and south-west of Monument Hill, and there is a mature pine break to the south. 54 birds (some may be repeats) of 9 species were observed in flight in this area. Flying birds were in view for about 14 minutes during the 2 hour period.

The approximate amount of time that birds spent in areas where wind turbines are proposed to be located was recorded. This zone was defined as about 20 to 100 metres above the ground, and within about 50 metres of a proposed turbine location. Flight height was estimated by reference to mature pine trees to the south, which had previously been measured with a clinometer. 21 bird movements passed through the zones, including 2 kestrels, that spent about one minute each in the areas where wind turbines are proposed to be installed, near the top of the Monument Hill.

Small flocks of Yellow-tailed Black-Cockatoos and Sulphur-crested Cockatoos followed the line of mature pines, and may take different routes if these trees were removed.

**Table 1: 2-Hour Watch, 2km Radius Circle Around Monument Hill. 0840-1040 Hrs, 7 October 2004**

<b>Species</b>	<b>Number Observed</b>	<b>No. of birds and minutes within turbine zone (~ 20-100m Above Ground Level, within 50m of a turbine site)</b>
Brown Falcon	1	0 (flew below 5 metres)
Australian Kestrel	2	2 birds for 1 min each
Yellow-tailed Black-Cockatoo	13	13 birds for ~ 0.5 mins each
Galah	3	0 (flew below 2 metres)
Sulphur-crested Cockatoo	26	6 birds for ~ 0.5 mins each
Australian Magpie	6	1 bird for about 0.5 mins
Pied Currawong	1	0 (low over woodland to east)
Richard's Pipit	1	0 (flew below 2 metres)
Skylark	1	0 (flew below 2 metres)

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## 2.4 Discussion

### 2.4.1 Raptors

Many raptor collisions at wind farms in Europe and North America involve turbines that have been placed in raptor migration corridors. However, regular raptor migrations do not occur in Australia. At Crookwell there appear to be relatively small numbers of resident raptors. During periods of high wind, when the turbines turn faster and present a higher risk, some raptors spend less time hunting and soaring, which may reduce the risk of them colliding with turbines.

A clustering of raptor movements was recorded around Monument Hill (shown in **Figure 1**). This is likely to be due to the suitability of the surrounding habitat and the amount of time spent surveying in this corner of the site, that provides a good vantage point to observe the surrounding area. It is probably also due in part to the position of this hill between two areas of woodland. It should be noted that raptors continue to be present in this area, which is less than 1 km from turbines at the existing (Crookwell I) wind farm. The 4 turbines proposed to be erected on the Monument Hill ridge have the greatest potential for causing raptor impacts.

Australian Kestrels hunt from perches and on the wing over open country, using thermals and up-draughts from hills. Individuals observed at the site were seen to spend their time at heights between 10 and 50m. They are an agile species, but nevertheless are prone to striking aircraft when hunting over airports. They would be at moderate risk of colliding with turbines, but they have a relatively rapid reproductive rate and are successful in grazed lands. They are also likely to habituate to the wind turbines with time. Potential turbine strikes would be unlikely to affect the viability of the local population.

Brown Falcons were also seen within 500 metres of the existing turbines. They hunt from perches and on the wing (at 10-50 metres), and soar on thermals (to 200 metres) (various authors in Marchant & Higgins 1993). Due to this behavioural trait, this species would also be at moderate risk of striking a turbine. They are a widespread and common species, successful in lightly timbered grazing land. They are also likely to habituate to the wind turbines with time. Potential turbine strikes would be unlikely to affect the viability of the local population.

The White-bellied Sea-eagle, seen at Pejar Dam, is not likely to be a permanent resident on the site and is unlikely to spend much time in the proposed turbine area as the nearest turbines are about one kilometer from the dam. Since this species is likely to be attracted to alternate sites with expansive water bodies, such as the dam, it is considered to be at low risk of striking a turbine.

Although not recorded in this census, Whistling Kites have also been reported to nest at Pejar Dam. They would also be expected to remain in the area of the dam and the river, and to be at low risk of entering the turbine area.

Little Eagles soar on thermals and up-draughts, and often search for prey on the wing. Little Eagles occasionally eat carrion, and the pair observed at Pejar Dam may hunt for rabbits over the proposed wind farm. However, there is unlikely to be more than one family group in the wind farm area, as they tend not

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to nest in solitary trees, and usually hold large well-spaced territories throughout the year. These birds would be at low to moderate risk of striking a turbine. An applicable potential mitigation measure in the event of unacceptable collision events is the controlling of rabbits across the site, resulting in a reduced risk for this species and other raptors.

Wedge-tailed Eagles are large birds with limited agility. They hunt on the wing, soaring on thermals and over slopes. They have a large home range, and a low reproductive rate. Using part of the turbine area as lambing paddocks could increase the amount of time that this species spends on the site. Wedge-tailed Eagles have collided with turbines in Tasmania and Victoria, and would be at moderate risk of striking a turbine on this site. This has the potential to adversely affect the local population of the species. In the event of unacceptable collision events, controlling rabbits on the site and reducing the amount of lambing within the turbine area could reduce the amount of time Wedge-tailed Eagles spend in the danger zone. This approach would require the agreement of the land owners.

Brown Goshawks and Collared Sparrowhawks may occur in the Elmgrove woodland (which was not accessible for this survey). These birds often fly at or below canopy height when hunting, but also soar high at times (various authors in Marchant & Higgins 1993). They would spend a lower proportion of their time in the rotor sweep zone than some other raptor species, but may be at risk when moving between the woodlands east and west of Monument Hill. Reducing potential prey (e.g. lambs) within the turbine area may also reduce potential collisions with these species were this to be occurring at an unacceptable rate during operation.

Peregrine Falcons hunt on the wing, flying low and high over open country. They are widespread, but have low population densities and a low reproductive rate. They soar and are agile, but stoop (dive on prey) at very high speeds. This species could be at moderate risk of colliding with a turbine, but they are likely to spend more time hunting along the river than over the open ridges.

### **2.4.2 Waterbirds**

Waterbirds disturbed by observers did not behave in a way that would put them at risk of colliding with a turbine. Instead they were observed to fly low and follow drainage lines. Such species included herons, cormorants and several species of duck. Many waterbird movements take place at night, and often when there is a moon.

Similar records are not presently available from the Crookwell I wind farm to show how often the turbines operate at night, which would help in assessing the risk of waterbirds colliding with turbines. Local waterbirds have been noted to habituate to large man-made structures by the site property owners and demonstrate collision avoidance tactics in their flight patterns. Installation of the transmission line at the south-eastern corner of the site is such an example. The local waterbirds would be expected to habituate to the presence of the turbines and the minimal collision rates expected would be likely to reduce with time.

**2.4.3 Other species**

Other birds which were seen to fly in the rotor sweep zone were mainly common medium-sized birds of open country, such as Little Ravens, Australian Ravens, Australian Magpies, Galahs and Sulphur-crested Cockatoos. These species are in the group designated as increasing in the NSW sheep/wheat belt (Reid 1999), being ‘moderately plentiful in highly fragmented landscapes’. Their success in this region is unlikely to be affected by the presence of Crookwell II.

Yellow-tailed Black-Cockatoos are less common, and probably feed and roost in the pine breaks on the site. Two of the major pine breaks are close to turbine rows, and are apparently to be thinned or removed. Removing large pines from the turbine area should reduce the collision risk for a number of species, including Yellow-tailed Black-Cockatoos.

**2.5 Risk assessment**

<b>Raptor species</b>	<b>Assessed risk</b>	<b>Possible mitigation measures to reduce risk</b>
Australian Kestrel	Moderate	This local species is likely to habituate to the proposed turbines.
Brown Falcon	Moderate	This local species is likely to habituate to the proposed turbines.
White-bellied Sea-eagle	Low	This species is not likely to spend time on-site. If utilising this area in drought conditions, it would be expected to occur at Pejar Dam and not at the site.
Whistling Kite (not observed during this study)	Low	This species is not likely to spend time on-site. It would be expected to occur at Pejar Dam and not at the site.
Little Eagle	Low – Moderate	Reducing potential prey (eg. lambs and rabbits) from occurring in the proposed turbine area.
Wedge-tailed Eagle	Moderate	Reducing potential prey (eg. lambs and rabbits) from occurring in the proposed turbine area.
Peregrine Falcon	Moderate	This local species is likely to habituate to the proposed turbines and is more likely to spend

<b>Raptor species</b>	<b>Assessed risk</b>	<b>Possible mitigation measures to reduce risk</b>
		most time hunting along drainage ways instead of ridge-tops. There are no potential roosting sites available. The area used for foraging and hunting
Brown Goshawks and Collared Sparrowhawks	Moderate	Reducing potential prey (eg. lambs and rabbits) from occurring in the proposed turbine area and enhancing off-site habitat to discourage movement across the Monument Hill ridge.

For all species listed, if high mortality rates were occurring, investigations into possible mitigation measures would be undertaken.

The spring survey results suggest that raptor numbers are low for all species recorded, as was found during the April surveys for the EIS (page 11.20).

There is some evidence that nesting raptors are sensitive to visual and auditory disturbance (Workman *et al.*, 1992; Krausman *et al.*, 1993; Weisenberger *et al.*, 1996). However, during the spring survey, no raptor roosts or nests were observed.

Several raptor movements were observed within the potential strike zone (i.e. they were observed flying at the approximate height of the proposed turbines). Overseas studies (summarised in Hull and Meredith 2001) suggest that birds observe wind farms and habituate to them including shifts in flight paths, usually on a horizontal plane rather than vertical.

Whilst raptors are one of the guilds of birds more prone to collision in general terms (Anderson *et al.*, 1999), the predicted collisions with turbines by raptors is expected to be low and not significantly effect the local raptor populations recorded on site. This is based on:

- the low numbers of raptors using the site;
- their expected habituation (becoming used to the wind farm site). This is discussed later in this report;
- no evidence of the raptors using the site for roosting or breeding; and
- a predicted avoidance rate of between 98-100% (detailed later in this report based on work done for the Heemskirk wind farm).

### 3.1 Existing Reports

Three reports were studied as part of this work:

- Brett Lane & Associates Pty Ltd., *Bald Hills Wind Farm - Flora, fauna and avian assessment* (Appendix 1 to Environmental Effects Statement) Unpublished report No. 2002.17(3.3), 2003 (sub contractor report for Wind Power Pty Ltd.)
- Bioresource Consultants (2004) *Developing methods to reduce bird mortality in the Altamont Pass Wind Resource area*. BioResource Consultants, for California Energy Commission. [www.energy.ca.gov/reports/index.html](http://www.energy.ca.gov/reports/index.html)
- Heemskirk Wind Farm Development Proposal, Volume 1 – Wind Farm Site, Chapter 10 – Avifauna, Hydro Tasmania, January 2003

The findings of these reports, with regards to raptors and bird strikes are summarised below.

#### 3.1.1 Bald Hills Wind Farm Report

As part of the Environmental Effects Statement for the Bald Hills wind farm in Victoria, a flora, fauna and avian assessment was conducted. Appendix 1 contains the details of the collision risk. The report included a summary of information from other wind farms around the world.

The report comments on the applicability of using the existing studies to predict mortality rates on the Bald Hills wind farm:

*An alternative analysis of wind generator impacts on birds is to review all available studies and calculate the numbers of bird deaths per turbine per year. Obviously, the limitation with this approach is that each site will be unique in some way and bird utilisation will not be consistent between sites.*

Brett Lane & Associates Pty Ltd., 2003

The review of studies from around the world found most wind farms in agricultural settings affect between 2 and 4 birds per turbine per year. However, the report states:

*The applicability of these results to wind farms in Australia is not known. However, the lack of comparable numbers of night-migrating songbirds, which account for about half of the observed bird mortality at North American wind farms (Erickson et al. 2001), may mean that mortality rates in Australia are correspondingly lower.*

Brett Lane & Associates Pty Ltd., 2003

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The report comments on recent work at the Codrington Windfarm near Port Fairy in coastal south-western Victoria (Biosis Research Pty Ltd 2002) that found very few dead birds under wind turbines. The study also found that:

*...avoidance of turbines has been observed at the rate of 100 percent. Of over 2,000 observations of birds approaching wind generators, all were observed to take avoidance action, by flying over, around or under the rotating turbine blades.*

Brett Lane & Associates Pty Ltd., 2003

The findings from the survey of bird flights suggests that birds do habituate to the wind farms and alter their flight path accordingly. The Bald Hills report makes reference to work by Winkelman (1994):

*Winkelman (1994) found that resident birds have been found to avoid wind generators at distances of 250 m to 500 m, with the disturbance causing between a 60% and 95% decline in bird usage near turbines.*

Brett Lane & Associates Pty Ltd., 2003

### 3.1.2 Carcass monitoring at Altamont Pass, California

The results of the large research and monitoring program at wind farms in the Altamont Pass area in California have just been made available on the internet ([www.energy.ca.gov/reports/index.html](http://www.energy.ca.gov/reports/index.html), BioResource Consultants 2004). This work involved 3-4 years of carcass searches at over 4,000 turbines. The frequency of searches was every 5 to 6 weeks.

This scale of survey allows statistical analysis of the results for this particular site. The Altamont Pass research concluded that at least 3 years of carcass searches are needed before *'the sample of wind turbines sufficiently stabilizes in the percentage of non-zero mortality values'*, and that less than 3 years of monitoring may give unreliable estimates of mortality. At lower levels of mortality, the required survey period may be longer. For Crookwell II, ongoing monitoring is recommended, to be conducted by trained operators following a procedure. Utilising operators will provide continuous monitoring by staff that will visit every turbine over the course of each month.

A number of mitigation measures were recommended from the study. However, most are experimental as yet and have not been tested and monitored to prove successful. For Crookwell II, bird strikes are not expected to be high. As such, implementing mitigation measures are considered unnecessary at this stage of the project. However, if during the ongoing monitoring by trained staff, bird strikes are considered to be higher than expected, mitigation measures will be investigated.

The experimental measures listed in the report include:

- remove isolated wind turbines or add them to groups, as isolated turbines may kill disproportionate numbers of birds (none of the turbines proposed for Crookwell II are considered isolated i.e. all are part of clusters);

- give special attention to turbines at the edge of the wind farm, edge of clusters or end of turbine rows, to make them more visible or encourage birds to fly further away when passing them. This includes painting the rotors with patterns that reduce ‘motion smear’ (see Hodos *et al.* 2001 and BioResources 2004, page 345), or installing poles as bird flight diverters (see BioResources 2004, p344). Note that patterned blades may produce visual flickering effects that are aesthetically undesirable for human observers;
- prevent stock from congregating in the shade of turbines, as enriching the pasture with their droppings may increase insect numbers and hence bird activity;
- management to reduce prey for raptors. Rabbit control is recommended at the wind farm, as well as prompt removal of stock carcasses and reduction in lambing areas; and
- use turbines with a higher rotor plane. Flight records showed that some raptors flew below the rotors at Altamont, and taller towers may reduce mortality. Many of the raptor movements observed at Crookwell in October 2004 were below 20 metres.

Although these actions may be useful in reducing potential impacts to raptor and waterbird species, it must be noted that they are still experimental and have not as yet been scientifically or statistically substantiated.

### 3.1.3 Heemskirk Wind Farm

The Heemskirk report contains details of the collision risk assessment conducted for the site. The work included the use of a risk model developed by Biosis that models mortality risk for wind farm sites. The use of the model was considered necessary for the Heemskirk project as endangered species (including orange bellied parrots) and threatened species (including certain raptors) were present on the site. The numbers of birds was also high in comparison to Crookwell II, given the wild and natural coastal environment.

The report states that:

*It has been well established overseas that even collision prone bird species avoid collisions with wind turbines on most (98-100%) occasions (Winkelman, 1992, Still et al, 1995)*

Hydro Tasmania Heemskirk Wind Farm Development Proposal

The results of the modelling for raptors showed that there is a low level of collision risk. The figures provided in the report show that for all of the raptors modelled against three common turbine types, the range of collision risk was between 0.005 and 0.15 birds per year for the wind farm. The three turbine types modelled would result in turbine numbers of 91 (for the smallest turbines), 80 and 53 (for the largest turbines).

### 3.2 AusWEA Guidance

A new impact assessment protocol is being developed by AusWEA that would set a baseline for future monitoring. The AusWEA guidelines are expected to be ready by the end of 2004. The WFJV will obtain a copy of the protocol when available and its content shall be considered when formulating or refining Crookwell II's operating procedures.

### 3.3 Relevance of Studies to Crookwell II

The assessment of other studies around the world has provided the following conclusions:

- the modelling work done for the Heemskirk site showed that despite the higher numbers of birds present, the collision risks were low, with the greatest risk being to Orange-bellied Parrots. The modelled risk for the Orange-bellied Parrots was 0.19 birds per year for the wind farm, based on a conservative 90% avoidance rate;
- given the relatively low numbers of common birds (including raptors) that exist on the Crookwell II site, modelling is not considered necessary for this project;
- there is no statistical basis for using the results of the Californian survey to calculate total bird mortality rates at Crookwell;
- the study of worldwide bird mortality rates from wind turbines (Brett Lane & Associates Pty Ltd., 2003) is not directly applicable to Australia given the different species present, and therefore different behaviours. Generic indicators cannot be transferred from site to site due to the difference in species;
- birds have been observed to avoid wind turbines (98-100% collision avoidance as detailed in the Heemskirk report), supporting the prediction that birds on the Crookwell II site will habituate i.e. get used to the wind turbines being there. This has been seen with the transmission line across the site;
- there are a number of mitigation measures that are experimental and not yet proven as effective measures. As bird strikes are not predicted to be high on the Crookwell II wind farm site, none of these measures are proposed at this stage. The possible mitigation measures may be considered if mortality rates are higher than expected at Crookwell II; and
- the WFJV will obtain a copy of the AusWEA protocol, when available. This shall be considered when developing or refining Crookwell II's operating procedures.

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This survey work has drawn the following conclusions:

- observations from Monument Hill showed the greatest number of raptor movements on the site, however raptor numbers on the proposed Crookwell II wind farm site were low for all species recorded (as found in the main EIS (page 11.20));
- during the spring survey, no raptor roosts or nests were observed being used on the site;
- an assessment of the raptors observed on site and their habits in terms of movement and feeding has concluded that raptor strikes are expected to be low for the proposed wind farm. As such, no further raptor surveys are considered as being required at this stage;
- many of the raptor species observed are expected to become accustomed to the wind farm, as has been found by studies of other wind farms (discussed in Section 3). This has been seen with the transmission line;
- whilst other bird strike surveys around the world provide no statistical basis for Crookwell II mortality rates, comparative principles can be utilised in predicting potential impacts. The Heemskirk collision risk modelling suggests that the risk of collisions at Crookwell II will be low;
- the Californian report provides a list of potential mitigation measures, although all of these are considered experimental at this stage;
- if a suitable procedure is developed and implemented, ongoing monitoring by trained operators will provide an assessment of the bird strikes on the site. This procedure will ensure regular visits to all turbines by trained operators, and interpretation of the gathered information by a qualified specialist; and
- when available, the AusWEA guidelines will be referenced when developing or refining Crookwell II's operating procedures.

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The following recommendations are as a result of this survey work:

- no alteration to the proposed wind farm is necessary as a result of the spring survey findings;
- no additional mitigation measures (as detailed in Section 3) are required at this stage as bird strikes are expected to be low;
- the WFJV should plan an operational carcass monitoring program for the Crookwell II wind farm site. This could be carried out by trained operational staff as part of their maintenance duties. Over the course of a month, each turbine will be visited for maintenance purposes. At this time, a carcass search could be conducted with the results sent for assessment by a qualified specialist;
- obtain a copy of the AusWEA guidelines, and reference when formulating or refining the Crookwell II operating procedures; and
- if high mortality rates (relative to individual species' on-site abundances) are observed by trained operators around individual turbines, further bird survey surveying may be considered in conjunction with relevant authorities. The purpose of such surveys would be to investigate mitigation measures (such as those discussed in Section 3.1.2) to reduce these rates.

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Bioresource Consultants (2004) *Developing methods to reduce bird mortality in the Altamont Pass Wind Resource area*. BioResource Consultants, for California Energy Commission.

[www.energy.ca.gov/reports/index.html](http://www.energy.ca.gov/reports/index.html)

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Heemskirk Wind Farm Development Proposal, Volume 1 – Wind Farm Site, Chapter 10 – Avifauna, Hydro Tasmania, January 2003

# APPENDIX 1

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The table on the following page provides the results of the bird survey.

The table contains the following labels:

- x = present
- f = flying
- breeding data codes: dy = dependent young, ih = inspecting hollow.

# APPENDIX 1

## Bird species observed at proposed Crookwell II Wind Farm site, 5-7 October 2004.

Species	Pasture	Paddock trees	Pine breaks	Farm dams	Wollondilly River	Pejar dam	Pejar Dam woodland	Other woodland remnants
Australasian Grebe				x		x		
Hoary-headed Grebe				x		150		
Great Crested Grebe						23		
Australian Pelican						4		
Great Cormorant						7		
Little Black Cormorant						32		
Little Pied Cormorant						12		
White-faced Heron					x	1		
Musk Duck				x		21		
Black Swan				x		18		
Domestic Goose						2		
Australian Wood Duck				x	x			x

# APPENDIX 1

Species	Pasture	Paddock trees	Pine breaks	Farm dams	Wollondilly River	Pejar dam	Pejar Dam woodland	Other woodland remnants
Pink-eared Duck						2		
Grey Teal				x	x	40		
Chestnut Teal						4		
Pacific Black Duck				x	x	5		
Hardhead				x		100		
Wedge-tailed Eagle	x(f, off-site)							
White-bellied Sea-Eagle						1		
Brown Goshawk						1	x	
Little Eagle						2	x	
Brown Falcon	x							x
Australian Kestrel	x	x	x					x
Peregrine Falcon					x			
Dusky Moorhen					x			

# APPENDIX 1

Species	Pasture	Paddock trees	Pine breaks	Farm dams	Wollondilly River	Pejar dam	Pejar Dam woodland	Other woodland remnants
Eurasian Coot				x	x(dy)	500		
Black-winged Stilt						15		
Red-capped Plover						7		
Black-fronted Plover						5		
Red-kneed Dotterel						4		
Banded Lapwing	x							
Masked Lapwing						15		
Sharp-tailed Sandpiper				x		7		
Silver Gull						7		
Crested Pigeon			x					
Yellow-tailed Black-Cockatoo	x(f)		x					x
Galah	x		x		x		x	x
Sulphur-crested Cockatoo	x		x		x			

# APPENDIX 1

Species	Pasture	Paddock trees	Pine breaks	Farm dams	Wollondilly River	Pejar dam	Pejar Dam woodland	Other woodland remnants
Crimson Rosella		x (ih)	x		x		x	x
Eastern Rosella			x				x	x
Red-rumped Parrot			x		x		x	x
Horsfield's Bronze-cuckoo			x					
Sacred Kingfisher							x	
Laughing Kookaburra		x			x		x	x
White-throated Treecreeper			x					x
Superb Fairy-wren					x			x
Red Wattlebird								x
Noisy Miner							x	x
Yellow-faced Honeyeater								x
White-fronted Chat						2		
Spotted Pardalote			x					x

# APPENDIX 1

Species	Pasture	Paddock trees	Pine breaks	Farm dams	Wollondilly River	Pejar dam	Pejar Dam woodland	Other woodland remnants
Striated Pardalote			x		x		x	x
White-browed Scrubwren			x		x			
Weebill					x		x	
Brown Thornbill			x					
Buff-rumped Thornbill			x					x
Yellow-rumped Thornbill			x		x		x	x
Striated Thornbill								x
Rufous Whistler							x	x
Golden Whistler							x	
Grey Shrike-thrush							x	x
Willie Wagtail			x		x		x	
Grey Fantail					x			x
Black-faced Cuckoo-shrike			x					x

# APPENDIX 1

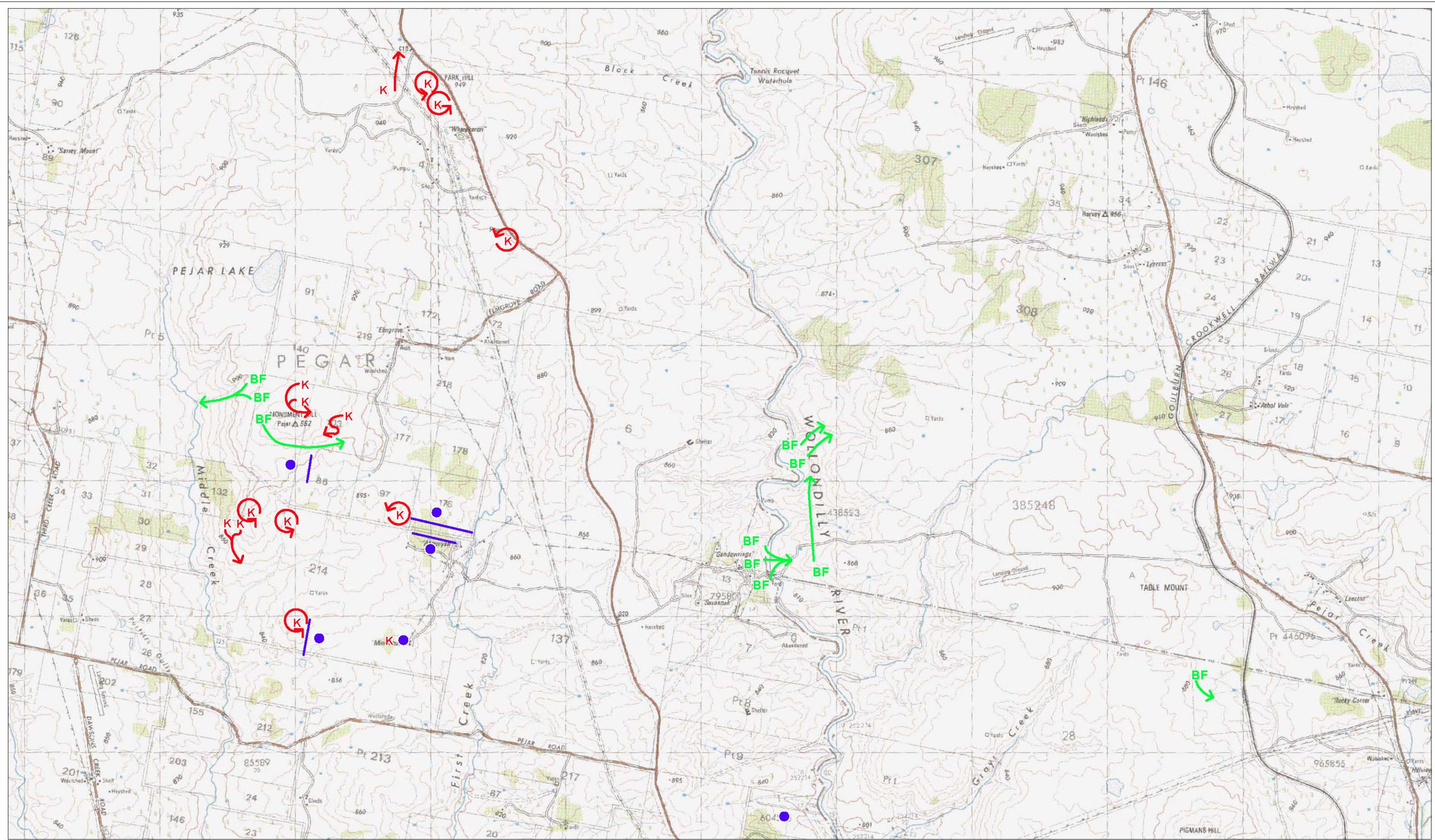
Species	Pasture	Paddock trees	Pine breaks	Farm dams	Wollondilly River	Pejar dam	Pejar Dam woodland	Other woodland remnants
Grey Butcherbird							x	
Magpie-lark			x		x		x	
Australian Magpie	x	x	x		x		x	x
Pied Currawong	x(f)						x	x
Australian Raven	x		x					x
Little Raven	x		x		x		x	x
White-winged Chough							x	x
Richard's Pipit	x		x				x	x
Skylark	x							x
European Goldfinch	x							x
Mistletoebird								x
Welcome Swallow				x	x	x	x	
Fairy Martin							x	

# APPENDIX 1

Species	Pasture	Paddock trees	Pine breaks	Farm dams	Wollondilly River	Pejar dam	Pejar Dam woodland	Other woodland remnants
Tree Martin							x	
Reed Warbler					x			
Silvereye							x	x
Common Blackbird					x			
Common Starling			x		x		x	x

# FIGURES

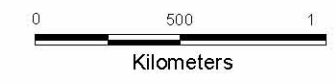
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Aerial Photo Source: Topoview Pty Ltd, captured 2000. © Topoview Pty Ltd.

**LEGEND**

- Spot Census (Stationary Observations)
- Linear Census (Mobile Observations)
- Australian Kestrel (K) Observed Movements
- Brown Falcon (BF) Observed Movements



PROJECT: 52848-001  
 FILE NAME: Figure 1\_0.WOR  
 DATE: 01/11/2004  
 PROJECTION: AMG 55

