

Kyoto energypark

Appendix A(ii)

Bird Impact Assessment
CEG Consult
(June 2008)

APPENDIX III
BIRD IMPACT ASSESSMENT



BIRD IMPACT ASSESSMENT

KYOTO ENERGY PARK MIDDLEBROOK STATION AND MOUNTAIN STATION SCONE

**JUNE 2008
(REF: CE40)**

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BIRD IMPACT ASSESSMENT

**KYOTO ENERGY PARK
MIDDLEBROOK STATION
AND MOUNTAIN STATION
SCENE**

JUNE 2008

Conacher Environmental Group

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PREFACE

This Bird Impact Assessment has been prepared by *Conacher Environmental Group* to identify the avian fauna characteristics of the proposed Kyoto Energy Park.

This assessment has been prepared under Part 3A of the *Environmental Planning and Assessment Act 1979*. The Director-General's Requirements require an assessment report to be prepared in accordance with the Departments of Environment and Conservation and Primary Industries and Auswind's *Wind Farms and Birds: Interim Standards for Risk Assessment*, July 2005 (Brett Lane & Associated 2005). This Bird Impact Assessment has been prepared in accordance with those guidelines to identify the avian characteristics of the subject sites and to provide a systematic assessment of bird impact risk with the proposed wind turbines. This assessment forms part of the Part 3A Assessment as required by the NSW Department of Planning.

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BIRD SPECIES LIST

SECTION 1

INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

Conacher Environmental Group has been engaged to prepare a Bird Impact Assessment for the proposed construction of the Kyoto Energy Park at Middlebrook Station on Middle Brook Road Scone and Mountain Station at Owens Gap Scone, in the Upper Hunter Shire Council Local Government Area.

This assessment has been prepared under Part 3A of the *Environmental Planning and Assessment Act 1979*. The Director-General's Requirements require an assessment report to be prepared in accordance with the Departments of Environment and Conservation and Primary Industries and Auswind's *Wind Farms and Birds: Interim Standards for Risk Assessment*, July 2005 (Brett Lane & Associated 2005). This Bird Impact Assessment has been prepared in accordance with those guidelines to identify the avian characteristics of the subject sites and to provide a systematic assessment of bird impact risk with the proposed wind turbines. This assessment will form part of the Part 3A Assessment as required by the NSW Department of Planning.

1.2 SITE DESCRIPTION

The planning and cadastral details of the subject site are provided in Table 1.1 while Table 1.2 summarises the geographical characteristics of the site.

TABLE 1.1 SITE DETAILS	
Location	"Middlebrook Station" Middle Brook Road Scone and Mountain Station on Merriwa Road Owens Gap, Scone.
Area	1923.76ha Middlebrook Station & 2030.12ha Mountain Station
Topographic Map	Parkville 1:25,000, Bunnan 1:25000 and Muswellbrook 1:100,000
Grid Reference	Middlebrook Station 291500E 6461500N MGA Mountain Station 287500E 6451500N MGA
Local Government Area	Upper Hunter Shire Council
Existing Land Use	Pastoral, sheep grazing
Proposed Development	Energy Park

TABLE 1.2 SITE CHARACTERISTICS	
Topography	Middlebrook Station: Undulating creek flats to steep rocky ridges and escarpments rising to undulating plateaus. Mountain Station: Elevated undulating plateaus falling to steep rocky slopes and escarpments and narrow gullies.
Slope	Varying from 5% to 80% along escarpments.
Aspect	Various, mostly east and west.
Soil Types of proposed development areas	Shallow to very shallow well to moderately drained Claustic Ridosols and Orthic Tenosols on crests and side slopes of the Wingen Maid soil landscape; Shallow to deep well to moderately drained Black Red and Brown Chromosols and Dermosols on crests and side slopes of the Ant Hill soil landscape; Moderately well drained, moderately deep Haplic Mesotrophic Black Dermosols across the plateau surfaces
Catchment	Hunter River
Drainage	Middlebrook Station: Overland flow into Middle Brook draining to Kingdom Ponds then the Hunter River to the east and draining to the west to Dart Brook then into the Hunter River. Mountain Station: Overland flow into Bullock and Little Bullock Gullies into Middle Brook to the east and draining into the Hunter River.
Vegetation	A total of seventeen (17) vegetation communities have been identified within the subject site by <i>Conacher Travers</i> or previous surveys (Hill <i>et al.</i> , 2001 and Peak, 2006). Refer to Section 2.2 for details

1.3 PROPOSED DEVELOPMENT

The proposed development is for the construction of an Energy Park comprising the utilisation of a combination of various energy-producing technologies and associated facilities. This includes:

- Wind turbine generators;
- Solar photovoltaic (PV) plant;
- Closed loop hydro plant;
- Visitors and education centre, Manager's Residence, Maintenance Shed;
- Site Substation and Switchyard;
- Electricity transmission line for connection to the grid;
- Construction and development infrastructure.

Details on the specific components of the development are provided below:

Wind turbine generators

It is proposed to construct approximately 11 turbines on Middlebrook Station and a maximum of 31 turbines within Mountain Station. Turbines are expected to be 100-105m in hub height with a blade length of 45-50m. A maximum blade tip height of 150m would be used. Figure 1.1 demonstrates these dimensions:

Turbines will be positioned along the ridgelines to enable access to prevailing winds. Figures 1.1 and 1.2 of the Flora and Fauna Assessment (Conacher Travers 2007) show the location of the wind turbines on Middlebrook Station and Mountain Station (Owens Gap) respectively.

Selective clearing of vegetation will be required to provide for the construction of anchorage pads and access roads.

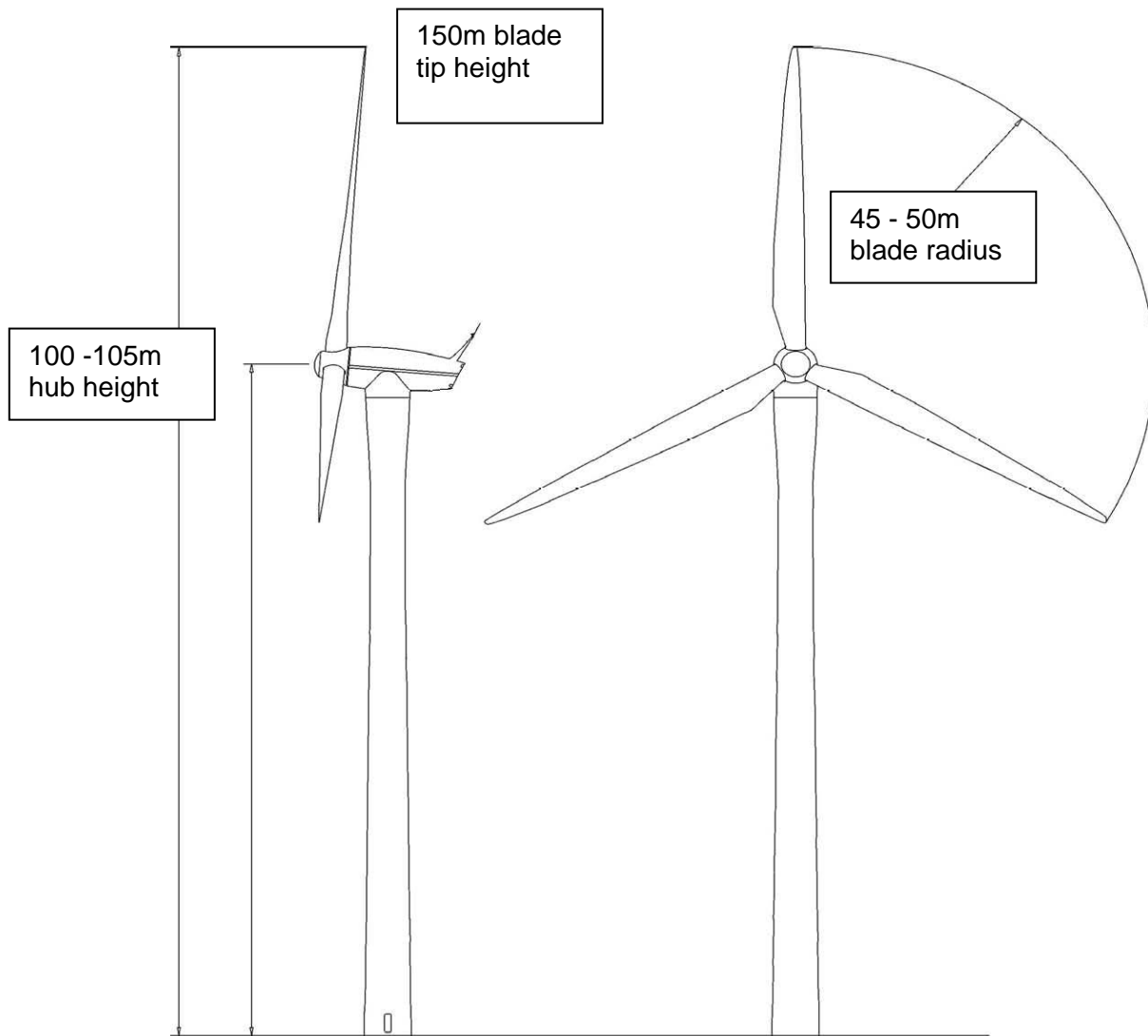


Figure 1.1 Wind Turbine dimensions proposed for Kyoto Energy Park, Scone.

Solar PV plant

The solar PV plant will cover approximately 15-21 hectares of existing cleared land on the plateau of Mountain Station, it is expected that clearing of native vegetation will not be required for its construction. Minor earthworks will be required for levelling and preparation of the area for installation of the solar array.

Closed loop hydro plant

The closed loop hydro plant will be located within the central valley of Mountain Station where the steep slopes are able to provide sufficient water velocity to generate power. Construction of this plant will require the removal of native vegetation and habitat disturbance to provide for the construction and access roads.

Visitors and education centre

This centre will be located on the cleared plateau of Mountain Station in the vicinity of the Solar PV plant. The proposed area is already cleared and it is unlikely that further clearing for bushfire protection areas and access will be required.

Electricity transmission lines

Pamada have indicated that the preferred options for line route connecting the Kyoto Energy Park to the electricity grid are Option 2 (66kV/33kV connection to the new Scone STS) and Option 4 (132kV/33kV connection to the Muswellbrook STS).

Option 2 (66kV/33kV overhead transmission line)

The 66kV overhead line commences between wind turbines 30 and 31 located in the south-east of Mountain Station. It is proposed to follow the Crown easement travelling east, then along Winters Rd, Yarrandi Rd and Moobi Rd to the intersection of Bunnan Rd/Satur Rd and Liverpool St. From this point the transmission route travels east along Liverpool St. There are variations to this route prior to entering the Scone town area included as variations A, B and C.

A 33kV overhead line would be used to connect the Middlebrook Station turbines to the Mountain Station substation. This line would utilise the same pole as the 66kV line and the line route would be along Bunnan Rd between both sites.

This line route option predominantly follows existing roads, and is to be contained within the road reserve, except the far western end of route option 2. Here the route leaves the road and road reserve, travelling west into Mountain Station for approximately 200m within vegetated land.

Option 4 (132kV/33kV overhead transmission line)

The 132kV overhead line commences at the Mountain Station site substation and follows Bunnan Road to the intersection of Yarrandi Road. The route follows the Yarrandi Rd and Nandowra Rd in a southerly direction to the intersection of Sandy Creek Rd where it continues south along Back Muswellbrook Rd. At the intersection of Back Muswellbrook Rd and Burton Lane two variations have been considered as variation A and B. Option 4B is the preferred route as it continues along Burton Lane crossing the New England Highway to the Muswellbrook STS connection point.

A 33kV overhead line would be used to connect the Middlebrook Station turbines to the Mountain Station substation. This line would utilise the same pole as the 66kV line and the line route would be along Bunnan Rd between both sites.

This line route option predominantly follows existing roads, with the line replacing existing overhead lines within the road reserve.

The proposal also includes ancillary infrastructure and associated developments such as:

Operational Infrastructure:

- Substation and switchyard;
- Managers residence;
- Maintenance shed;
- Permanent tracks;
- Bushfire asset protection zones;
- Electrical and telephone services including underground and overhead lines.

Facilities used during Construction only:

- Construction offices and laydown area;
- Concrete batching plant.

The details of the proposal are provided as separate site plans.

1.4 ASSESSMENT PROCEDURES

The following sections provide details on the application of the assessment methods and results for the risk assessment completed in accordance with the Interim Standards for Risk Assessment – Wind Farms and Birds (Brett Lane & Associates, 2005). These Interim Standards identify a staged or progressive methodology for investigating the impact of proposed wind farms on birds. Brief details of the levels of investigation are provided below.

Level 1 Investigations – Initial Risk Assessment

Objective : To provide an estimate of the risk of significant bird impact.

Investigation protocols applied:

- Regional overview of bird species including threatened species, key habitats, special matters of interest;
- Site Investigations;
- Bird utilization surveys (site surveys);
- Roaming surveys (site, local area).

Outcomes to be achieved:

- Identification of ‘Species of Concern’;
- Determination of levels of risk of significant bird impact on ‘Species of Concern’.

Details regarding the application and results of the Level 1 investigation are provided in Section 2 of this Report.

Level 2 Investigations – Refined Risk Assessment

Objective : To provide a more refined estimate of the level of significant bird impact risk.

Investigation protocols applied:

- Seasonal variation in bird utilization;
- Gradient studies (local area bird data);
- Roaming surveys (site surveys other than point census);
- Risk modelling.

Outcomes to be achieved:

- Estimates of level of risk of significant bird impact;
- Identification of ‘Species of Concern’ with medium to high risk of significant impact;
- Consideration of appropriate mitigation measures, design reviews or siting alterations.

Details regarding the application and results of the Level 2 investigation are provided in Section 3 of this Report.

Level 3 Investigations – Confirmed Risk Assessment and Mitigation

Objectives : To further reference risk assessment in the context of the regional or wider population of birds.
To inform wind farm feasibility, design and operational measures sufficient to achieve acceptable levels of bird mortality risk.

Investigation protocols applied:

- Population assessments for significantly impacted 'Species of Concern';
- Population viability analysis for significantly impacted 'Species of Concern'.

Outcomes to be achieved:

- Statement of residual risk for 'Species of Concern';
- Consequences on bird populations in relation to increased probability of extinction of 'Species of Concern'.

Comments in relation to the application of a Level 3 Investigation are provided in the Conclusions of Section 4 of this Report.

1.5 SPECIALIST CONSULTATION AND ADVICE

Following initial investigations of the site and local area it was determined that the installation of the wind turbines had potential to impact on raptor species, particularly the Wedge-tailed Eagle which was regularly observed during surveys. It was considered that a specialist consultant ornithologist should be engaged to provide input into the survey, reporting and assessment component of the project.

Dr Stephen Debus, a consultant ornithologist based at the University of New England Armidale was engaged to provide technical input into the project. Dr Debus spent three days completing on-site and local area surveys with particular attention given to raptor species including the Wedge-tailed Eagle. These surveys were undertaken on 26, 27, 28 February 2008.

1.6 REVIEW OF SIMILAR PROJECTS

The following is a summary of the documentation collected as part of the review stages of this study. The major findings of each of these studies prepared for proposed and approved wind farms in other parts of Australia is provided.

Harper Somers (2006) Black Springs WindFarm (Oberon) Flora and Fauna Assessment. July 2006

- Located at Oberon, NSW.
- Proposal for 18.9 MW wind farm with 9 turbines (S88 Suzlon units) with 80m hub height and 88m rotor diameter.
- Subject site (527 ha) consists of several minor creeks and cleared, open paddocks with scattered vegetation and remnant woodland patches with sheep and cattle grazing as predominant land uses. Turbines are to be located on existing cleared knolls, ridgelines and elevated flats.
- One threatened bird species recorded (Blue-billed Duck).
- Wedge-tailed Eagle and Black-shouldered Kite observed.
- Most forest/woodland species were usually restricted to their habitats.

- Acknowledges previous research demonstrating impacts to birds and factors that affect those impacts eg siting, turbulence etc.
- Raptors and other common local resident birds most likely to be prone to turbine collisions. In respect to migratory birds, report states that experienced dominant breeders trend not to migrate and the majority of their time would be spent in their usual habitat (ie not near turbines).
- Acknowledges there may be potential loss of an unknown number of bats, however is considered unlikely that this would place any local population at risk of extinction due to their key habitat remaining relatively unaffected.
- Concludes that some minor impacts to birds and bats may be expected due to turbine collisions, however are likely to be in line with stated AusWEA (2004) collision rates of several individuals per turbine per year. Some minor changes to the local distribution and abundance of locally occurring common species were also expected, however were not expected to be significant.

Harper Somers O'Sullivan (2005) Liverpool Range Wind Farm, Nowlands Gap Murrurundi Flora and Fauna Assessment. July 2005

- Located in Upper Hunter Valley near Murrurundi.
- Proposal for 8 MW wind farm with 2 to 4 turbines with 80m hub height and 45m blade length.
- Subject site (45ha) contained degraded creeklines and was largely cleared for agricultural purposes, particularly sheep and cattle grazing.
- Subject site is part of regional corridor along the Liverpool Range (as shown by NPWS Key Habitats and Corridors Data)
- Considered that the proposal would have relatively minor ecological impacts.
- States Nowlands Gap is an important habitat corridor for migratory, nomadic and dispersive birds (and bats) due to a natural topographic bottleneck, therefore a higher level of potential impact would be likely to these species. However, collision potential would be minimised due to the small number of turbines.
- Bird and bat impacts similar to Black Springs WF.

BIOSIS Research (2003) Mussleroe Wind Farm, Ringarooma Floodplain Avian Surveys. February 2003

- Located in north-east Tasmania.
- Subject site contains a number of freshwater wetlands surrounded by remnant woodland, heathland and swamp scrub. The eastern side of the subject site was grazed and supported introduced pasture.
- Overall, potential impacts to birds were expected to be low, with a negligible impact on the Wedge-tailed Eagle. There was, however, a higher risk to waterbirds due to the location of transmission lines.
- Predicted likely loss of suitable breeding and foraging habitat for a number of bird species.

NGH Environmental (2005) Snowy Plains (NSW) Wind Farm Statement of Environment Effects. February 2003

- Proposal for 16 turbines with an 80m hub height.
- The subject site's western boundary is the Gungarlin River.
- Vegetation is subalpine with an inverted treeline having woodland on the ridgetops and treeless areas below in the valleys. Subalpine grassland exists on the mid-lower slopes, and wetland complexes exist on the ridges.
- Clearance and fragmentation of habitat was considered to be a threat to mammals
- Predicted no significant impact to microchiropteran bats.

- Many diurnal and nocturnal insects, including the Bogong Moth, were observed on-site which would be expected to increase the risk for insect predators.

Sinclair Knight Merz (2002) Emu Downs and Joanna Plains Wind Farm Sites Flora and Fauna Report. January 2002

- Located 200km north of Perth.
- Proposal for 80 MW wind farm with 48 turbines with a 68.5m hub height and 41m blade length.
- Subject sites were fragmented with relatively large areas of remnant vegetation (in relation to the surrounding region). Presence of local flyway on Joanna Plains site for waterfowl and raptors, however is considered a low risk due to distance away from proposed turbines.
- Concludes that both sites had a relatively low risk to bird and bat species.

Centre for Environmental Management (2006) Leonards Hill Wind Park Fauna Assessment. July 2006

- Proposal for 2 turbines.
- The large majority of the subject site is farmland with a small number of remnant trees where only a small proportion contain hollows.
- The report considered it a very low risk to fauna due to the small size of the subject site and limited habitat value.

Gilmore and Mueck (2006) Newfield Wind Farm Flora and Fauna Assessment. July 2006

- Located near Port Campbell in south-west Victoria.
- Proposal for 15 turbines.
- Subject site (approx. 200ha) contained predominantly introduced vegetation with a few remnant patches of native vegetation.
- 5 broad habitat types identified: forest, wetlands (farm dams and drainage lines), pasture, scattered remnant trees and planted vegetation.
- Preliminary fauna assessments only- fauna impacts not clearly identified.

Kevin Mills and Associates (2005) Capital Wind Farm, Southern Tablelands NSW Flora and Fauna Assessment. March 2005

- Located south of Tarago, NSW.
- Proposal for 140MW wind farm with up to 70 large turbines with 80m hub heights and 45m blade lengths.
- Most of the subject site had cleared vegetation with woodland existing on steep, undulating terrain (ridges).
- Subject site contained woodland, riparian, wetland, pasture and rocky outcrop habitats.
- Identified the following bird groups to be most likely at risk: wetland species that form large flocks, raptors, and species that flock and fly above the canopy.

Gilmore (2006) Yarram Wind Farm, South Gippsland Victoria Bat Activity Report. May 2006

- Proposal for 9 turbines 120 – 130m high.
- Research suggests bat species most at risk are high flying and/or migratory species eg White-striped Freetail Bat, *T. australis*, *Mormopterus sp.*, *V. regulus* and Common Bentwing Bat.

- Results from survey indicated bat activity in cleared areas (where turbines were proposed) was low and also had a reduced diversity when compared to nearby woodland areas.

Brett Lane and Associates (2006) Yarram Wind Farm Bird Utilisation Survey. May 2006

- The subject site (120ha) is cleared grazing land with a few areas of remnant, degraded woodland mainly in the form of scattered eucalypts. The ridgelines are generally cleared of native vegetation and covered with exotic pasture grasses.
- Proposed wind farm site supports a low diversity of opportunistic and adaptable native bird species, exotics and a few raptors and waterbirds.

Hydro Tasmania (2005) Heemskirk Wind Farm Project Environmental Assessment. August 2005

- Proposal for 80 turbines, depending on size.
- Subject site is predominantly button grass and coastal heath with sparsely distributed trees. Some of the subject site contains a portion of Heemskirk Regional Reserve.
- Strategically significant site for the Orange-bellied Parrot as population moves through area twice per year.
- Used collision risk modelling and population viability analysis for the Orange-bellied Parrot.
- Considers the project as a new threat to the species that could put the entire population at risk.
- Concludes that the significant decline or destruction of avifauna habitat is considered unlikely due to the degraded nature of site, the proposed sensitive placement of infrastructure and the small footprint of the wind farm site.
- Used predicted collision rates for the Wedge-tailed Eagle recorded on-site (between 1 and 20 individuals over the projects 20 year life span based on avoidance rates between 90 and 99%). Using this, considered that project would be unlikely to have a significant impact on the species population.
- Calculated collision and avoidance rates for migratory species using the White-bellied Sea-Eagle as an example. Stated the collision rate to be between 1 and 5 individuals over the projects 20 year life span (based on 90-99% avoidance rates).
- Calculated avoidance rates and collision risks for raptors observed on-site.

URS (2004) Woodlawn Wind Farm Environmental Impact Statement. June 2004

- Proposal for 25 turbines with hub heights of 60 or 78m.
- The subject site (4.86ha) contains cleared land (on flatter areas) and remnant native vegetation. A large proportion of the subject site is classed as a wildlife refuge.
- The proposed wind farm site has only limited habitat potential, having a lack of vegetation structure and limited foraging and feeding sources.
- Vegetation along the ridge was cleared open forest.
- No significant impacts on any fauna species during construction phase. Only minimal impacts were expected such as degradation/minimal loss of habitat, loss of connectivity to other potential habitat, loss of hollow-bearing trees and degradation of water quality were to be expected.
- Expected greatest impact to be on resident birds present in low numbers with a moderate risk of collision.
- Assessed raptors as having a moderate to high collision risk.
- Assessed migratory birds (particularly migratory honeyeaters) as having a moderate collision risk, however the number of birds exposed to the risk to be low.
- Assessed the Glossy Black-Cockatoo as having a moderate collision risk, however the annual strike rate to be low.

These environmental assessment documents related to wind farm proposals and completed across a range of habitats within Australia show that impacts upon birds as a result of rotor strike are likely. However it must be noted that while preliminary studies on likely impacts have been completed and those impacts have been identified, empirical data is generally lacking on the actual impacts of turbines upon birds in Australia in various habitats. The ongoing monitoring of approved wind farms, including the Kyoto Energy Park, will aid in providing direct evidence as to the impacts of rotors upon bird species.

SECTION 2

LEVEL 1 INVESTIGATIONS INITIAL RISK ASSESSMENT

2.1 ASSESSMENT METHODOLOGY

Wind Farms and Birds: Interim Standards for Risk Assessment (Brett Lane & Associates 2005) recommends a hierarchy of studies to be conducted involving increasing levels of detail and specificity in investigations. This section constitutes Level 1 Investigation (Initial Risk Assessment).

Qualitative and quantitative data were used to assess the likelihood and consequence of significant bird impacts in relation to the operation of the proposed Energy Park. As outlined in Brett Lane & Associates, (2005) the following steps were followed:

- Regional overview to provide a qualitative overview of bird usage of the subject site and surrounding region, and species occurrence. This involved a detailed review of existing data and site inspection;
- Point bird utilisation survey, and
- Roaming survey.

Methods followed for the point bird utilisation survey and roaming survey are detailed in Section 2.1.2.

Particular emphasis has been given to Species of Concern in conducting this assessment. “Species of Concern” include those species listed as threatened in Schedule 1 and 2 of the *Threatened Species Conservation Act 1995*, species listed as threatened or as listed migratory species within the *Environment Protection and Biodiversity Conservation Act 1999* as well as species that exhibit behaviour that puts them at risk of regular collision with operating wind turbines (Brett Lane & Associates 2005).

The results from Level 1 investigations were then evaluated to determine whether higher-level investigations will be required (Levels 2 and 3) The level of risk of significant bird impact is provided in Table 2.1.

TABLE 2.1 RISK MATRIX FOR PRODUCING LEVEL OF RISK OF SIGNIFICANT BIRD IMPACT				
Likelihood	Consequence			
	Insignificant	Minor	Moderate	Significant
Very rare	L	L	M	H
Rare	L	L	M	H
Possible	L	M	H	H
Probable	M	H	H	H
L = low risk M = medium risk H = high risk				

A literature review of information on birds on the site and the surrounding region was conducted to aid this assessment. A summary of reports consulted is provided in Table 2.2.

**TABLE 2.2
LITERATURE REVIEW OF BIRD SPECIES AND IMPACTS WITH WIND FARMS**

Name of Report	Author	Date Published	Key Species	Issues Addressed
Overview of cumulative risk modelling for avian collisions at multiple wind farms	Ian Smales (Biosis Research)	Feb 2006	Tasmanian Wedge-tailed Eagle	Risk modelling for individual species
Risk level to select species listed under the EPBC Act of collision at wind farms in Gippsland, Victoria	Ian Smales and Mark Venosta (Biosis)	Dec 2005	Grey-headed Flying-fox, White-throated Needle-tail	Risk modelling for selective EPBC species. Tabulated risk assessment.
Modeled cumulative impacts on the Tasmanian Wedge-tailed Eagle of wind farms across the species' range	Ian Smales and Stuart Muir (Biosis)	Sept 2005	Tasmanian Wedge-tailed Eagle	Tas WTE modelling, reproductive ecology, home ranges
Environmental Impacts of Wind-Energy Projects	National Research Council (USA)	May 2007	Birds and bats	Habitat disturbance, noise, lighting, vortices, turbulence.
Wind Turbines and Birds: A Background Review for Environmental Assessment. (Draft)	Kingsley and Whittam (Canada)	May 2005	Birds, raptors	Migrating birds, topography, turbine design, lighting, blade speed, guy wires
Assessing the impacts of wind farms on birds	Drewitt and Langston	2006	Birds	Collision risk conditions, displacement
Wind Turbines and Avian Risk: Lessons from Communication Towers	Kerlinger		Birds	Lighting
Assessing Impacts of Wind-Energy Development on Nocturnally Active Birds and Bats: A Guidance Document	Kunz, Arnett, Cooper, Erickson, Larkin, Mabee, Morrison, Strickland and Szewczak	2007	Birds and bats	Risk assessment and prediction, monitoring of birds and bats
Breeding Biology and Diet of the Wedge-tailed Eagle <i>Aquila audax</i> in the New England Region of New South Wales	Debus, Hatfield, Ley and Rose	2007	WTE	Breeding biology and diet, juvenile development
Wind Farms: The facts and the fallacies	Macintosh and Downie	Oct 2006	Birds and bats	Collision risk, siting of wind farms, behaviour/ecology
Expert Witness Statement of Dr Gregory Charles Richards: Expert of Macarthur Wind Farm Pty Ltd, Victoria	Dr Gregory Charles Richards	Jan 2006	Southern Bentwing Bat, Common Bentwing Bat	Flight height, behaviour
Bird Behaviour in and near a Wind Farm at Tarifa, Spain: Management Considerations	Janss (Spain)		Birds	Flight behaviour and turbine avoidance. Resident birds vs migrants.

Name of Report	Author	Date Published	Key Species	Issues Addressed
Review of Carnaby's Cockatoo <i>Calyptorhynchus litirostris</i> , Great Egret <i>Egretta alba</i> and Rainbow Bee-eater <i>Merops ornatus</i> at the Emu Downs and Joanna Plains Windfarm Sites	RE & C Johnstone		Great Egret and Rainbow Bee-eater	Collision risk determinations

2.2 FIELD SURVEY METHODOLOGY

In order to detect the possible occurrence of bird species specific methods as outlined in DEC (2004) and Brett Lane & Associates (2005) were completed. These methods included:

Roaming Surveys/Oppportunistic surveys

These surveys involved walking across the proposed turbine location areas and surrounding areas recording all birds seen. Surveys were undertaken during all site visits on the following dates:

- 27 April 2007;
- 7, 8, 9 & 11 May 2007;
- 1 & 2 August 2007;
- 10, 11 & 12 December 2007;
- 26, 27 & 28 February 2008.

Point Bird Utilisation Surveys

These surveys were conducted at fixed points where the construction of wind turbines is proposed or where areas of disturbance for road construction are proposed. Figure 1 and Figure 2 of this report show location of fixed survey points.

A total of 11 Bird Utilisation survey sites were selected and their location recorded by GPS. A star picket tagged with the survey site number was driven into the ground to enable easy relocation of the survey point for future surveys. The co-ordinates of each of the bird survey points are provided in Table 2.3.

Survey Point	AMG East	AMG North
1	288944	6451185
2	286481	6543232
3	286104	6453945
4	287336	6455922
5	290577	6456181
6	291506	6455941
7	291741	6456084
8	292041	6459452
9	291752	6460644
10	291053	6463010
11	287881	6452329

Surveys were conducted during two sessions the 10 – 12 December 2007 and the 26 – 29 February 2008. Surveys were undertaken for a period of 20mins at each survey point;

The birds were identified as was their flight direction and flight height above ground level recorded. All survey sites were visited at least once during each survey period, some were visited twice.

Limitations

During surveys bad weather played a role limiting surveyors access to survey points due to rain affected roads and tracks, low visibility and high winds.

2.3 BIRD HABITATS AND UTILISATION

The bird habitats available throughout Middlebrook and Mountain Stations are dominated by Box Woodland and Cleared Grazing Land as described by Cooper and McAllan (1999). There is some minor variation of these habitat types within the sheltered gullies where moister forest types occur. All habitat types have suffered disturbances through clearing for access and pasture creation and stock grazing.

Open forest vegetation occurs on the lower slopes and mid slopes as well on the basalt soils of the upper slopes. This open forest vegetation provides suitable foraging and roosting habitat for forest bird species such as honeyeaters and some parrot species.

The cleared grazing lands dominate the upper slopes of the Mountain Station at Owens Gap and offer only a limited resource for bird species such as cockatoos, magpies and raptors.

The topography of both subject sites includes steeply rising slopes and rock escarpments rising over 200m in some areas. These topographical features create wind disturbances such as up drafts. These updrafts of wind are utilised by raptors such as the Wedge-tailed Eagle to aide soaring. Raptors usually soar when searching for prey species and have been observed at both Owens Gap and Middlebrook Station soaring within updrafts created by the steep ridges.

During surveys, there was no presence of any large bird concentrations within either the subject site or the surrounding areas. No wetlands or coastal habitats occur within either the subject site or the surrounding area that could support listed migratory species that may fly across the site.

The NPWS Key Habitats and Corridors (NPWS 2008) mapping was accessed which determined there was no defined corridors or key habitats within the subject site. Middlebrook Station has a common boundary with Towarri National Park in the north-west of the site.

2.4 RESULTS OF SURVEYS

In order to determine the full extent of the bird biodiversity of the subject site and the surrounding area the databases listed below were accessed to complement species observation records. This allowed the compilation of a comprehensive bird list for the local area. Databases accessed for information include:

- Birds Australia Atlas;
- Atlas of NSW Wildlife (NPWS 2008);
- BioNet (web based database which incorporates records from Australian Museum, NSW Fisheries, NSW national Parks and NSW Forests;
- EPBC protected matters search.

A comprehensive avian species list is included in the Appendices which lists bird species observed during Roaming and Point bird utilisation surveys (including opportunistic sightings), Middlebrook and Owens Gap records (New Atlas 1998 – 2007), and results from a 50km search using these databases (DECC 2008). Results from the Point bird utilisation surveys are provided in Table 2.4.

**TABLE 2.4
INDIVIDUAL BIRD SPECIES RECORDED AND MAXIMUM FLIGHT HEIGHT AT OBSERVATION POINTS**

Species	This data has been extrapolated from the bird utilisation and gradient surveys																			
	P1		P2		P3		P4 + P5		P6		P7		P8		P9		P10		P11	
	N	H	N	H	N	H	N	H	N	H	N	H	N	H	N	H	N	H	N	H
Wedge-tailed Eagle	2	C	1	20			2	50	2	C					1	90				
Little Eagle																				
Nankeen Kestrel	3	C	5	55			1	20												
Australian Hobby																	1	70		
Common Bronzewing Pigeon							1	C												
Sulphur-crested Cockatoo									2	20			3	30						
Galah	1	40							4	50										
Eastern Rosella							4	C	1	C										
Crimson Rosella											1	C	4	C	3	C			1	C
Australian King Parrot											1	C			2	C				
Little Lorrikeets																	5	C		
Fantail Cuckoo															1	C				
White-throated Needletail															15	70				
Dollarbird																				
Laughing Kookaburra																			1	C
Sacred Kingfisher																			1	C
Yellow-rumped Thornbill															4	C	5	C	6	C
Striated Pardalote					5	C			1	C	2	C	1	C			2	C	1	C
Spotted Pardalote											1	C			1	20	1	C	1	C
White-throated Treecreeper													1	C	2	C			1	C
Red Wattlebird															1	20				
Noisy Miner							1	C					1	20			8	20		
Noisy Friarbird					1	C	1	C	1	C	1	C	2	C	2	25	2	C	9	C
Yellow-faced Honeyeater																			5	C
Rufous Whistler																			1	C
Grey Shrike-thrush															1	C				
Black-faced Cuckoo Shrike	1	C					2	C	1	C			2	C					1	30
White-winged Chough																			5	C
Australian Magpie	3	C	2	C	1	C	5	18			4	C	3	C	2	C	2	C	4	C
Pied Currawong											2	30	2	15	1	C	4	18	1	C
Grey Butcherbird															1	C	1	C		
Pied Butcherbird					1	C											2	15		
Australian Raven							2	C											1	C

Observation points P1 – P12. N=Number of individuals recorded. H=Average flight height. C= Flight height within canopy level i.e. <15m

A cumulative species curve was created using results from the Point bird utilisation surveys conducted between 27 April 2007 and 28 February 2008 during the months of April, May, August, December and February (13 days of survey all together). A total of 69 bird species were observed during these surveys.

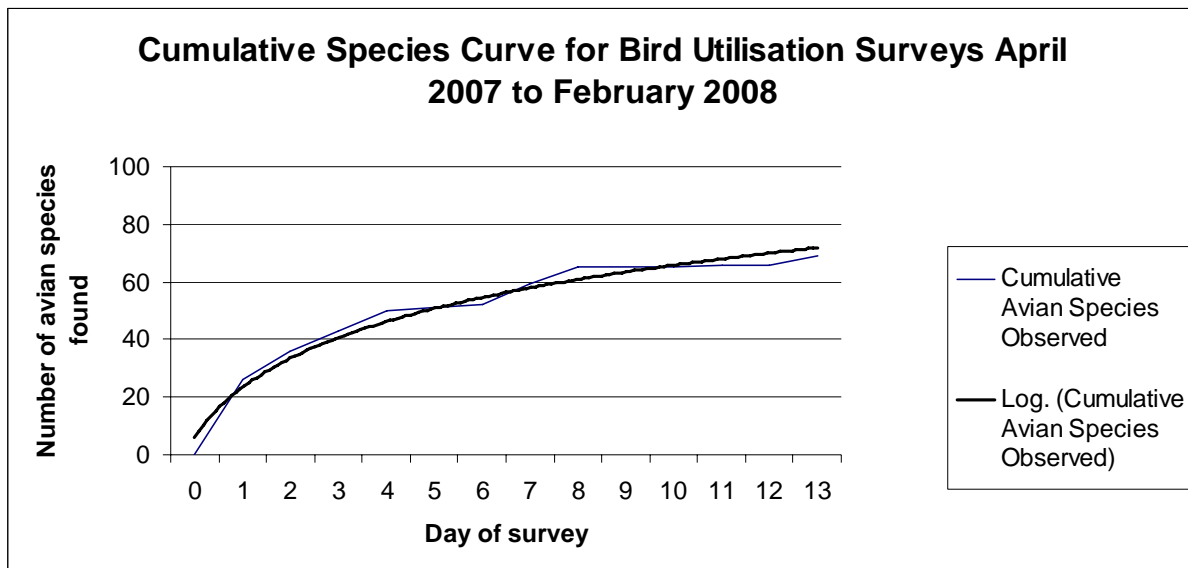


Figure 2.1 Cumulative species curve for species observed during Point Census bird utilisation surveys April 2007 to February 2008.

2.5 SPECIES OF CONCERN

From the comprehensive bird list, 'Species of Concern' were selected for further consideration as Level 1 Investigation – Initial Risk Assessment as per Brett Lane & Associates (2005).

'Species of Concern' include those species listed as threatened in Schedule 1 and 2 of the *Threatened Species Conservation Act 1995*, species listed as threatened or as listed migratory species within the *Environment Protection and Biodiversity Conservation Act 1999* as well as species that exhibit behaviour that puts them at risk of regular collision with operating wind turbines (Brett Lane & Associates 2005)

Table 2.5 lists 'Species of Concern' and their likelihood of regularly occurring within the Rotor Swept Area (RSA) of the wind turbines. The Rotor Swept Area refers to the area covered by the rotating blades of each turbine. In this case, the Rotor Swept Area is between 60 metres above ground level and 150 metres above ground level. Species which exhibit a low assessed risk of occurring within the RSA will not be further assessed. Species which exhibit a moderate to high risk of occurring within the RSA will be assessed as Level 2 Investigation – Refined Risk Assessment as per Brett Lane & Associates (2005).

**TABLE 2.5
SPECIES OF CONCERN AND THEIR
LIKELIHOOD OF MOVEMENT WITHIN THE RSA**

Common_name	Scientific_name	Middlebrook		Owens Gap		Likelihood of Movement in Rotor Swept Area		
		Habitat		Habitat		Low	Medium	High
		Yes	No	Yes	No			
Acanthizidae								
Speckled Warbler ^{TS}	<i>Pyrrholaemus sagittata</i>	x		x		x		
Accipitridae								
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>	x		x			x	
Brown Goshawk	<i>Accipiter fasciatus</i>	x		x			x	
Grey Goshawk	<i>Accipiter novaehollandiae</i>	x		x			x	
Wedge-tailed Eagle	<i>Aquila audax</i>	x		x				x
Spotted Harrier	<i>Circus assimilis</i>	x		x			x	
Black-shouldered Kite	<i>Elanus axillaris</i>	x		x			x	
Red Goshawk ^{TS}	<i>Erythrotriorohis radiatus</i>	x		x			x	
White-bellied Sea-Eagle ^{MS}	<i>Haliaeetus leucogaster</i>		x		x			x
Whistling Kite	<i>Haliastur sphenurus</i>	x		x			x	
Little Eagle	<i>Hieraaetus morphnoides</i>	x		x				x
Square-tailed Kite ^{TS}	<i>Lophoictinia isura</i>	x		x			x	
Black Kite	<i>Milvus migrans</i>	x		x			x	
Anatidae								
Blue-billed Duck ^{TS}	<i>Oxyura australis</i>	x		x		x		
Freckled Duck ^{TS}	<i>Stictonetta naevosa</i>	x		x		x		
Apodidae								
Fork-tailed Swift ^{MS}	<i>Apus pacificus</i>	x		x				x
White-throated Needletail ^{MS}	<i>Hirundapus caudactus</i>	x		x				x
Ardeidae								
Great Egret ^{MS}	<i>Ardea alba</i>	x		x		x		
Cattle Egret ^{MS}	<i>Ardea ibis</i>	x		x		x		
Burhinidae								
Bush Stone-curlew ^{TS}	<i>Burhinus grallarius</i>	x		x		x		
Cacatuidae								
Little Corella	<i>Cacatua sanguinea</i>	x		x			x	
Long-billed Corella	<i>Cacatua tenuirostris</i>	x		x			x	
Glossy Black-Cockatoo ^{TS}	<i>Calyptorhynchus lathami</i>	x		x			x	
Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>	x		x			x	
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	x		x			x	
Gang-gang Cockatoo ^{TS}	<i>Callocephalon fimbriatum</i>	x		x			x	
Galah	<i>Cacatua roseicapilla</i>	x		x			x	
Ciconiidae								
Black-necked Stork ^{TS}	<i>Ephippiorhynchus asiaticus</i>	x		x		x		
Climacteridae								
Brown Treecreeper ^{TS}	<i>Climacteris picumnus</i>	x		x		x		
Brown Treecreeper (eastern subspecies) ^{TS}	<i>Climacteris picumnus victoriae</i>	x		x		x		
Coraciidae								
Dollarbird	<i>Eurystomus orientalis</i>	x		x			x	
Dicruridae								
Black-faced Monarch ^{MS}	<i>Monarcha melanopsis</i>	x		x		x		

**TABLE 2.4 (Cont.)
SPECIES OF CONCERN AND THEIR
LIKELIHOOD OF MOVEMENT WITHIN THE RSA**

Common_name	Scientific_name	Middlebrook		Owens Gap		Likelihood of Movement in Rotor Swept Area		
		Habitat		Habitat		Low	Medium	High
		Yes	No	Yes	No			
Satin Flycatcher ^{MS}	<i>Myiagra cyanoleuca</i>		x		x	x		
Rufous Fantail ^{MS}	<i>Rhipidura rufifrons</i>	x		x		x		
Estrildidae								
Diamond Firetail ^{TS}	<i>Stagonopleura guttata</i>	x		x		x		
Falconidae								
Brown Falcon	<i>Falco berigora</i>	x		x			x	
Peregrine Falcon	<i>Falco peregrinus</i>	x		x			x	
Nankeen Kestrel	<i>Falco cenchroides</i>	x		x			x	
Australian Hobby	<i>Falco longipennis</i>	x		x			x	
Black Falcon	<i>Falco subniger</i>	x		x			x	
Hirundinidae								
White-backed Swallow	<i>Cheramoeca leucosternus</i>	x		x			x	
Welcome Swallow	<i>Hirundo neoxena</i>	x		x			x	
Tree Martin	<i>Hirundo nigricans</i>	x		x			x	
Fairy Martin	<i>Hirundo ariel</i>	x		x			x	
Megapodiidae								
Malleefowl ^{TS, MS}	<i>Leipoa ocellata</i>		x		x	x		
Meliphagidae								
Painted Honeyeater ^{TS}	<i>Grantiella picta</i>	x		x		x		
Regent Honeyeater ^{TS, MS}	<i>Xanthomyza phrygia</i>	x		x		x		
Meropidae								
Rainbow Bee-eater ^{MS}	<i>Merops ornatus</i>	x		x		x		
Pachycephalidae								
Olive Whistler ^{TS}	<i>Pachycephala olivacea</i>	x		x		x		
Petroicidae								
Hooded Robin ^{TS}	<i>Melanodryas cucullata</i>	x		x		x		
Hooded Robin (south-eastern form) ^{TS}	<i>Melanodryas cucullata cucullata</i>	x		x		x		
Psittacidae								
Swift Parrot ^{TS}	<i>Lathamus discolor</i>	x		x			x	
Turquoise Parrot ^{TS}	<i>Neophema pulchella</i>	x		x		x		
Superb Parrot ^{TS}	<i>Polytelis swainsonii</i>	x		x		x		
Strigidae								
Powerful Owl	<i>Ninox strenua</i>	x		x			x	
Southern Boobook	<i>Ninox novaeseelandiae</i>	x		x			x	
Barking Owl ^{TS}	<i>Ninox connivens</i>	x		x			x	
Rostratulidae								
Australian Painted Snipe ^{TS}	<i>Rostratula australis</i>		x		x	x		
Painted Snipe ^{TS, MS}	<i>Rostratula benghalensis</i>							
Scolopacidae								
Latham's Snipe ^{MS}	<i>Gallinago hardwickii</i>		x		x	x		
Tytonidae								
Sooty Owl ^{TS}	<i>Tyto tenebricosa</i>		x		x	x		
Masked Owl ^{TS}	<i>Tyto novaehollandiae</i>	x		x		x		

TS Threatened Species Listed on the NSW Threatened Species Conservation Act (1995)

MS Migratory Species listed on the Commonwealth Environment Protection & Biodiversity Conservation Act (1995)

SECTION 3

LEVEL 2 - SIGNIFICANT BIRD IMPACT RISK ASSESSMENT

3.1 INTRODUCTION

This section will further assess bird species which have been identified in the Level 1 Assessment as having a greater than low risk of impact with the wind turbines ie. medium or high.

Bird Utilization Surveys and Roaming Surveys were further conducted in February 2008 to further determine how birds use the subject site. The subject site includes favourable topography for soaring raptors ie. steeply rising high ridges incorporating escarpments. Observation points were placed within these areas to identify how birds use this environmental gradient. The Bird Utilization Surveys undertaken within these environmental gradient areas provided data sufficient to undertake the gradient studies for these areas.

Table 2.1 and Table 2.2 which highlight 'Species of Concern' were further extrapolated to only include those species known to be using the RSA's regularly. Other species known to occur within the local area ie. 50km radius of the subject site were excluded from further assessment where they did not regularly occur within the subject site i.e. observed during on site surveys and adjacent area surveys.

Table 3.1 identifies those 'Species of Concern' which have been recorded within the proposed Rotor Swept Area (RSA).

Species	Times observed at RSA	No. individuals at RSA
Wedge-tailed Eagle	2	3
Nankeen Kestrel	1	5
Australian Hobby	1	1
Galah	1	4
White-throated Needletail	1	15

Discussion of each of the species listed in Table 3.1 will identify those species that may be at a high risk of rotor impact due to their behaviour, ecology or habitat use types.

3.2 ASSESSMENT OF 'SPECIES OF CONCERN'

3.2.1 Wedge-tail Eagle (*Aquila audax*)

Habitat Requirements:

Wedge-tailed Eagles inhabit wooded and forested lands and open country across Australia extending into arid zones and from sea level to alpine regions (Marchant & Higgins 1993). Wedge-tailed Eagles are highly aerial soaring expertly for long periods gaining lifts from thermals and updrafts off cliffs and escarpments reaching heights of at least 2000m (Marchant & Higgins 1993).

Established pairs remain resident with young birds and non breeding birds dispersing usually in autumn. Home range size varies across their range. Home ranges of 30-35km² have been

recorded near Armidale on the New England Tablelands NSW (Marchant & Higgins 1993). Wedge-tailed Eagle breeding seasons are not clearly known but broadly considered to be from April to September throughout Australia (Marchant & Higgins 1993).

Subject Site Utilization:

Wedge-tailed eagles were recorded across both subject sites and throughout the local area during surveys. Wedge-tailed Eagles were observed soaring at RSA height in search of prey at both Middlebrook and Mountain Station as well as soaring at ridge top height adjacent to the ridges using air thermals and currents. Wedge-tailed Eagles are regularly observed at both sites often below RSA height.

Eagle nesting activity has been observed at Middlebrook at the northern end of the Glen Ridge off the eastern escarpment with a single nest identified. It is considered likely that a resident pair of Wedge-tailed Eagles occupy a home territory at Middlebrook with a separate pair occupying Mountain Station.

It is considered that the level of risk of rotor impact for Wedge-tail Eagle is moderate. As such it is to be considered for Level 3 Assessment.

3.2.2 Nankeen Kestrel (*Falco cenchroides*)

Habitat Requirements

Prefers open country with low, sparse vegetation cover in well watered areas particularly lands cleared for pasture or crops. Nankeen Kestrels are common across New South Wales and widespread throughout Australia. This species has benefited with the encroachment of farming lands creating preferred habitat types (Marchant & Higgins 1993).

In the south-east of Australia Nankeen Kestrels are considered resident throughout the year with juveniles dispersing widely. Home range has been recorded in Armidale NSW at 1600 hectares (S. Debus pers. comm. 2008). This species may move from areas in response to weather or availability of food especially large influxes such as mouse plagues. Nankeen Kestrels predate predominately on vertebrates especially mice, small birds, reptiles and insects. This species forages throughout the day in Australia hunting from perches and aerial prey searching by high-quartering and hovering in windy weather and has been recorded soaring up to 1100m (Marchant & Higgins 1993). Nankeen Kestrels breed between August to December. Nests form a scrape within tree hollow, nests of old birds, cliff tops etc (Marchant & Higgins 1993).

Subject Site Utilization:

Nankeen Kestrel's were observed during all surveys conducted on Mountain Station, Owens Gap mostly on the higher cleared peaks at photo points 1, 2, 4 & 5. They were mostly observed flying well below RSA using the updrafts associated with the steep bare terrain dropping over the escarpment then using updrafts to soar back up the escarpment face searching for prey. Nankeen Kestrels were not observed at photo points positioned on Middlebrook's Glen Ridge. Nankeen Kestrels were observed flying within the RSA on one occasion with 2 birds soaring at 55m at photo point 2 using an updraft. Although both subject sites provide suitable habitat for breeding no nests sites have been identified.

It is considered that the level of risk of rotor impact for Nankeen Kestrels is moderate. As such it is to be considered for Level 3 Assessment.

3.2.3 Australian Hobby (*Falco longipennis*)

Habitat Requirements:

The Australian Hobby is distributed throughout mainland Australia and inhabits wooded and forested lands and open country in tropical and temperate Australia extending into arid zones. (Marchant & Higgins 1993). This species is generally considered to be partly migratory although many regions contain resident birds.

The Australian Hobby is known to hunt both diurnally and nocturnally taking insects, birds, and small mammals such as the house mouse. This species broadly breeds in spring and summer nesting in the large stick nests of other bird species such as Australian Magpie. Home range sizes are not known (Marchant & Higgins 1993).

Subject Site Utilization:

One individual Australian Hobby was observed at photo point 10 flying above Glen Ridge at RSA height. It was not clear whether this bird was searching for food or dispersing. As only one individual sighting of this species was observed on one occasion we are unable to say how this species would use the subject site. The subject site offers suitable foraging and breeding habitat for the Australian Hobby.

It is considered that due to the likely low abundance of this species within the subject site that the level of risk of rotor impact for numbers of Australian Hobby is low.

3.2.4 Galah (*Cacatua roseicapilla*)

Habitat Requirements:

The Galah occurs in a wide variety of open habitats such as grassland and agricultural lands, open lightly timbered areas such as open forests, woodlands and savannas (Higgins 1999). The Galah is widespread throughout Australia. Formerly occurred mainly in the western regions of NSW but has expanded east and is now common in coastal regions (Higgins 1999).

Subject Site Utilization:

Galaha are common and widespread across both subject sites and within the local area. Galahs feed extensively on the pasture weeds within the cleared areas of the site rarely venturing into the more forested areas. Large numbers of galahs are using the subject site at any given time and appear sedentary in behaviour. It is unusual for galahs to fly within the RSA and are only likely to do this when dispersing to other feeding grounds beyond the ridges. A small flock of 4 Galahs were observed at photo point 6 flying within the RSA, this flight movement is considered to be outside their usual flight pattern.

It is considered that due to the usual low altitudinal flight patterns of Galahs the likely risk of rotor impact is low.

3.2.5 White-throated Needletail (*Hirundapus caudacatus*)

Habitat Requirements:

The White-throated Needletail is almost exclusively aerial occurring over most types of habitat more often over wooded areas, including open forest and rainforest and less commonly over woodland. Often seen around coastal cliffs and other areas with prominent updrafts such as ridges, volcanic craters and sand dunes (Higgins 1999).

White-throated Needletails breed in Siberia migrating to Australia in the summer months. In NSW this species is widespread on and east of the Great Dividing Range with scattered records elsewhere (Higgins 1999). White-throated Needletails are insectivorous taking a

wide variety of insects and spiders. This species has been recorded aerial foraging from as low as 1m from the ground to 1800m above ground level (Higgins 1999).

Subject Site Utilization:

A foraging flock of 15 White-throated Needle-tails were observed at photo point 9 above the Glen Ridge, aerial foraging within the RSA. This species is a summer migrant to the Scone area and has only been observed on one occasion.

It is considered that due to the low abundance and the migratory nature of the White-throated Needle-tail the level of risk of impact for this species is low.

3.3 CONCLUSION

Level 1 and Level 2 site investigations have been completed within the site to identify those bird species that may be at risk as a result of the proposal.

The Level 1 investigations identified a number of bird Species of Concern based on their flight behaviour or occurrence on statutory species lists (*Threatened Species Conservation Act 1995*, *Environmental Protection and Biodiversity Conservation Act 1999*). The likelihood of these Species of Concern movement within the rotor swept area was then assessed during detailed site surveys to determine those species most likely to be at risk of collision and therefore targeted for further assessment under Level 2 investigations. Those species not occurring within the rotor swept area were not considered to be at any significant bird impact risk.

Species of Concern occurring within the rotor swept area (Wedge-tailed Eagle, Nankeen Kestrel, Australian Hobby, Galah, White-throated Needle-tail) were subject to detailed assessment under Level 2 investigations. As a result it was considered that the Wedge-tailed Eagle and Nankeen Kestrel were at moderate risk of rotor impact. The Australian Hobby, Galah and White-throated Needle-tail were considered to be of low risk of rotor impact.

At this stage Level 3 investigations in regards to impacts upon the Wedge-tailed Eagle or Nankeen Kestrel have not been undertaken. The Environmental Management Plan to be prepared for the site will include measures for monitoring these species within the site based on their identification as significantly impacted Species of Concern. The Environmental Management Plan process will be completed to include information as per Level 3 investigations. This will include population assessments and viability analysis in analysing risks and management for species of concern.

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- Threatened Species Conservation Act* (1995), New South Wales Government

**APPENDIX I
BIRD SPECIES LIST**

TABLE A1 FAUNA OBSERVED AND RECORDED		
Common Name	Scientific Name	Method
Birds		
Stubble Quail	<i>Coturnix pectoralis</i>	C
Brown Quail	<i>Coturnix ypsilophora</i>	C
Pacific Black Duck	<i>Anas superciliosa</i>	OC
Grey Teal	<i>Anas gracilis</i>	OC
Australian Wood Duck	<i>Chenonetta jubata</i>	OC
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>	OC
Black-fronted Dotterel	<i>Elseya melanops</i>	O SP
Masked Lapwing	<i>Vanellus miles</i>	OC
Brown Goshawk	<i>Accipiter fasciatus</i>	O
Wedge-tailed Eagle	<i>Aquila audax</i>	O
Little Eagle	<i>Hieraaetus morphnoides</i>	O
Whistling Kite	<i>Haliastur sphenurus</i>	O
Brown Falcon	<i>Falco berigora</i>	O
Nankeen Kestrel	<i>Falco cenchroides</i>	O
Black-shouldered Kite	<i>Elanus axillaris</i>	O
Australian Hobby	<i>Falco longipennis</i>	O
Little Button-quail	<i>Turnix velox</i>	O
Wonga Pigeon	<i>Leucosarcia melanoleuca</i>	C
Common Bronzewing	<i>Phaps chalcoptera</i>	O
Crested Pigeon	<i>Ocyphaps lophotes</i>	O
Glossy Black-Cockatoo ^{TS}	<i>Calyptorhynchus lathami</i>	OCSc
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	OC
Little Corella	<i>Cacatua sanguinea</i>	OC
Galah	<i>Cacatua roseicapilla</i>	OC
Little Lorikeet	<i>Glossopsitta pusilla</i>	OC
Musk Lorikeet	<i>Glossopsitta concinna</i>	OC
Australian King-Parrot	<i>Alisterus scapularis</i>	OC
Crimson Rosella	<i>Platycercus elegans</i>	OC
Eastern Rosella	<i>Platycercus eximius</i>	OC
Red-rumped Parrot	<i>Psephotus haematonotus</i>	OC
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	OC
Eastern Koel	<i>Eudynamys orientalis</i>	C
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>	O
Southern Boobook	<i>Ninox novaeseelandiae</i>	C
White-throated Nightjar	<i>Eurostopodus mystacalis</i>	SP
White-throated Needletail	<i>Hirundapus caudactis</i>	O
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	OC
Sacred Kingfisher	<i>Todiramphus sanctus</i>	OC
Rainbow Bee-eater	<i>Merops ornatus</i>	O
Dollarbird	<i>Eurystomus orientalis</i>	OC
White-throated Treecreeper	<i>Cormobates leucophaeus</i>	OC
Superb Fairy-wren	<i>Malurus cyaneus</i>	OC
Spotted Pardalote	<i>Pardalotus punctatus</i>	OC
Striated Pardalote	<i>Pardalotus striatus</i>	OC
White-browed Scrubwren	<i>Sericornis frontalis</i>	OC
Speckled Warbler ^{TS}	<i>Pyrrholaemus saggitata</i>	OC
Brown Gerygone	<i>Gerygone mouki</i>	OC

**TABLE A1 (Cont.)
FAUNA OBSERVED AND RECORDED**

Common Name	Scientific Name	Method
White-throated Gerygone	<i>Gerygone olivacea</i>	C
Brown Thornbill	<i>Acanthiza pusilla</i>	OC
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>	C
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>	OC
Yellow Thornbill	<i>Acanthiza nana</i>	OC
Noisy Friarbird	<i>Philemon corniculatus</i>	OC
Red Wattlebird	<i>Anthochaera carunculata</i>	OC
Noisy Miner	<i>Manorina melanocephala</i>	OC
Striped Honey-eater	<i>Plectorhyncha lanceolata</i>	O
Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>	OC
White-eared Honeyeater	<i>Lichenostomus leucotis</i>	OC
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>	OC
Eastern Yellow Robin	<i>Eopsaltria australis</i>	O
Scarlet Robin	<i>Petroica multicolor</i>	OC
Jacky Winter	<i>Microeca fascinans</i>	OC
Rufous Whistler	<i>Pachycephala rufiventris</i>	OC
Grey Shrike-thrush	<i>Colliuricincla harmonica</i>	C
Grey-crowned Babbler TS	<i>Pomatostomus temporalis</i>	OC
Golden Whistler	<i>Pachycephala pectoralis</i>	OC
Willie Wagtail	<i>Rhipidura leucophrys</i>	O
Grey Fantail	<i>Rhipidura fuliginosa</i>	OC
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	OC
Olive-backed Oriole	<i>Oriolus sagittatus</i>	OC
Pied Butcherbird	<i>Cracticus nigrogularis</i>	C
Grey Butcherbird	<i>Cracticus torquatus</i>	OC
Australian Magpie	<i>Gymnorhina tibicen</i>	OC
Magpie-lark	<i>Grallina cyanoleuca</i>	OC
Pied Currawong	<i>Strepera graculina</i>	OC
White-winged Chough	<i>Corcorax melanorhamphos</i>	OC
Australian Raven	<i>Corvus coronoides</i>	OC
Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>	OC
Rufous Songlark	<i>Cincloramphus mathewsi</i>	OC
Australasian Pipit	<i>Anthus novaeseelandiae</i>	O
Zebra Finch	<i>Taeniopygia guttata</i>	OC
Fairy Martin	<i>Hirundo ariel</i>	OC
Welcome Swallow	<i>Hirundo neoxena</i>	OC
Common Myna *	<i>Acridotheres tristis</i>	OC
Common Starling *	<i>Sturnus vulgaris</i>	OC

Key to Methods of Observation			
O	-	Observation	S - Search
C	-	Call identification	Sp - Spotlight
Sc	-	Scat, Track or Sign	
* = Exotic species TS = Threatened species			