

# Interim Guidelines

for the Assessment, Avoidance,  
Mitigation and Offsetting of  
Potential Wind Farm Impacts on  
the Victorian Brolga Population 2011

Revision 1 February 2012





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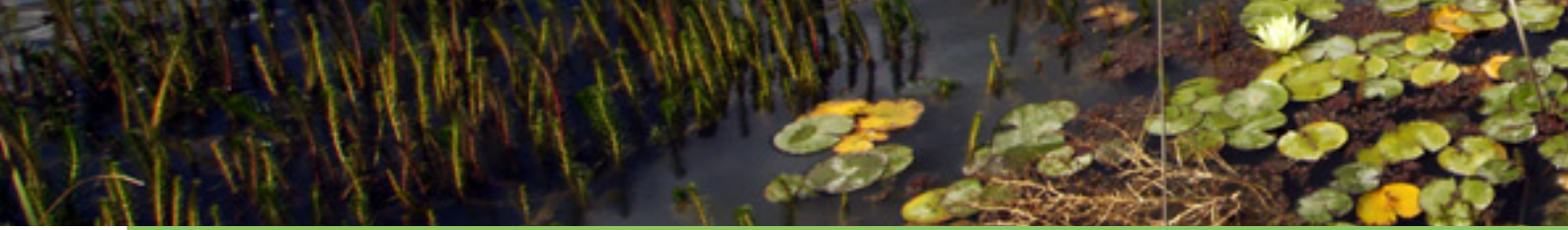
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## Introduction

The Brolga (*Grus rubicunda*) is listed as 'threatened' under the *Flora and Fauna Guarantee Act 1988* (FFG Act), and is classified as 'vulnerable' on the *Advisory List of Threatened Vertebrate Fauna in Victoria – 2007*. The potential impact of wind farms on Victoria's Brolga population is seen as a key environmental issue for the wind energy industry in South-West Victoria. This is because a large proportion of the population occurs within prospective areas for wind farm development.

The Victorian and Commonwealth Governments have joined with the wind energy industry (represented by the Clean Energy Council) to form a partnership called the South-West Victorian Brolga Research Project. This project aims to develop a standard approach for assessing, mitigating and offsetting impacts of wind energy development on Victorian Brolgas, and supports a research project to further develop knowledge on these impacts and how to mitigate them.

## Purpose of the Guidelines

The Interim Guidelines for the Assessment, Avoidance, Mitigation and Offsetting of Potential Wind Farm Impacts on the Victorian Brolga Population (the Guidelines) have been developed by the Brolga Scientific Panel (the panel), which is convened by the South-West Victorian Brolga Research Project. The panel comprises experts in the biology of Brolgas and wind farm impacts on avifauna.

The Guidelines respond to the perceived risk posed to Brolga by the new wind industry by outlining an approach to manage the effects of both individual wind farms and the broader wind energy industry.

The methodology recommends taking a cautious approach to the assessment and mitigation of potential impacts on Brolgas. This is for the following reasons:

- The majority of the State's population of Brolgas lies within areas preferred for wind farm development;
- There is uncertainty around the type and scale of impacts that may occur;
- There are inherent uncertainties in estimating the scale of any impacts without species-specific data; and
- There is a requirement to avoid any cumulative impacts of the wind farm industry on the Victorian Brolga population.

These are interim guidelines, and will be reviewed from time-to-time by the panel in light of findings from the research and other relevant new information that may become available.

## Policy Framework

Wind farm development in Victoria is regulated through local government planning schemes under the *Planning and Environment Act 1987*. Responsibility for assessment and approval of wind farm proposals rests with the relevant municipal council.

The Department of Sustainability and Environment (DSE) contributes to the planning process by providing advice and expertise on environmental matters, in particular in relation to potential biodiversity impacts (i.e. Brolga). The Brolga Guidelines play a key part in DSE's current approach to assessing potential impacts of proposed new wind farms impacts on Brolga.

Planning schemes in Victoria have a number of clauses which trigger consideration of biodiversity matters in decision making for wind farms. The two key clauses are:

- 12.01 Biodiversity
- 52.32 Wind Energy Facilities

Clause 12.01 provides the key link between the FFG Act and the planning and approval process. It includes a strategy to "Assist the conservation of the habitats of threatened and endangered species and communities as identified under the *FFG Act*..." and requires that planning must consider, as relevant: "Any State.g.y, relevant Governor-in-Council orders and Action Statements prepared under the *FFG Act*".

Under Clause 52.32, an application for a wind farm must include an assessment of "the impact of the proposal on any species (including birds and bats) listed under the *FFG Act* or *Environment Protection and Biodiversity Conservation Act 1999* (Cwth)," and requires that the responsible authority must consider: "The impact of the facility on the natural environment and natural systems". Further information on consideration of biodiversity values is provided in the incorporated document *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria* (DPCD 2011).

Although the FFG Act doesn't carry any stand-alone approvals for wind farms, these links with the planning scheme ensure that its objectives are considered.



## The Brolga

The Brolga is one of two indigenous crane species in Australia. It is distinguishable by its long neck and legs, and the light grey plumage and red head colouration of adult birds. Adults stand up to 1.4 m tall and range in weight between 3.7 – 8.7 kg. Like many crane species, they are highly wetland dependant throughout their entire lifecycle and require access to wetlands for breeding, roosting and foraging (Marchant and Higgins 1993).

## Distribution

Brolgas are widely distributed and very common to abundant across northern Australia (Marchant and Higgins 1993). Once common in New South Wales, widespread habitat loss has caused range contractions within that state. Brolgas historically had a wider distribution in southern Australia, with birds reported from coastal East Gippsland to South-Eastern South Australia. However the distribution of the southern ('Victorian') population is now largely restricted to South-West Victoria and lower South-East South Australia (Figure 1). The southern populations may now be reproductively isolated from the northern Australian populations Arnol *et al.* (1984).

## Breeding

Brolgas are monogamous. Pairs annually return to wetlands at the start of the breeding season to re-establish territories. Breeding territories typically comprise a nest constructed within a shallow herb- or sedge-dominated freshwater wetland and associated foraging areas adjacent to the breeding wetland. Clutches of usually two e.g.s are laid in large nest mounds constructed from vegetation sourced from the surrounding wetland. Pairs may return to 'traditional' breeding sites year after year (Marchant and Higgins 1993).

## Non-breeding Season

During the non-breeding or 'flocking' season, Brolgas tend to congregate and roost communally on deep freshwater marshes and permanent fresh or saline open water called flock roosts. During this time, Brolgas feed in flocks in adjacent areas. Some pairs remain in the vicinity of breeding territories rather than moving to these flocking sites.

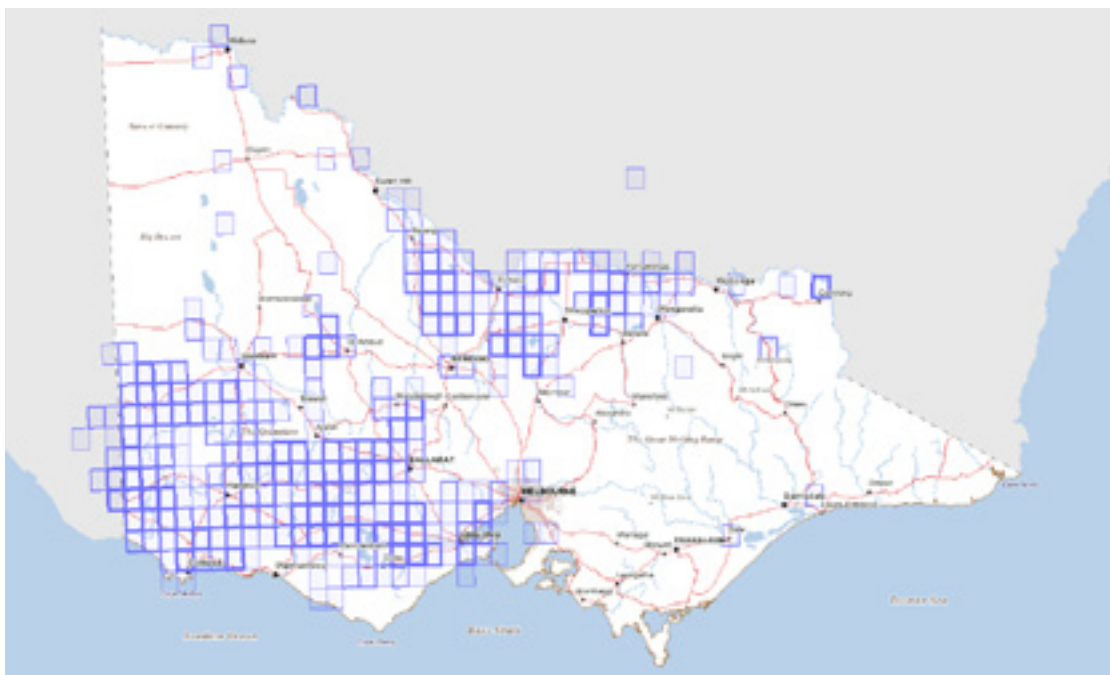


Figure 1. Current distribution of the Brolga in Victoria (DSE 2011).  
Current distribution of the Brolga in Victoria (DSE 2011). Darker squares reflect concentrations of sightings.



In Victoria, the non-breeding season occurs in summer and autumn (DSE 2003). The timing of movements to flocking sites coincides with the drying of ephemeral breeding wetlands. In most years the majority of the South-West Victorian population is confined to a small number of flocking sites. These sites have a unique combination of suitable roosting habitat and proximity to suitable feeding habitat. (Sheldon 2004)

## Foraging

Brolgas feed in a wide variety of wetlands and dryland habitats. They are omnivorous, consuming a variety of plant and animal material on a seasonal basis including insects, spiders, molluscs, amphibians, small mammals and wetland plants. In Victoria, where large portions of traditional foraging habitats have been converted to agriculture, Brolgas now rely substantially on food resources from agricultural operations. The residual cereal grain in post-harvest stubble fields is considered to be a particularly important food resource for the Victorian Brolga (e.g. King 2008).

## Movements and Social Organisation

Brolgas establish exclusive home ranges or territories during the breeding season each year, moving within them both on foot and in flight. The size of these territories is not well known but may be several hundred hectares e.g. 256 ha; Arnol *et al.* (1984). Brolgas flock together in dozens to hundreds of birds during the non-breeding season and occupy a home range which may be considerably larger. Non-breeding Brolgas regularly move up to 3 km from the flock roosting wetland (Herring 2005, King 2008) but may move up to 5 km (Herring 2005).

Brolgas can undertake seasonal movements of many tens of kilometres between breeding and non-breeding sites. These movements are thought to be initiated in response to seasonal climatic and habitat variation; however these movements are not well understood. The South-West Victorian Brolga Research Project is currently undertaking research into movements within and between breeding and non-breeding areas.

## Conservation Status

The Victorian Brolga population has been severely impacted by the modification and drainage of wetland breeding habitats and is listed as 'threatened', under the *FFG Act*. While total population size is not known with precision, it is estimated to be between 600-650 individuals which

includes a population of 60-70 individuals in the northern plains Riverina area. The species is believed to be in decline in Victoria due to low reproductive success (DSE 2003).

Brolgas generally return to traditional flocking sites each year, and numbers at flocking sites have declined significantly over the past century. For example, in the early 1940s, around 1450 birds were recorded at a flocking site near Willaura (Sheldon 2004); counts at the same flocking site in the past 5 years rarely exceed 150 (I. Veltheim unpubl. data).

Recruitment in western Victoria, measured by the proportion of juveniles and sub adults at flocking sites in late summer, appears to be low compared with northern Australian flocks (R.Hill unpubl. data). The primary causes are likely to be the limited availability of suitable breeding habitat, resulting from drainage, disturbance and de.g.radation of suitable breeding wetlands, and prolonged drought.

A Population Viability Analysis (PVA) model has been prepared for the Victorian Brolga population (McCarthy 2008). The PVA provides a framework to evaluate the likely fate of the Victorian population under different scenarios of impacts, and is designed to model the additional effect of proposed new wind farms.

## Objectives of the Guidelines

The overall objective of these guidelines is to manage the cumulative impact of multiple wind farms planned, assessed and operating independently within the Brolga's range in Victoria, so that there is no 'net effect' or, ideally, a positive effect can be achieved for the population. The specific objective of these guidelines is that individual wind farms have, at a minimum, a zero *net* impact on the Victorian Brolga population. The DSE recommends these assessment guidelines are used whenever any number of Brolgas and/or known or potential Brolga habitats occur within the 'radius of investigation' (see Definitions p20) of a proposed wind farm.





## Potential Wind Farm Impacts on the Victorian Brolga Population

Wind farms may impact on Brolgas in three key ways:

- Direct effects, particularly mortality resulting from collision with turbines
- Indirect effects, including habitat avoidance
- Barrier effects.

### Collision of Birds with Wind Turbines and Powerlines

Wind farms have been operating around the periphery of the Brolga range in western Victoria for the past decade, but there is no data on turbine collision risk for this species. However, the large size of cranes and their relatively low mobility suggest that cranes may be vulnerable to collision (USFWS 2009).

Based on existing knowledge of Brolga behaviour, there are marked differences in the collision risk profile of the species at different sites and times of year. The following information illustrates this.

- A pair of breeding Brolgas may make two or fewer flights per day within an exclusive breeding territory of up to several hundred hectares (e.g. c. 260 bird flights over an approximate 130 day breeding event) Arnol *et al.* (1984).
- A flocking aggregation of 60 Brolgas may make four flights per day to and from nocturnal and diurnal roost sites (BLA unpubl.). Brolgas flock for about 6 months of each year in Victoria (i.e. total of 240 flights *per day* for up to six months).

Wind turbines located within these different areas of sensitivity (i.e. breeding versus flocking sites) will have different collision risks. It is important that the annual variation in presence and movement of Brolgas around a proposed wind farm is understood to enable estimates of collision risk to be assessed.

Brolgas are known to collide with powerlines (Goldstraw and Du Guesclin 1991), so new powerlines associated with wind farm development which are within Brolga habitats will pose new collision risk.

### Indirect Disturbance

Some bird species are known to avoid wind farms, or be less likely to use habitats close to wind turbines. For example, Navarette *et al.* (2011) reported reduced habitat use, more clumped distributions, and more vigilance behaviour in Sandhill Cranes (*Grus canadensis*) at wind farms in Texas. The mechanism for this effect is unclear but might be a result of birds being more vigilant and consequently being less able to forage efficiently close to wind farms. The USFWS (2009) recommended a minimum setback of 500 yards from nearest turbine to important Whooping Crane (*Grus americana*) habitat. The Brolga Scientific Panel currently recommends a minimum indirect disturbance setback of 300 m from breeding and non-breeding Brolga home ranges (see Definitions p20).

### Barrier Effects

It is suggested that long arrays of wind turbines may create partial barriers to some bird movements, forcing birds to travel further and thus increase the energy requirements of these movements (Drewitt and Langston 2006). Overseas observations suggest that occasional gaps at least 1.5 km wide between turbine clusters can avoid such impacts on Common Cranes (*Grus grus*) (Gerjets 2005). Such a strategy may be appropriate to facilitate the movements of Brolgas from an area with, for example, a high density of breeding sites to a significant flocking site, where these are located on different sides of a long turbine array.



## Defining and Protecting Brolga Habitats

- Breeding site: The nest of a Brolga breeding pair and the perimeter of the surrounding wetland. Also includes wetlands with previous records of Brolga nests from any relevant information source. A wetland remains a breeding site providing it has not been permanently drained and/or planted with trees. Wetlands that have been ploughed can still be breeding sites providing the wetland retains some level of filling.
- Flock roost site: A permanent or ephemeral wetland known to be utilised by a Brolga flock for nocturnal roosting. Specifically a flock roost site should meet the criteria listed in the table below (after Sheldon 2004).

Siting turbines to avoid and minimise impacts on breeding and non-breeding habitats where Brolgas spend the vast majority of the year is an important strategy for avoiding potential wind farm impacts on Brolgas. In the case of breeding habitat “turbine siting would be used

to exclude any significant reduction in breeding success caused by turbines” (Brolga Scientific Panel 2008). This will be achieved by establishing turbine-free areas around all potential Brolga nesting sites sufficient to have no significant impact on the likelihood of successful reproduction. At non-breeding or flocking sites, turbine-free buffers should be designed to exclude any significant impact on the survivorship of Brolgas whilst occupying that flocking site (Brolga Scientific Panel 2008).

As a general recommendation, these guidelines recommend that a 3.2 km and 5 km radius turbine-free buffer from breeding sites and flock roost sites respectively, will adequately meet the objectives set for these habitats. However, recognising that the spatial requirements of Brolgas are not well understood, a proponent may propose reduced buffer areas providing that they can be shown to meet the objectives set for breeding and non-breeding habitats. Proposed buffer distances should meet with the satisfaction of the DSE.

### Criteria used to identify a flock roost site. The site should meet all three criteria.

Criteria	Justification
More than one year of recording	<ul style="list-style-type: none"> <li>• to ensure the selection of traditional and regularly used sites.</li> </ul>
One or more records of counts equal to or greater than 10 birds	<ul style="list-style-type: none"> <li>• to include sites which have been used often or traditionally by flocking Brolgas. The assumption is made that if more than 10 birds are recorded on a wetland, flocking behaviour is likely.</li> </ul>
Recorded in more than one month	<ul style="list-style-type: none"> <li>• to include sites where Brolgas flock for periods greater than one day or one week, i.e. to include sites used traditionally for the majority of the flocking or non-breeding season.</li> </ul>





## Assessment Methodology

The assessment framework recommends a three-step approach:

1. to the extent that is practicable, design the wind farm including all infrastructure to avoid and mitigate potential effects consistent with these guidelines;
2. estimate any remaining and unavoidable risk using tools such as collision risk modelling (CRM) and population viability analysis, to ascertain likely effects on the population;
3. determine appropriate compensatory measures to, at a minimum, completely offset unavoidable effects.

The objective of the assessment framework is to ensure that by implementation of these steps each wind farm development has a *zero net* impact on the size of the Victorian Brolga population. Note that Steps Two and Three are applicable only if all potential risk cannot be removed by Step One.

The assessment methodology follows a staged risk assessment process consistent with the AusWEA Interim Standards for Risk Assessment (AusWEA 2005).

## Level One Assessment: Initial Risk Assessment

The Level One Assessment provides a preliminary determination of whether a proposed wind farm development represents any level of risk to the Victorian Brolga population. A Level One Assessment aims to identify the potential presence, number and location of any Brolgas or potential Brolga habitat within the radius of investigation for a proposed wind farm. A Level One Assessment will be triggered by one or more of the conditions listed below.

### Triggers for a Level One Assessment:

- The proposed wind farm site is situated within the Victorian range of the Brolga (Figure 1).
- The presence of Brolgas within the radius of investigation (i.e. within 10 km of the proposed wind farm boundary);
- The presence of potential Brolga habitat within the radius of investigation; or
- The location of the proposed development is within an area that may be used by Brolgas during seasonal movements between breeding and flocking habitats.

## Methodology: Level One Assessment

Level One Assessments should be carried out utilising a combination of desktop data review, field studies and consultation with local residents, representatives of local environmental agencies and community environment groups.

1. Identify all known and potential Brolga habitats within the radius of investigation;
2. Develop a comprehensive understanding of all Brolga sightings within the radius of investigation; and
3. Estimate the likelihood and extent of Brolga use of radius of investigation, including past use.

### Step One: Undertake desktop studies into known and potential habitat areas for Brolga.

Desktop studies should review all relevant information sources to identify known and potential breeding and flocking sites within the radius of investigation. A proponent will have made a reasonable effort to obtain Brolga records if all relevant information sources have been thoroughly consulted. It should be noted that other verified records may arise during the assessment process and still require consideration.

### Step Two: Undertake field inspection and local community consultation.

Field studies for Level One Assessments should incorporate site inspections and the collection of relevant local knowledge on the historical and current occurrence of Brolgas. The aim of site inspections is to field-verify the nature and extent of known and potential Brolga habitats within the radius of investigation, as identified via initial desktop studies. Site inspections should be undertaken in consultation with local landholders whose properties may contain Brolga habitat, and relevant local community groups such as Landcare Groups and local branches of the Victorian Field Naturalists, Birdlife Australia, Field and Game Australia and DSE. Proponents should liaise with DSE to identify relevant community stakeholders for consultation, as well as relevant DSE personnel with local knowledge.

Liaison with landowners near a proposed wind farm site may be a sensitive issue for wind farm proponents, but early consultation is strongly recommended. The proponent should attempt to gather initial information on the presence of Brolgas in the area during community consultation, particularly via one-on-one meetings with landholders. This early consultation should lay the groundwork for more detailed discussions about a landowner's knowledge



to provide the most up-to-date and comprehensive information on known Brolga habitat in the radius of investigation.

The findings of the Level One Assessment should be used to decide whether a Level Two Assessment is required using the qualitative risk assessment method detailed in AusWEA (2005). Proponents are advised to consult with DSE at this stage to verify their risk assessment.

## Level Two Assessment

The level Two Assessment seeks to provide a comprehensive record of the location, nature and extent of Brolga habitats within the wind farm radius of investigation and to assess the potential for impacts arising from collision risk, indirect disturbance and barrier effects.

### Triggers for a Level Two Assessment:

- Records of breeding or flocking habitats within the radius of investigation;
- The proposed development is located in an area which may be used by Brolgas moving seasonally between breeding and foraging sites, and may potentially create a barrier effect reducing movements between these habitats;
- The proposed development is located in an area which may be used by Brolgas for diurnal movements between foraging and roosting sites; or
- The proposed location of new powerlines associated with the development may create new collision risks for Brolgas.

## Methodology: Level Two Assessment

The level Two Assessment collects comprehensive data about the location, nature and extent of Brolga habitats, and patterns of habitat use and behaviour at breeding, flocking and foraging sites within the radius of investigation. The objectives of Level Two Assessments are to:

- Obtain detailed information on the occurrence of Brolgas within the radius of investigation;
- Obtain data on Brolga flight behaviour suitable for CRM should a Level Three Assessment be required; and
- Assess the magnitude, extent and likelihood of potential direct and indirect impacts.

Field surveys should be conducted at the appropriate time(s) of year relevant to the type of Brolga habitat located within the radius of investigation:

- Known and potential breeding habitats should be surveyed for breeding Brolgas during July to December;
- Known and potential non-breeding flocking habitats should be surveyed for Brolga flocks during December to June.

This data can be collected via a range of methods however field investigations should include one or more of the methods detailed below. All observations of Brolga for all levels of assessment must include dates and times of observations and details of individual bird locations. As a minimum (and depending on specific circumstances, which should be determined in consultation with DSE) it is likely that aerial surveys, roaming surveys and flight behaviour surveys would be incorporated into a Level Two Assessment. Field investigations should include dawn and/or dusk censuses of any roost sites, recording detailed descriptions of time, height, direction and duration of any flights in relation to wind conditions. Care should be exercised to ensure monitoring does not cause undue disturbance of Brolgas.

It is recommended that final design of sampling protocols be developed in consultation with local DSE staff.

### Roaming Surveys

Roaming surveys are a good method to detect Brolga which typically occur at low densities. Roaming surveys in winter and spring should search all potential breeding habitat, and in December to June should search potential flocking roosts at dawn and dusk and potential foraging areas during the day.

### Aerial Surveys

Aerial surveys can be used to identify Brolga breeding sites. The recommended methodology involves use of a Cessna 172 overhead wing aircraft to conduct east-to-west survey transects 500 m apart (Appendix A).

### Flight Behaviour Studies

Flight behaviour studies aim to describe Brolga flight paths and movement patterns to determine buffer location and design and for use in CRM. The method involves describing flight heights, lengths and frequencies along with mapping patterns of movement within (or between) flocking or breeding sites to gain an estimate of the areal extent of bird activity, the distances and height of flights, and habitat utilisation.



## Gradient Studies

Gradient studies describe variation in bird utilisation across environmental gradients. In the case of Brolgas, gradient studies aim to describe habitat preferences by assessing the frequency of occurrence of Brolgas within a particular habitat type relative to availability of that habitat type within the landscape. Gradient studies can inform both assessments of impact and potential mitigation strategies.

## Time-activity Budgets

This method aims to quantify the proportion of time that Brolgas allocate to particular activities throughout the day and may be undertaken in conjunction with flight behaviour studies. Time-activity budgets show the behaviour of individual birds or can help understand habitat choice, resource limitations and sources of indirect disturbance.

## Level Three Assessment

A Level Three Assessment has the objective of using site design and turbine placement to avoid significant impacts on breeding and non-breeding habitats and to then quantify the residual 'unavoidable' risk posed to Brolgas by the proposed wind farm and offsetting that measured risk to achieve a zero net impact.

Given the uncertainty in estimates of site utilisation by Brolgas, and the resulting estimates of collision risk, it is recommended that a conservative approach is undertaken for risk estimation at all steps in this process. For example, South-West Victoria has experienced more than a decade of below-average winter/spring rainfall resulting in a change in the distribution, utilisation rates and potentially the population of Brolga during this period. In many areas utilisation rates are likely to be well below the longer-term utilisation rates. Proponents are expected to take account of these periodic changes in rainfall and associated habitat distribution and habitat availability when undertaking impact assessments. All assessments should provide a statement of how year-to-year variability in habitat conditions within the radius of investigation have been considered.

## Triggers for a Level Three Assessment

- Qualitative risk assessment (AusWEA 2005) of project following site design is greater than "low".

If the AusWEA guidelines assess the risk of significant impact on Brolgas as low, it may be appropriate to consult with DSE to discuss appropriate mitigation without proceeding to the more detailed Level Three Assessment. Note that any mitigation proposed at this stage should be consistent with the approach recommended by a Level Three Assessment.

## Methodology: Level Three Assessment

The Level Three Assessment comprises four steps to identify suitable mitigation measures for the proposed development to produce a zero net impact on the Victorian Brolga population.

### Step One: Avoid or mitigate all potential impacts to Brolga breeding and flocking home ranges within the radius of investigation with turbine-free buffer areas.

Turbine-free buffers should be designed to remove any significant impact on Brolgas within their breeding and non-breeding home ranges. This will be achieved by locating wind turbines to:

- Avoid the Brolga breeding home range (identified in the Level Two Assessment or use the generic guideline of 3.2 km);
- Avoid the Brolga non-breeding home range (identified in the Level Two Assessment or use the generic guideline of 5 km);
- Avoid an additional 300 m radius around each home range to avoid disturbance effects.

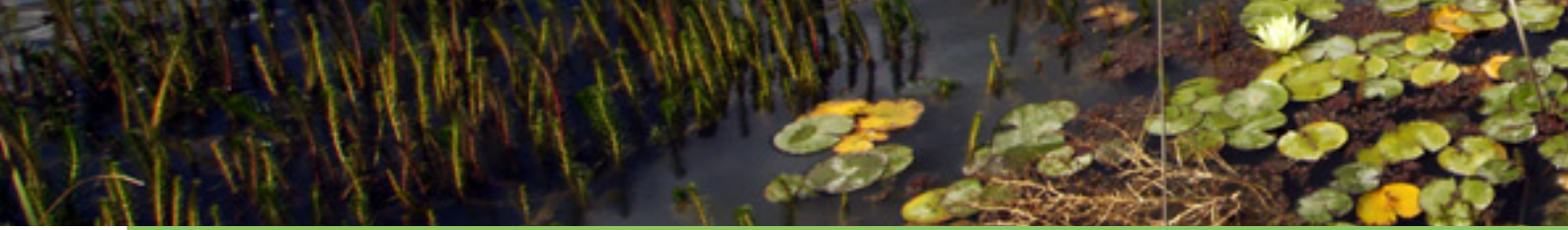
Proponents should meet with DSE prior to undertaking the design of turbine-free buffers for Brolgas. DSE will be able to provide advice on the current understanding of Brolga behaviour in relation to wind farms.

Brolga breeding and non-breeding home ranges are likely to vary with local habitat quality and extent and seasonal conditions. Unless site specific investigations can show with a high level of confidence the size and shape of home ranges for a project, then the DSE's default breeding and flocking site home ranges should be used for the project. Proposed site-specific buffer distances should be agreed to by DSE.

### Step Two: Develop a site-specific collision risk model for Brolgas utilising or moving through the radius of investigation.

The objective of CRM is to estimate the residual number of Brolga movements which have the potential to interact with wind turbines on the proposed site and from this estimate the annual collision risk. The modelled number of flights will be equal to the total projected number of Brolga movements across the site, minus those movements which occur within turbine-free areas. Where relevant this will include two seasonal movements between breeding and flocking sites.





Standard CRM input parameters include data on Brolga movements between and within the radius of investigation, specifications of the type and number of turbines with which birds may interact and turbine avoidance rates. If proposed new powerlines are likely to be crossed by Brolgas then this additional collision risk should also be quantified.

DSE recommends the use of peer-reviewed CRMs. Proponents should meet with DSE to discuss and agree on the assumptions used in developing collision-risk estimates.

### **Step Three: Use PVA to estimate the impact of the proposed development.**

The site-specific collision risk output is then used in the PVA to model the potential impact of the proposed wind farm on the Victorian Brolga population. The model is available for use by proponents on a contract basis with the University of Melbourne.

### **Step Four: Identify appropriate compensation strategies to ensure a zero net impact on the Victorian Brolga population.**

The PVA model can be used to assess different scenarios to offset the potential impact estimated in Step Three. The objective of Step Four is to identify and, as much as possible quantify, appropriate strategies to fully offset the predicted impact from Step Three.

## **Offset Options**

The purpose of offsetting is to either increase population growth rates or reduce another source of mortality commensurate with the increased mortality expected to result from the wind farm's operation, thereby cancelling out the impact of the wind farm on the Victorian Brolga population. Suggested options follow.

Where there is no current information about the effectiveness of an offset measure, implementation of that measure should be coupled with a monitoring program so that its effectiveness can be quantified.

## **Reducing Mortalities from Powerline Collisions**

Powerline collision is an important source of anthropogenic mortality for many crane species, and is a recognised cause of Brolga mortality (Goldstraw and Du Guesclin 1991).

Marking powerlines to reduce collision mortality has been demonstrated to markedly reduce collision risk for other species of cranes (Brown and Drewien 1995). A range of bird flight diverter products are commercially available.

## **Protection and Enhancement of Breeding Sites**

Improving Brolga breeding habitat to enhance breeding success may also be an appropriate offset, although the benefits of enhancement are more difficult to quantify than powerline marking. As a general principle, these works should focus on known breeding sites. This work should preferentially be undertaken within the area local to the proposed wind farm.

Any mitigation undertaken to provide protection and enhancement of Brolga habitat breeding sites should be combined with active and on-going management. The offset should be secured for the life-time of the proposed project.

Measures to protect or improve breeding sites are detailed by Herring (2005) and may include:

- restoration of the natural flooding regime of wetlands by closing drains;
- increasing inundation frequency of breeding wetlands through artificial flooding;
- creating new potential breeding habitat by damming or modifying existing wetlands or dams;
- management of wetland vegetation condition through controlled grazing (or stock removal) to improve suitability as a breeding site;
- addition of nesting material to potential breeding wetlands to facilitate nest building;
- fox control measures at breeding sites.

Note that some of these measures may be subject to various regulatory approvals.



## Glossary of Terms

- **Associated Infrastructure:** All constructions involved in wind farm development which may affect Brolga habitats or Brolga population viability.
- **At Risk Flights:** Flights at rotor swept height within development footprint.
- **Breeding Season:** Generally between July and December. The actual timing of individual breeding attempts vary with local and seasonal climatic and wetland conditions during this period.
- **Collision Risk Modelling (CRM):** Collision risk modelling estimates the risk of bird collision with wind turbines. The estimates are based on a number of input parameters including rates of utilisation of the proposed site, flight behaviour, and assumptions about the de.g.ree to which the species will actively avoid collision. Site-specific models can produce estimates of the total number of collisions per year for a particular species.
- **Direct Impact:** Effects including collision mortality and loss or de.g.radation of habitat.
- **Home Range:** The area that a Brolga occupies while undertaking daily activities including breeding, flocking, feeding, and roosting. An individual Brolga will utilise different and generally distinct home range areas in the breeding and non-breeding seasons. Based on current understanding, non-breeding season home ranges appear to be contained within a 5km radius of the flock roost site. Breeding season home ranges can include areas up to 3.2 km from breeding sites. Current research is focussed on better understanding Brolga home ranges.
- **Indirect Impact:** Indirect impacts of wind farm development on Brolgas may include but are not limited to displacement where suitable habitat becomes unavailable if Brolgas avoid approaching turbines or associated infrastructure, loss of habitat from wind farm construction and turbines creating barriers to movement.
- **Mitigate:** To reduce the likelihood and/or magnitude of ne.g.ative effects of a wind farm through for example: site design, turbine operation, burying or marking of new powerlines or fences to reduce collision risk.
- **Non-breeding Season:** The non-breeding season typically occurs between December and June. During this period Brolgas tend to congre.g.ate in flocks for feeding and roosting.
- **Offset:** Compensate for any unavoidable impacts on a species through measures which improve population viability in some way. For example: marking of existing powerlines which pose high collision risk, or enhancing breeding success. The population viability gains of an offset should be measurable.
- **One-off Flocking Site:** A site where a flock of Brolgas is observed or has been observed previously on a single occasion, but the site is not a traditional and re.g.ularly-used site.
- **Population Viability Analysis (PVA):** PVA attempts to model the fate of animal populations over time. It is widely used in threatened species management to quantify the effects of, for example, increased species mortality as a result of a new wind farm.
- **Potential Brolga Habitat:** Potential Brolga habitat includes but is not limited to permanent and ephemeral freshwater and saline wetlands, pastures and crop land within the recorded distribution of the Victorian Brolga population. Consideration should also be given to the airspace potentially occupied by Brolga during seasonal and daily movement along commuting routes.
- **Radius of Investigation:** The footprint of the proposed development, as well as the area within 10 km of the site boundary. In addition, any proposed new overhead powerlines which extend from the proposed wind farm and a 10km corridor either side of those powerlines.
- **Relevant Information Source:** Includes Victorian Biodiversity Atlas, Viridans Biological Databases; the Atlas of Australian Birds (Birdlife Australia) and current research, including relevant theses, research papers, results of unpublished projects and DSE Bioregional Action Plans. Includes breeding sites and non-breeding or flocking sites identified in proponent's field studies, by local land holders, community members, conservation groups, DSE, and other reliable sources. Third party records of breeding sites should be supported with documentary evidence (e.g. photos).
- **Roosting Site:** A permanent or ephemeral freshwater or saline wetland (including dams, swamps etc) at which Brolgas have been observed to roost (nocturnally or diurnally).
- **Seasonal Movements:** The movement of Brolgas between breeding sites and flocking sites. These movements occur at least twice annually at the end of the breeding and non-breeding seasons.
- **Turbine-free Buffer Zone:** Turbine-free buffer zones are recommended to remove potential impacts of wind farm development on breeding and non-breeding Brolga habitats. Within these areas new powerlines should generally be excluded or placed underground. Other infrastructure which might impact on Brolgas such as new roads should be placed to avoid disturbance.
- **Zero net impact:** An outcome where offsets are proposed to fully compensate for all unavoidable effects of the proposed development, leading to an overall neutral effect on the Victorian Brolga population.



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## Appendix A: Recommended Survey Methodology for Conducting Aerial Surveys for Breeding Brolgas

- Use of a Cessna 172 or equivalent, four-seat, high-wing, fixed wing aircraft;
- Flight height of 500 feet;
- Flight speed of 60-70 knots;
- East to west transects at 500 metres apart;
- Two observers observing 250 metres to the north and the south of the transects;
- Observers should scan the landscape and all wetlands, dams, creeks and drainage lines with binoculars (10x42);
- Each observer should have an aerial map showing wetlands;
- The aerial map should show numbered transects;
- Each observer should have a GPS;
- Each observer should have a data sheet;
- For each Brolga sighted, the location should be marked with a GPS and a note should be made on the data sheet on the transect number it was sighted on, and the distance and direction from the transect;

Other points that should be taken into account:

- The survey team should include a navigator (pilot or an additional person), to ensure the plane stays on the transect and that the observers know which transect is being flown at any one time;
- Bad lighting conditions, turbulence, using naked eye rather than binoculars and motion sickness is likely to reduce detectability of Brolgas;
- Where possible, each Brolga observed should be confirmed by both observers for a positive identification;
- There is sometimes a need to fly around a wetland to confirm a sighting;
- It is useful to ground-truth observations to accurately fix a sighting to a location in the landscape (e.g. wetland, dam, paddock).

