Hexham Wind Farm

Chapter 10

Brolga

WIND PROSPECT

10.1 Overview

This chapter describes the assessment of potential impacts from the construction, operation and decommissioning of the project on Brolga, listed as endangered in Victoria under the *Flora and Fauna Guarantee Act 1988*, and the measures taken to avoid and minimise these impacts in accordance with the Interim Guidelines for the Assessment, Avoidance, Mitigation and Offsetting of Potential Wind Farm Impacts on the Victorian Brolga Population (DSE, 2012) (Interim Brolga Guidelines).

This chapter is based on the findings of the ***Brolga Impact Assessment*** (Appendix C1) prepared by Nature Advisory. Due to the required methods of assessment, potential impacts on Brolga have been presented separately from the broader flora and fauna impact assessment (Chapter 8 – ***Biodiversity and habitat).***

The assessment included a review of database records, landowner consultation, aerial surveys, and a combination of field surveys and hydrological modelling to assess wetland suitability as Brolga breeding habitat.

Twenty-two Brolga breeding wetlands are located within five kilometres of the project site. Eight breeding pairs of Brolga are considered to be the maximum that would occur in this area in any given year. This was the number of breeding pairs identified within the investigation area in 2019, a year in which good rainfall and wetland availability provided good conditions for successful breeding.

To minimise the impact of the project on the Victorian Brolga population, turbine-free buffers have been established around wetlands used for Brolga breeding (nesting, egg incubation). The buffer is then extended using an 'elastic band' approach to include other suitable wetlands within two kilometres of the breeding wetland that may be used for foraging and night-roosting, as well the non-wetland areas located between these wetlands. A further 300-metre buffer has then been applied to this area to limit disturbance from human activity. No Brolga flocking activities have been observed within the investigation area, with the closest flocking site located 20 kilometres to the north-west near Penshurst.

Collision Risk Modelling was used to predict the risk of Brolga colliding with wind turbines over the 30-year life of the project. With the application of a conservative 90% avoidance rate, it was found that between one and ten birds may be affected over the life of the project.

A Population Viability Assessment was also undertaken to assess the potential impact of the project on the Victorian Brolga population. This assessment estimates that after 30 years the population would be reduced by 2.5 birds, assuming a conservative 90% avoidance rate of turbine collision.

It is expected that, by adhering to the Interim Brolga Guidelines, the project will not contribute a cumulative impact on the Victorian Brolga population from the wind energy industry in south-western Victoria.

10.2 EES objectives and key issues

The EES scoping requirements specify the following evaluation objective and key issues, outlined in Table 10.1, relevant to Brolga that have guided this assessment.

Table 10.1 EES evaluation objective and key issues

Evaluation objective	
Biodiversity and habitat: *To avoid, and where avoidance is not possible, minimise potential adverse effects on biodiversity values within and near the site including native vegetation, listed threatened species and ecological communities, and habitat for these species. Where relevant, offset requirements are to be addressed consistent with state and Commonwealth policies.*	
Key issues	• Direct loss or degradation of habitat for migratory or threatened flora and fauna listed under the EPBC Act and/or the FFG Act. • Disturbance and/or degradation of adjacent or nearby habitat that may support listed threatened or migratory species or other protected flora, fauna or ecological communities • Disturbance and increased mortality risk to flora and fauna species listed under the EPBC Act and/or FFG Act. • Indirect habitat loss or degradation resulting from other effects, such as edge effects, surface hydrological changes, groundwater drawdown, noise, vibration, light or the introduction of weeds/ pathogens. • Potential collision risk for protected bird and bat species with project infrastructure, including with wind turbine blades. • Potential impacts on groundwater dependent ecosystems. • Potential cumulative effects on relevant listed threatened and migratory species and communities of flora and/or fauna, in particular, but not limited to, **Brolga**, Southern Bent-wing Bat, Grey-headed Flying-fox, White-throated Needletail and Black Falcon from the project in combination with the construction and operations of other energy facilities.

10.3 Legislation, policy and guidelines

The key legislation, policies and guidelines relevant to the ***Brolga Impact Assessment*** (Appendix C1) are summarised in Table 10.2 below.

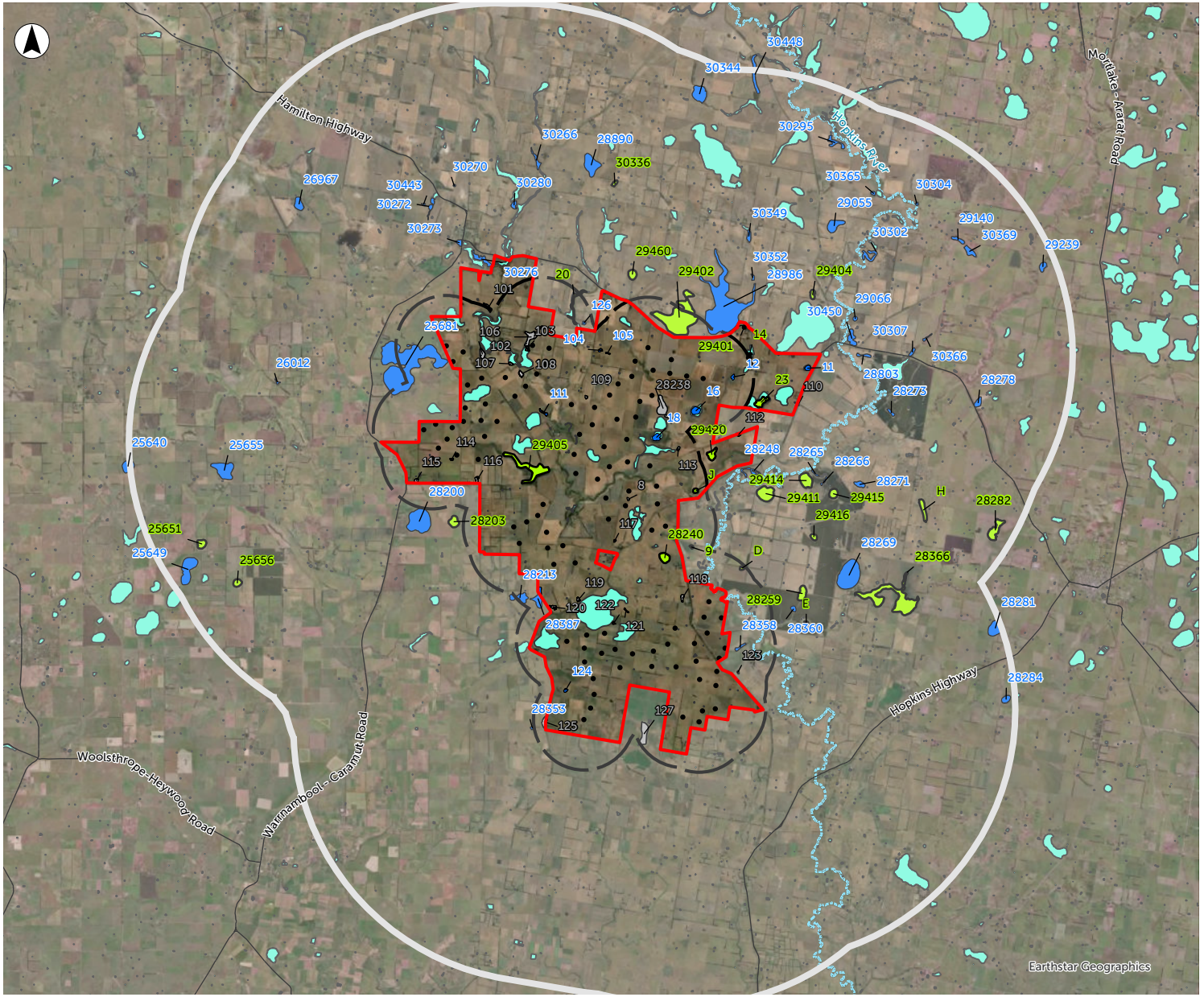
Table 10.2 Relevant legislation, policies and guidelines

Legislation, policy and guidelines	Description	Relevance to project
Victorian Flora and Fauna Guarantee Act 1988 (FFG Act)	The FFG Act lists threatened and protected species in the State of Victoria.	Brolga is listed as endangered under the FFG Act.
Planning and Environment Act 1987	The purpose of the *Planning and Environment Act 1987* is to establish a framework for planning the use, development and protection of land in Victoria. This Act sets out the process for obtaining permits under schemes, settling disputes, enforcing compliance with planning schemes and permits, and other administrative procedures.	The Moyne Planning Scheme is relevant to the project and is administered by the Moyne Shire Council. The following clauses of the Planning Policy Framework and Municipal Strategic Statement contained within the Moyne Planning Scheme are relevant to biodiversity for the project: • 12.01-1S Protection of biodiversity objective is "*to assist the protection and conservation of Victoria's biodiversity*." • 12.01-2S Native vegetation management objective is "*to ensure that there is no net loss to biodiversity as a result of the removal, destruction or lopping of native vegetation*." • 52.32 Wind Energy Facility: this clause facilitates the establishment and expansion of wind energy projects, in appropriate locations, with minimal impact on amenity of the area. It requires that impacts of wind energy projects on FFG Act listed species be assessed.
Planning Guidelines for Development of Wind Energy Facilities (Planning Guidelines) (DTP, 2023a)	The Planning Guidelines provide advice to inform planning decisions about a wind energy facility proposal. Responsible authorities must consider the impacts of wind farm developments on Brolga before making decisions on permit applications.	The Planning Guidelines require that impacts of wind farms on FFG Act listed species be assessed.

Legislation, policy and guidelines	Description	Relevance to project
Interim Guidelines for the Assessment, Avoidance, Mitigation and Offsetting of Potential Wind Farm Impacts on the Victorian Brolga Population (Interim Brolga Guidelines) (DSE, 2012)	The Interim Brolga Guidelines respond to the perceived risk posed to Brolga by the wind industry by outlining an approach to achieving a zero net impact to the Victorian Brolga population. To achieve this objective, three levels of investigation may be required. Information is gathered at each investigation level to inform the impact assessment and mitigation strategies. Each level informs the next and all three levels are applied if there is potential for a significant impact that requires informed mitigation and offset.	The project has been assessed in accordance with the Interim Brolga Guidelines.
Handbook for the development of renewable energy in Victoria (the Handbook) *(DEECA, 2025a)*	The Handbook includes new species-specific guidance for Brolga for onshore wind energy facility developments.	Under the transitional arrangements, the Handbook does not apply to a project that was referred to the Minister for Planning for assessment under the *Environment Effects Act 1978* or where an assessment under the *Environment Effects Act 1978* commenced prior to the commencement of the Handbook. These transitional arrangements apply to the project, and as agreed in consultation with DEECA, the project will be assessed under the Interim Brolga Guidelines

10.4 Investigation area

The investigation area includes the project site and a 10-kilometre buffer of the project site boundary, shown in Figure 10.1. This investigation area is referred to as the Radius of Investigation, in the Interim Brolga Guidelines.



Data: State of Victoria (DECCA/Land Use Victoria), Commonwealth of Australia, Wind Prospect, and specialist studies/reports. Data is indicative only; accuracy and completeness are not guaranteed.

Figure 10.1 Investigation area

10.5 Method

The potential impact of wind farms on Victoria's Brolga population is seen as a key environmental issue for the wind industry in southwest Victoria. This is because a significant proportion of the Victorian Brolga population's range occurs in areas proposed for wind farm development. To provide better guidance, the Victorian Government issued the Interim Brolga Guidelines (DSE, 2012). These guidelines outline a standard approach to assessing a wind farm project's impact and achieving a zero net impact on the Victorian Brolga population.

10.5.1 Level of assessment triggers and methods

The assessment framework outlined in the Interim Brolga Guidelines recommends a three-staged approach:

- design the wind farm including all infrastructure to avoid and mitigate potential effects, to the extent that is practicable
- estimate any remaining and unavoidable risk using tools such as collision risk modelling and population viability analysis, to ascertain likely effects on the population
- determine appropriate compensatory measures to, at a minimum, completely offset unavoidable effects.

The assessment methodology follows a staged risk assessment process, consistent with the approach outlined in the Wind Farms and Birds: Interim Standards for Risk Assessment (AusWEA, 2005). If all potential risks cannot be removed by the first assessment, then steps two and three apply (refer to text box below).

Level 1 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."*

Level 2 assessment aims to

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

Level 3 assessment aims to implement *"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."*

Figure 10.2 provides a summary of how the different assessment methods of the Interim Brolga Guidelines were used to identify Brolga habitat within the investigation area. These assessment methods are further detailed in the following paragraph.

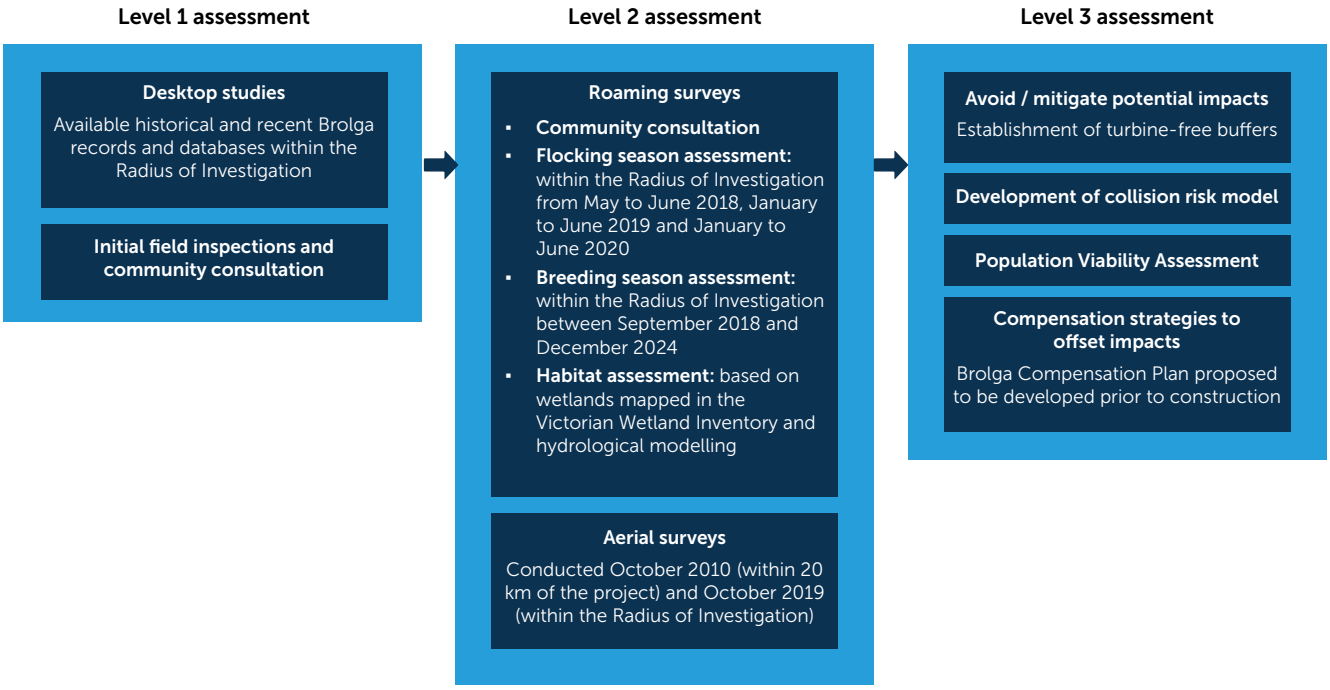


Figure 10.2 Brolga assessment methods

Level 1 assessment

The level 1 assessment provides an initial assessment as to whether a proposed wind farm development represents a risk to the Victorian Brolga population. It is triggered by one or more conditions, with an assessment of the project against these triggers provided in Table 10.3.

The method of assessment, in accordance with the requirements of the Interim Brolga Guidelines, and how the project addressed these requirements, is summarised in Table 10.4.

Table 10.3 Level 1 assessment triggers

Triggers	Applicable to project?	Comments
The proposed wind farm site is situated within the Victorian range of the Brolga.	✓	The proposed wind farm site is situated within the Victorian range of the Brolga.
The presence of Brolga within the Radius of Investigation (i.e., within 10 kilometres of the proposed wind farm boundary).	✓	Brolga are known to occur within 10 kilometres of the project site.
The presence of potential Brolga habitat within the Radius of Investigation (i.e., within 10 kilometres of the project site).	✓	There is potential Brolga breeding habitat within the investigation area
The location of the proposed development is within an area that may be used by Brolga during seasonal movements between breeding and flocking habitats.	✓	As Brolga are known to nest within and around the project site there is the possibility that the area is used for seasonal movements.

Table 10.4 Level 1 assessment method

Step	Brolga Interim Guidelines requirement	Project investigations
1	Undertake desktop studies into known and potential habitat areas for Brolga.	A desktop review was conducted of all available historical and recent Brolga records and databases within the investigation area. This included correspondence from local landholders of Brolga sightings.
2	Initial field inspection and local community consultation.	Initial field surveys were undertaken to identify potential Brolga breeding habitat within and surrounding the project site. These initial Brolga searches occurred between November 2009 and February 2010, with Brolga breeding season searches undertaken during 2012-2013. Extensive landholder consultation within the investigation area has been undertaken to identify current and historical Brolga flocking and breeding wetlands not recorded in available databases or accessible during field studies. This consultation is ongoing.

Level 2 assessment

The level 2 assessment collects data about Brolga habitats (location, nature and extent) and patterns of habitat use and behaviour at breeding, flocking and foraging sites within the Radius of Investigation. An assessment of the project against the level 2 assessment triggers provided in Table 10.5 with the assessment method provided in Table 10.6.

Table 10.5 Level 2 assessment triggers

Triggers	Applicable to project?	Comments
Records of breeding or flocking habitat within the Radius of Investigation.	✓	There are records of breeding within the investigation area, however no flocking sites are known to occur in this area.
The proposed development is in an area which may be used by Brolga moving seasonally between breeding and foraging sites, and may potentially create a barrier reducing movements between these habitats.	✓	Brolga are known to nest within the investigation area and there is a possibility that the area is used for seasonal movements.
The proposed development is located in an area which may be used by Brolgas for diurnal movements between foraging and roosting site.	✓	As Brolga are known to nest within and around the project site there is the possibility that the area is used for diurnal movements between foraging and roosting site.
The proposed location of new powerlines associated with the development may create new collision risks for Brolga.	✓	New powerlines proposed by the project are located outside of Brolga breeding buffers

Table 10.6 Level 2 assessment method

Step	Brolga Interim Guidelines requirement	Project investigations
-	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. This data can be collected via a range of methods however field investigations should include one or more of the methods detailed below:	
	• Roaming surveys	Site-specific field investigations have been undertaken during breeding and non-breeding periods in 2009-2011, 2013, 2018-2024 to document the extent of Brolga activity, as well as current and historical spatial patterns of activity in the investigation area. The roaming field surveys occurred during various weather conditions, including high and low rainfall seasons. **Brolga flocking season assessment** A Brolga flocking survey was undertaken in the investigation area from May to June 2018, January to June 2019 and January to June 2020. **Brolga breeding season assessment** Ground searches for breeding Brolga were undertaken within the investigation area between September 2018 and December 2024. As part of the breeding surveys, landowners and neighbours were consulted on Brolga activity. **Brolga habitat assessment** Potential Brolga habitat was modelled based on wetlands mapped in the Victorian Wetland Inventory (administered by DEECA) and hydrological modelling. Wetlands mapped in the Victorian Wetland Inventory database were considered for their potential suitability to provide Brolga habitat. This database shows the extent and types of wetlands in Victoria, incorporating local and regional wetland datasets. During monitoring undertaken over two years it was observed that many of the Victorian Wetland Inventory wetlands were inaccurate in terms of size, shape, and/or presence of water. Hydrological investigations were undertaken by Water Technology to develop a surface water model to accurately define the location and extent of these wetlands. This model was used to assess which wetlands can hold water for 120 days, at least once in 10 years (i.e., wetlands considered most likely to provide Brolga habitat (either for nesting or productive foraging) that supports breeding). Farm dams within 2,000 metres of known breeding wetlands were also mapped and assessed.
	• Aerial surveys	Wetlands that could not be visited in the field (mostly due to private land access limitations) were assessed using aerial photography and aerial survey to determine their suitability as Brolga breeding habitat. In October 2010, an aerial survey was conducted to record potential Brolga nests within 20 kilometres of the project. Nest locations were recorded and visited on the ground, where possible. A second aerial survey of the investigation area was undertaken in October 2019 over three days.

Level 3 assessment

The Interim Brolga Guidelines recommend a conservative approach to eliminate risk at all steps in the process. A level 3 assessment is required if the results of the level 2 assessment indicate that the residual risk of significant impacts to Brolga from the proposed wind farm is greater than low (as defined in the AusWEA guidelines (2005)) shown in Table 10.7.

The Level 3 Assessment consists of a four-step process (Table 10.8) that aims to identify suitable mitigation measures to result in an overall net-zero impact on the Victorian Brolga population.

Table 10.7 Level 3 assessment triggers

Triggers	Applicable to project?	Comments
Qualitative risk assessment (AusWEA, 2005) of project following site design is greater than "low".	✓	Noting the potential presence of Brolga within the site, a precautionary approach was followed and a level 3 assessment was completed.

Table 10.8 Level 3 assessment method

Step	Brolga Interim Guidelines requirement	Project investigations
1	Avoid or mitigate all potential impacts to Brolga breeding and flocking home ranges within the Radius of Investigation with turbine-free buffer areas.	The establishment of turbine-free buffers around Brolga breeding sites has been agreed in consultation with DEECA. As no flocking sites occur within the investigation area, mitigation is only required to address impacts on breeding wetlands.
2	Develop a site-specific collision risk model for Brolga utilising or moving through the Radius of Investigation.	A site-specific collision risk model for Brolga was developed to estimate turbine collision risk for the life of the project.
3	Use DEECA (Melbourne University) Brolga Population Viability Assessment to estimate the impact of the proposed development on the population.	Based on the outcomes of the collision risk model, the Melbourne University Brolga Population Viability Assessment was used to estimate the impact of the project on the Brolga population.
4	Identify appropriate compensation strategies to ensure a zero net impact on the Victorian Brolga Population.	Based on the outcomes of the collision risk model, a Brolga Compensation Plan is proposed to be developed prior to construction.

10.6 Existing conditions

10.6.1 Species description

Brolga are large-bodied, long-lived birds, belonging to the crane family (*Gruidae*). Adult birds range in weight between four and eight kilograms and stand up to 1.8 metres tall with a wingspan of two metres.

During the non-breeding season, Brolga form large flocks, occasionally as large as 200 birds but typically in groups of around 10 to 20 individuals. Breeding pairs form long-term bonds and if one of the pair dies, the remaining individual can take several seasons to find another mate.

Brolga breed once a year and pairs typically produce one or two offspring. During the breeding season (July to December), territorial pairs nest in shallow freshwater wetlands that are often ephemeral and hold water reliably in winter and spring. The flocking (non-breeding) season (December to June) is when Brolga disperse from their breeding wetlands, which are drying up, to larger wetlands that are more permanent. Here, they form flocks that roost at the wetland and forage in adjacent terrestrial and wetland habitats.

Between the breeding and flocking seasons, Brolga move between their breeding and flocking sites during two migration periods that are roughly consistent with the breeding and flocking (non-breeding seasons) above although variations due to weather can be expected.

10.6.2 Population and distribution

Across Australia, Brolga population numbers are in the tens of thousands, giving it a secure conservation status. However, the population of Brolga within Victoria is declining due to habitat loss from agriculture wetland drainage, and predation from foxes. As such, Brolga is listed as Endangered in Victoria under the FFG Act.

The most recent census of the Brolga population in southwest Victoria occurred in 2025 (SWIFFT, 2025). The population was estimated to be at least 856 individuals.

Brolgas generally return to traditional flocking sites each year, and numbers at flocking sites have declined significantly over the past century. Consistent flocking sites in south-west Victoria account for a significant proportion of the southern population. These sites include:

- The Grampians region
- Strathdownie
- Cressy
- Streatham (mainly on Lake Wongan and the Skipton area)
- Hamilton, Dunkeld and Penshurst areas
- Edenhope area
- Toolondo
- Willaura and Stavely areas
- Darlington.

A review of existing databases for records of Brolga breeding, flocking and sighting was undertaken by Nature Advisory. Information provided by local landowners and land managers (not recorded in databases) was also considered and incorporated into the assessment.

One flocking record was identified within the investigation area (Sheldon, 2005). In April 2003, 35 Brolga were recorded near wetland 28243 (labelled as '16' on Figure 10.1), located within the project site. However, the landholder has not observed Brolga flocking on their property (EHP, 2014). A Brolga observation was also recorded at this site in May 1997, although the number of Brolga observed was not disclosed. The review by Nature Advisory concluded that wetland 28243 does not meet the criteria for a traditional flocking site and is considered to have supported a one-off flocking site. During flocking season surveys from 2018-2020, no Brolga flocking activity was observed in the investigation area. Given the lack of flocking records and the lack of large, permanent wetlands in the investigation area, there is no evidence of traditional Brolga flocking sites near the project site. The nearest flocking site is located near Penshurst, approximately 20 kilometres north-east of the investigation area.

Based on field investigations undertaken during Brolga breeding seasons in 2018-2020 and 2022-2024 to document the extent and patterns of Brolga activity within the investigation area, it is estimated that the area supports up to eight breeding pairs of Brolgas. A summary of the survey results is provided in Table 10..

Table 10.9 Summary of Brolga roaming surveys

Year	Brolga breeding observation	Brolga non-breeding observations
2018	• Local landholders reported a pair breeding at wetland H and wetland 30336.	• A pair observed in May and June at wetland 30369, which is a non-breeding season foraging and roosting site. • A pair observed in September and October at wetland 29420 (VWI 28245). Breeding was unconfirmed but likely attempted. • A pair observed in October and December foraging in open paddocks at the northern end of wetland 29405. • A pair observed in November foraging at drained wetland 29402 (VWI 28966). • A pair observed in November foraging along Mustons Creek.

Year	Brolga breeding observation	Brolga non-breeding observations
2019	A pair observed attempting to nest in July at wetland 28366. The pair failed to raise any chicks though stayed in the area until November. A pair observed attempting to nest in August at wetland 29420 (VWI 28245). Breeding attempt failed; no chicks raised. A pair observed nesting in August at wetland 28282. Successfully reared one chick. Brolga confirmed nesting at wetland 25656 during aerial survey in October. Nesting attempt in October at wetland 29460 (VWI 28916). The pair was present in November though no chicks were confirmed. Sight was limited by tall grass. Nesting attempt observed during November at wetland 30336. The landholder reported Brolga raising a chick at wetland 20 (VWI 30330). A local landholder reported a pair breeding at wetland H.	A pair observed in January foraging in paddocks near wetland 29405. A pair observed in March and June at wetland 30369, which is a non-breeding season foraging and roosting site. Three individuals seen near the Mortlake sale yards in July. Flew from the east side of Hamilton in a westerly direction. A single Brolga observed at wetland 18 (VWI 28236). A pair observed in October foraging at wetland 23 (VWI 28249). No breeding activities observed. A pair was observed during aerial surveys in October at wetland 28269. No breeding activity observed. Likely to be the pair that nest to the east at wetland 28366. A pair observed in July and August foraging at a drained wetland number 28890. No breeding here, likely to be the pair that nest at wetland 30336. A pair reported by local landholder in November foraging at wetland 29402 (VWI 28966). Likely the pair the nested at wetland 29460 (VWI 28916).
2020	Nesting observed in September at wetland 9. No chicks raised. Nesting observed in September at wetland 23 (VWI 28249). Nesting observed in September at wetland 29420 (VWI 28245). Heavy rains flooded the nest. The pair nested again in November. Unknown if the pair raised any chicks. Nesting attempt in October at wetland 28240. No chicks raised. A pair observed nesting in October at wetland 29460 (VWI 28916).	Two pairs observed during the non-breeding season in January and one pair in February, March, May and June foraging at wetland 29402 (VWI 28966). A pair with their fledgling observed in February foraging at wetland 28278. A pair observed foraging in May in the overflow swampy area of wetland 29405. During the breeding season a pair observed foraging in November at wetland 29402 (VWI 28966). No breeding activity observed. A local landholder reported 10 individuals foraging in November at an adjoining property to the north of the project site.
2022	Brolga observed breeding at northern end of wetland 28282 in September and October, approximately 10 kilometres east of the project site. Nesting observed at wetland 9 in November. Two adult Brolga observed at wetland 28240 in December, appeared to be nesting. A pair of Brolga was observed at wetland 14 throughout December. No young were observed due to long vegetation in wetland though breeding behaviour was observed including adult sitting on ground during stormy conditions indicating it was brooding young.	Two adults were observed walking/ foraging at wetland 29402 in October and by landowner in December. A Brolga was heard trumpeting behind Blue Gums west of wetland 29416 but not seen.

Year	Brolga breeding observation	Brolga non-breeding observations
2023	Brolga pairs were confirmed to be attempting to breed at wetlands 9, 14, 23, 28259, 29402 and 29420. Nest incubation was observed at wetland 9 in August, but no adult Brolga or chicks were observed in September, hence it was likely a failed attempt. Nest incubation was observed at wetland 14 in September, and adults feeding chicks in October. Breeding was recorded at wetland 23 in July and August. Nesting was observed in July. Adults and two chicks were observed in August. Nesting of a pair was observed at wetland 28259 in August. In September, a single adult was observed once. A landowner reported seeing a pair of Brolga with a chick at wetland 29402 in November. Courtship behaviour was observed at wetland 29420 in October.	Non-breeding records occurred at wetlands 29411, 29416, and nearby wetland 29460. An individual was seen at wetland 29411 in November. Additionally, the landowner observed a pair foraging in a paddock to the southeast of this wetland in August. A pair were seen foraging in wetland 29416 in August. An individual was observed foraging in a paddock less than 500 m from wetland 29460 on two separate days in August. It is possible that a breeding attempt was made at this wetland but could not be confirmed due to lack of landowner permission.
2024	A pair was observed nest building at wetland 28259. A pair with a juvenile were seen in a paddock adjacent to wetland 30336 in September.	A pair were observed at wetland 28966 with a juvenile individual in July. A juvenile was observed at wetland 28966 in October, no adults were seen. A pair and juvenile were observed in a cow paddock 100 m from wetland 30336 in September. A pair were seen at wetland 28259 in August, September and October A pair were seen at wetland 9 in August, September and October. A landholder reported seeing a pair at various locations on their property east of the Hopkins River in July and August. A landholder reported seeing a pair in a paddock 1 kilometres north of wetland 9. A landholder reported hearing Brolga in wetland 28966 in early August and December. A landholder reported seeing Brolga at wetland 28259 in early August. A landholder reported seeing Brolga at wetland 30330 in October. Two Brolga were observed standing in wetland 28236 in November.

10.6.3 Brolga habitat

In Victoria, Brolga occur in a variety of habitats. During the breeding season, pairs nest in shallow freshwater wetlands that are often ephemeral, holding water reliably only in winter and spring, while in non-breeding season they congregate at larger, often permanent waterbodies where they roost, drink and forage. Emergent vegetation at these wetlands plays a crucial role in providing Brolga habitat as it provides nesting material, food resources and cover from predators for young chicks (Johnsgard, 1983). Dense, tall emergent vegetation over one metre in height is generally avoided as Brolgas need to maintain a panoramic view of their surroundings (Herring 2007). Both breeding and nearby foraging support a successful breeding outcome, with access to at least three wetlands more likely to result in optimum breeding success (Veltheim et al., 2019).

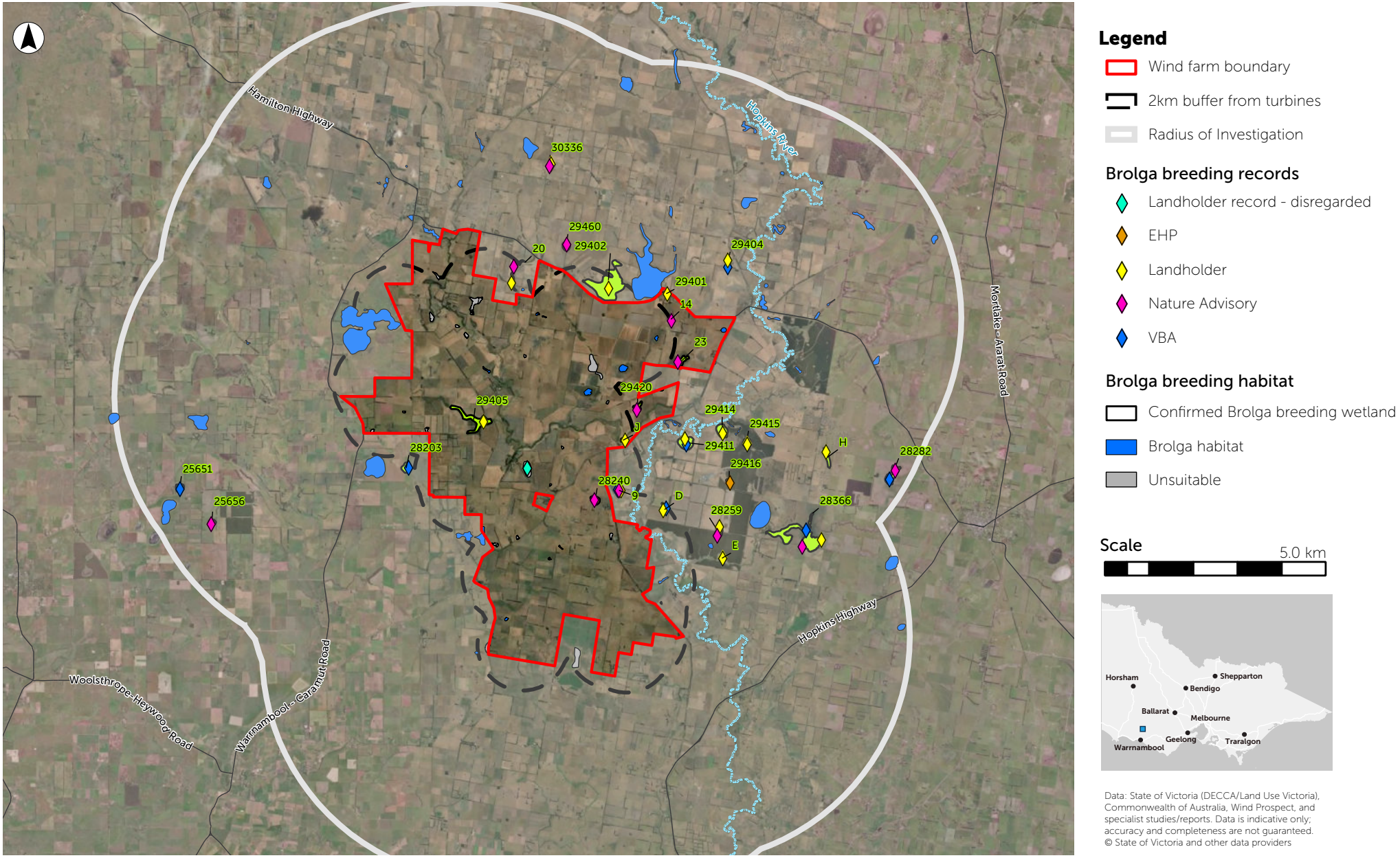
Brolga prefer larger expanses of water to protect them from ground predators, rather than drainage lines, flowing creeks and rivers (Herring, 2004; Veltheim et al., 2019). As such, the key threat to Brolga is the drainage and alteration of the wetland hydrology. Wetlands that have been partially- or fully-drained typically do not provide the physical and biotic resources needed to build nests, incubate eggs, feed and shelter young chicks from ground predators or feed older chicks until they fledge, as they may not hold water long enough for successful breeding (DEECA, 2025a) or may reduce in size to the point that Brolgas are unlikely to select them for breeding (Veltheim et al., 2019). However, DEECA has advised that there are records of partially drained wetlands being used for nesting.

Nature Advisory assessed 206 wetlands in the investigation area (Figure 10.1). These wetlands were assessed for their suitability to support Brolga reproduction, vegetation presence, physical attributes (e.g., size, depth and steepness of banks) and their condition. Sixty-two per cent of the assessed wetlands were deemed unsuitable as Brolga habitat as they were inaccurately mapped or permanently drained, with no confirmed breeding records. Drained wetlands included those that had been dry for many years as they had been drained and converted for agricultural use. Seventy-nine wetlands (38%) were identified as suitable Brolga habitat, which also included partially or permanently drained wetlands with confirmed breeding records.

To determine the extent of Brolga breeding wetlands and other suitable wetland areas that would support successful Brolga breeding, hydrological investigations were undertaken and a surface water model of the project site developed. The model was used to determine wetlands that can hold water for a period of 120 days or more during the Brolga breeding season. A wetland that retains water for this period during the Brolga breeding season and located within 2 kilometres of a breeding wetland is likely to support a successful breeding attempt.

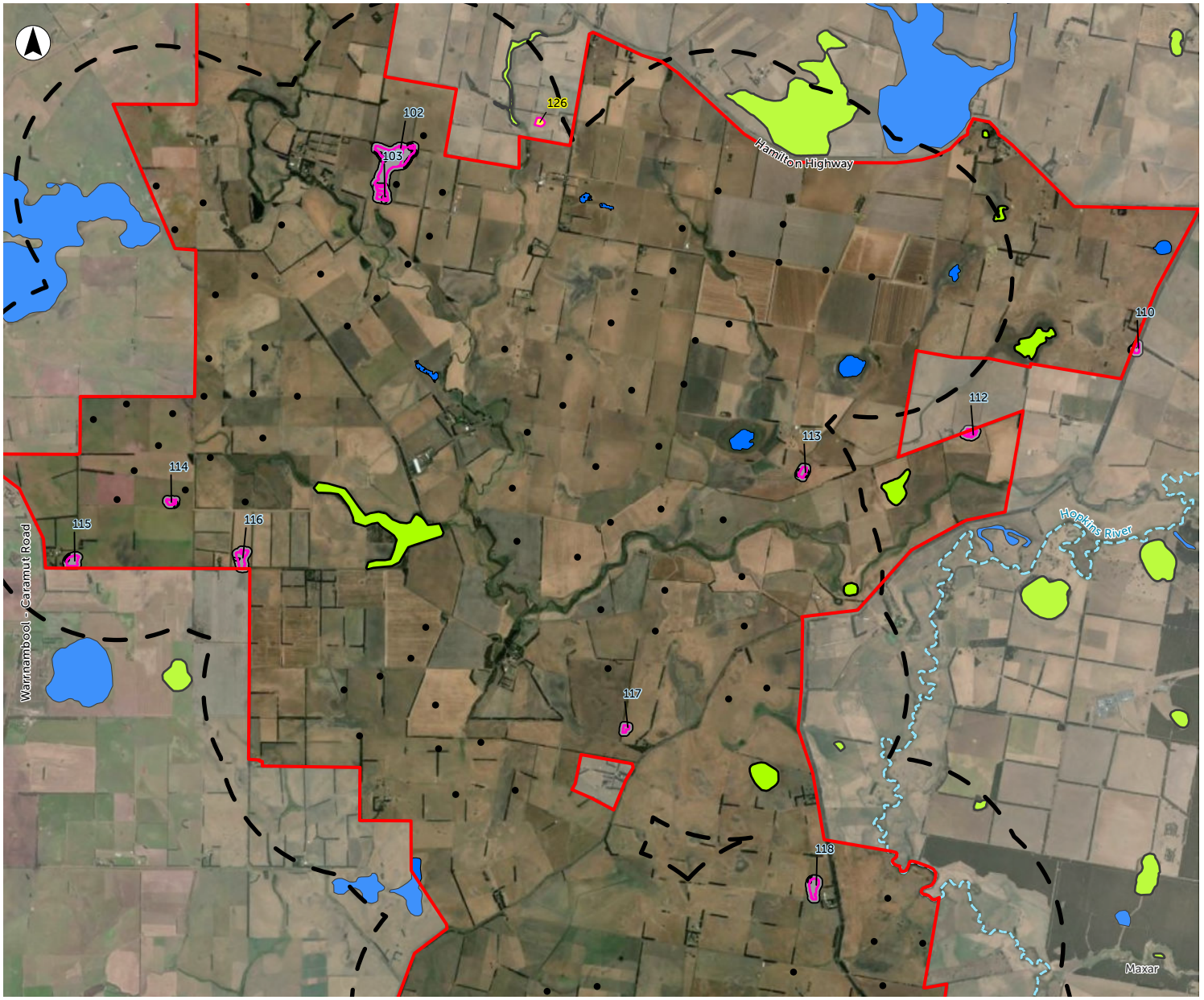
This assessment found that within the investigation area, 26 wetlands were accepted as Brolga breeding wetlands, and 14 of these had confirmed breeding activity between 2018 and 2024. Six of these wetlands are located within the project site (Wetlands J, 29405, 29420, 28240, 23 and 14) (Figure 10.3). Nature Advisory estimates that up to eight Brolga pairs were known to be breeding simultaneously within the investigation area.

Farm dams within 2 kilometres of known Brolga breeding wetlands were assessed for suitability as Brolga habitat. Of the 11 farm dams assessed in 2024, 10 did not contain habitat features, such as vegetation and shallow areas for nesting or foraging, while one dam (farm dam 126) was considered to provide potential Brolga habitat, primarily in wet years (i.e., one in 10 years) when vegetation growth and water depth are adequate (Figure 10.4). Although most of these areas are not formally identified as potential Brolga breeding habitat, Brolgas can be observed in any location and may be considered Brolga habitat in general terms if sightings have occurred. Brolgas are known to be highly flexible, foraging across a variety of landscape features, including paddocks, cultivated areas, and multiple wetland types, even when these areas are not used for nesting (Archibald et al., 2020; Scambler et al., 2023).



Data: State of Victoria (DECCA/Land Use Victoria), Commonwealth of Australia, Wind Prospect, and specialist studies/reports. Data is indicative only; accuracy and completeness are not guaranteed.

Figure 10.3 Confirmed Brolga breeding wetlands



Legend

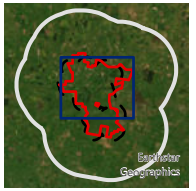
- Wind farm boundary
- Turbine
- 2km buffer from turbines
- Radius of Investigation

Farm dam assessment

- Potential Brolga habitat
- Unsuitable
- Wetlands assessed

Brolga breeding habitat

- Confirmed Brolga breeding wetland
- Brolga habitat



Scale 2.5 km

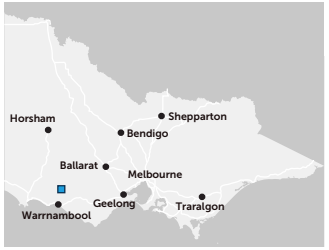


Figure 10.4 Farm dam assessment

10.7 Impact assessment

10.7.1 Impact pathways

Wind farms have the potential to impact on Brolgas through:

- direct effects, particularly due to collisions with wind turbines or powerlines
- indirect effects including:
  - habitat avoidance
  - disturbance from construction activities including access track construction, installation of wind turbines, increased traffic movements and quarry activities
  - barrier effects created by long rows of wind turbines.

Collisions with wind turbines or powerlines

Once the wind farm is operating, the impacts to Brolga mostly relate to the interaction with wind turbines. The most obvious impact is due to death via collision with turning blades. Other causes include collision with stationary infrastructure such as transmission lines.

To date, a single, potential Brolga collision with a wind turbine has been recorded, occurring at the Dundonnell Wind Farm in October 2022, during its second year of operation (Biosis, 2023). Independent assessment, undertaken at the request of DEECA, was unable to conclude the cause of death, however turbine strike is considered the most probable cause. This single confirmed mortality at Dundonnell Wind Farm was within the range of moralities projected to occur through collision risk modelling. Brolga collisions with powerlines have also been reported in Victoria (Goldstraw & Du Guesclin, 1991; Herring, 2005). While wind turbines are not a key threat to the Victorian Brolga population, they are considered vulnerable to collision due to their large size and relatively low aerial mobility.

In the absence of extensive and replicated observations on the interactions of flying Brolga with wind turbines, international research from closely related species was considered. The Brolga belongs to the crane family and wind turbine interactions have been observed for two other crane species: the European Common Crane (*Grus grus*) and the North American Sandhill Crane (*G. canadensis*).

Habitat avoidance

Brolgas may avoid areas, or be less likely to use habitats, near wind turbines. This avoidance may disrupt breeding, foraging and roosting behaviours.

However, there is evidence to suggest that Brolga can adaptively respond to the indirect impacts of wind turbines, informed by observations at wind farms located in Victoria (Veltheim et al., 2019), including the Macarthur Wind Farm, located approximately 45 kilometres west of the project site (Wood, 2014; Wood, 2017; and unpublished Nature Advisory data). At the Macarthur Wind Farm, Brolga have bred within 400 metres of constructed and operating turbines for at least six out of the last ten years and have been consistently observed foraging within 100 metres of the base of operating turbines. This includes a pair of nesting Brolgas (presumed to be the same pair) at the Macarthur Wind Farm which have been monitored by Nature Advisory in 2018, 2019 and 2021 at the same breeding wetland.

Previously, at another wetland adjacent to the Macarthur Wind Farm, a pair of Brolga were observed breeding in 2013 and 2014 (Wood, 2014). This wetland is surrounded by six turbines which are located between 50 and 420 metres from the edge of the wetland, and Brolga were observed foraging within as close as 50 metres from one of these turbines in the 2014 breeding season (Wood 2014), and within 90 metres of a turbine during the 2016 breeding season (Wood, 2017). Brolga were also observed flying low, directly under an operating turbine on at least two occasions.

Disturbance from construction activities

The Brolga is susceptible to disturbance from frequent human activity. The project will result in physical disturbance that includes vegetation clearance, excavation, trenching and earthworks such as stockpiling, or cut-and-fill material movements required to construct project infrastructure. Physical disturbance will mostly occur during construction, although it is also expected during decommissioning.

Wind farms are constructed progressively so construction activities in any location would be temporary. These activities would occur over several weeks with the exception of the proposed on-site quarry, substation and battery energy storage system areas, concrete batching plants, and construction site compounds, which would experience regular activity over the construction phase.

During wind farm construction, there will be heavy vehicle movements and activity, as well as human activity on the site, resulting in noise. There will also be noise from the operation of the proposed on-site quarry, including blasting. This noise and vibration has the potential to disturb breeding Brolga.

The construction of roads and larger infrastructure has the potential to alter existing drainage patterns if not accounted for through design. Prolonged changes to drainage patterns can lead to permanent changes to vegetation structure. Hydrological effects have the potential to occur over a large area, due to the nature of the shallow topographical relief of floodplain systems.

The eventual decommissioning of the project will involve the removal of wind farm infrastructure. During this process there are potential disturbance impacts because of noise, traffic and human presence, particularly during the breeding season. Activity associated with decommissioning is much less then that required during construction.

Barrier effects

Brolgas may modify their behaviour in response to the presence of the wind farm. They may be reluctant to fly through or over the wind farm (known as the 'barrier effect'). Long rows of turbines have the potential to create partial barriers to some bird movements, which in turn forces birds to travel further and increases their energy requirement (Drewitt and Langston, 2006).

The layout, orientation and spacing of wind turbines are important factors to reduce barrier effects. Occasional gaps between turbine clusters may allow movement of Brolga from high density breeding areas to flocking sites (DSE, 2012).

10.7.2 Design mitigation

In accordance with the Interim Brolga Guidelines, the mitigation hierarchy was adopted whereby:

- Avoidance measures have been taken to avoid impacts, primarily through the development of turbine-free buffers surrounding breeding wetlands.
- Minimisation measures have been implemented to reduce the duration, intensity and/or extent of impacts that cannot be completely avoided, as far as is practically feasible, including limiting overhead powerlines lines to the minimum required.
- Offset measures are taken to compensate for any residual, adverse impacts that cannot be avoided, minimised and/or rehabilitated or restored, in order to achieve no net loss or preferably a net gain of the Brolga population.

Turbine and on-site quarry placement

The design layout of project has avoided long rows of turbines to minimise potential barrier effects to Brolga movements.

The proposed on-site quarry and associated access track have been sited outside Brolga breeding site buffers.

Turbine-free buffers

The main mitigation measure implemented during the project design to avoid or minimise impacts to the Victorian Brolga population has been the development of turbine-free buffers around confirmed or historical Brolga breeding sites. These site-specific buffers have been agreed in ongoing consultation with DEECA.

The turbine-free buffer areas were designed to limit impacts to Brolga breeding success during construction (i.e., disturbance) and operation (i.e., collision with wind turbines). Project-specific Brolga buffers were developed based on:

- consultation with DEECA, landowners, land managers and special interest groups
- the recent Brolga research (satellite tracking) undertaken by Veltheim et al. (2019) in south-west Victoria
- known Brolga movements around breeding wetlands from several observational studies of Brolga flight behaviour by Nature Advisory
- observations of the movements of Brolga breeding at the Macarthur Wind Farm since 2012
- breeding wetland home range mapping published in the EES Referrals for the Penshurst Wind Farm (Biosis Research, 2011) and Mt Fyans Wind Farm (Biosis, 2017).

Turbine-free buffers developed for the project considered the following key habitats that support Brolga breeding:

- confirmed or valid historical breeding wetlands used for breeding and night-roosting
- wetlands providing habitat used for foraging and/or alternate night-roosting within 2,000 metres of breeding wetlands
- non-wetland areas around breeding wetlands used for foraging
- movement corridors between breeding wetlands and other wetlands.

These habitats are further described below:

Brolga breeding and night-roosting wetlands

Wetlands with valid historical breeding records were identified from government databases and the Atlas of Australian Birds and Birdata, as well as consultation with landowners. Breeding wetlands within the investigation area were also identified from field surveys over multiple years. A hydrological assessment of wetlands within the project site as discussed in Chapter 12 – ***Surface Water,*** identified and mapped wetlands that retain water for 120 days or more at least once in a 10-year period. These are wetlands most likely to provide habitat that supports Brolga breeding (i.e. either nesting or productive foraging wetlands). Home ranges have been generated by considering all wetlands within 2 kilometres of a breeding site that would support Brolga breeding. The combined home ranges across these wetlands were used as the basis for a turbine-free buffer for these wetland complexes.

Non-wetland foraging areas and movement corridors

Based on the satellite tracking of Brolga chicks, Veltheim et al. (2019) concluded that the most important consideration for breeding site protection and enhancement at wind farms was the inclusion of multiple wetlands within breeding home ranges inside the turbine free buffers. They note that both breeding wetlands and non-wetland habitat should be incorporated into turbine-free buffers to allow barrier-free movement between wetlands and non-wetland foraging areas.

Non-wetland habitat most likely to be used by Brolga is either within 600 metres of a wetland or between two wetlands that are within 2,000 metres of each another (Veltheim et al., 2019).

Veltheim et al. (2019) concluded that a distance of 2 kilometres from a nesting or roosting wetland encompasses foraging habitat and movement corridors within the 95% utilisation distribution (i.e., a 95% probability that an animal is found at a given point in space, based on a statistical model). This distance from the edge of breeding wetlands was used to map home ranges and develop turbine-free buffers.

The Brolga breeding wetlands and other wetlands (Brolga habitat) that are within 2 kilometres of each other are included in the home range for that breeding wetland. A single turbine-free buffer was created around these wetland complexes to allow barrier-free movement between breeding wetlands, other wetlands and non-wetland foraging areas.

Defining Brolga home range

The Brolga home range represents the area where Brolgas are likely to occur more frequently throughout their breeding season. It includes:

- Grouping of wetland habitats within 2 kilometres of confirmed Brolga breeding wetlands (i.e., those that meet the criteria of retaining water for a period 120-days at least once in a 10-year period) that form a wetland complex.
- A 600-metre buffer around each wetland within a complex, which encompasses most Brolga flights from nesting wetlands, as defined based on consultations with DEECA. The 600-metre buffer is considered a conservative approach.

Brolga home range: includes wetland complexes and intervening non-wetland terrestrial habitat. These areas are considered to provide adequate resources for successful breeding. Brolga home range is determined based on distances moved by Brolga families within, between and around wetlands (Veltheim *et al*., 2019).

Brolga home range is defined by Brolga movement patterns, based on research undertaken by Veltheim et al. (2019), and flight data collected on breeding pairs in southwest Victoria. The Brolga home range identified for the project is shown in Figure 10.5.

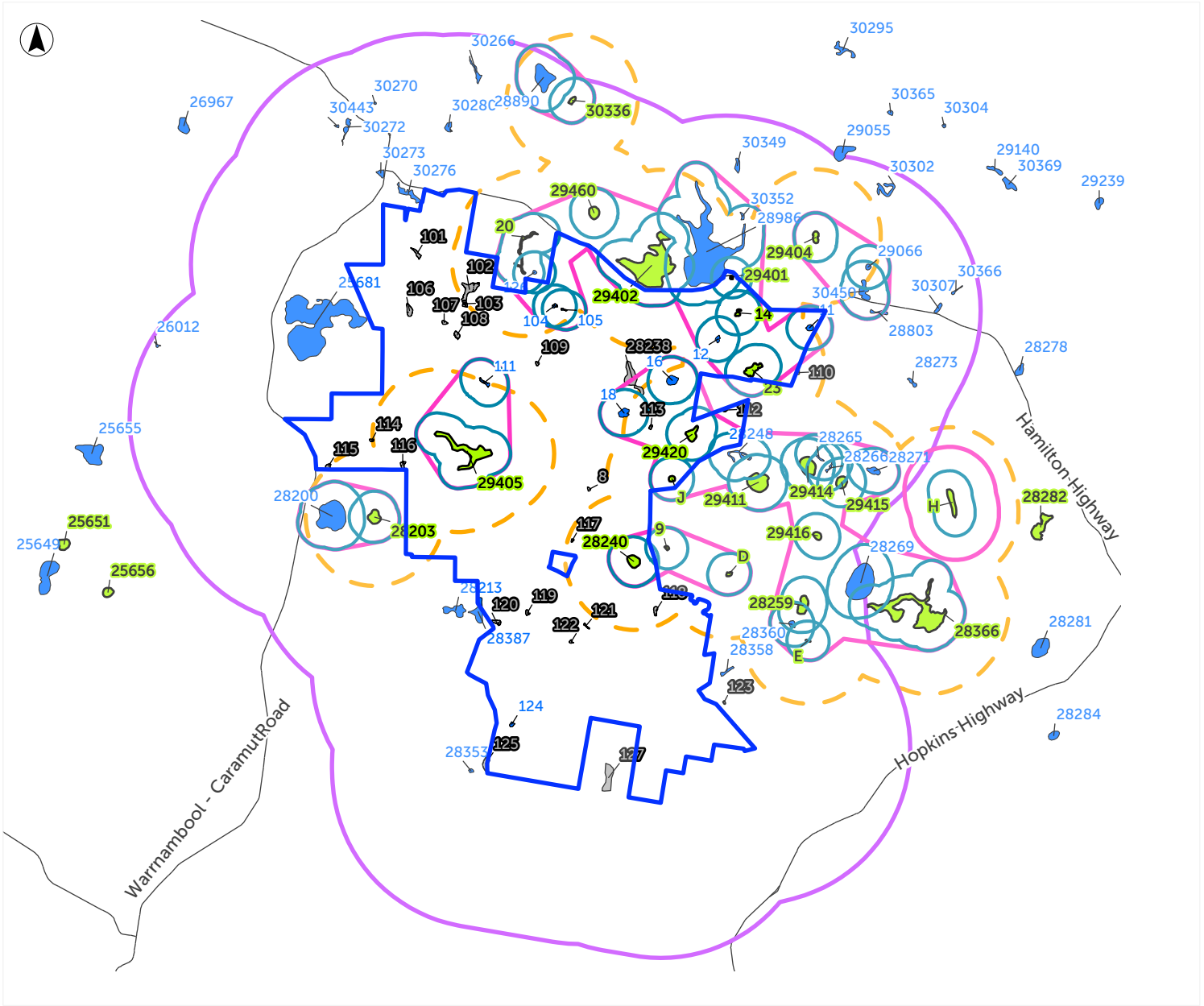


Figure 10.5 Brolga home ranges

Final turbine free buffers

The final turbine-free buffers include:

- the Brolga home range
- an additional area comprising a 300-metre disturbance buffer applied around the perimeter of the home range boundary, recommended by the Interim Brolga Guidelines, to prevent indirect disturbance to breeding Brolga, plus a 95-metre turbine blade length buffer to account for the proposed project turbine blade length.

The outer edge of these additional zones around the home range represents the turbine-free buffer for Brolga breeding wetlands. This is shown for all breeding wetlands within and near the project site in Figure 10.6.

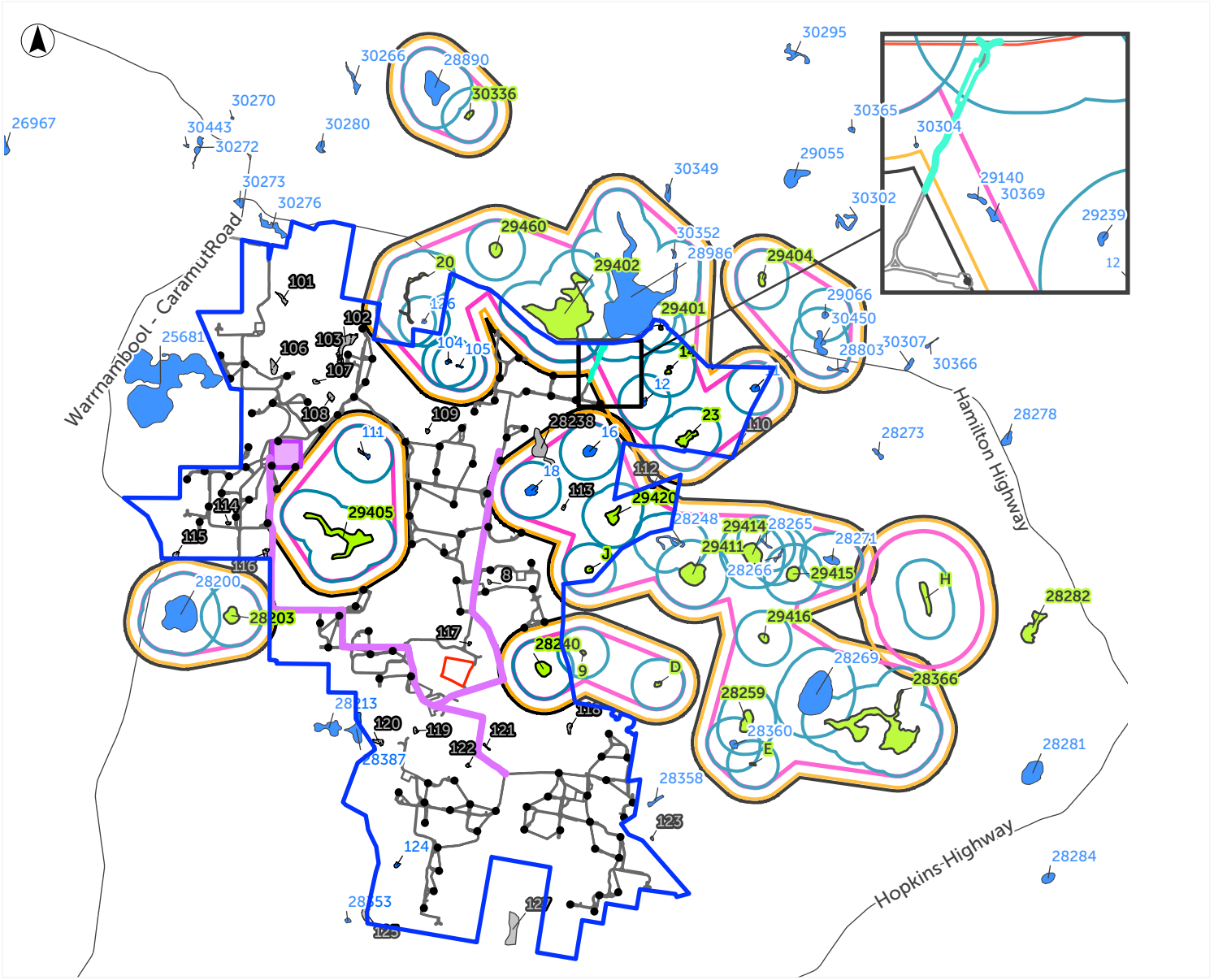


Figure 10.6 Turbine free buffer

10.7.3 Environmental management measures

To minimise potential impacts to Brolga, the mitigation hierarchy was adopted whereby key avoidance and risk minimisation measures were applied during the design of the project. To ensure project-related disturbance does not aversely effect Brolga breeding success or that there are no unexpected turbine collisions, the management measures outlined in Table 10.10 have been proposed for the project.

As no flocking sites occur within the investigation area, management measures are only required to address potential impacts on breeding wetlands.

Table 10.10 Measures to manage adverse impacts to Brolga

Brolga impact	Project phase	Management measures	Number
Direct effects, particularly due to collisions with wind turbines or powerlines	Construction Operation	**Brolga Compensation Plan** 1. Prior to the commencement of construction, a Brolga Compensation Plan is to be developed for the project in accordance with the Interim Brolga Guidelines for the Assessment, Avoidance, Mitigation and Offsetting of Potential Wind Farm Impacts on the Victorian Brolga Population (Department of Sustainability and Environment, 2012), in consultation with the Department of Energy, Environment and Climate Action, Glenelg Hopkins Catchment Management Authority, Moyne Shire Council and participating landowners. 2. The Brolga Compensation Plan will require impacts on the Victorian Brolga population predicted in the Population Viability Assessment to be fully offset.	BR01

Brolga impact	Project phase	Management measures	Number
	Operation	**Bat and Avifauna Management Plan** 3. Attachment V - Bat and Avifauna Management Plan has been prepared for the project in accordance with the following guidelines and will be implemented prior to the commencement of operation to minimise impacts to bat and avifauna species: a. Onshore Wind Farm Guidance – interim guidance on bird and bat management (Department of Agriculture, Water and the Environment, 2022) b. Onshore Wind Farm Guidance: Best practice approaches when seeking approval under Australia's national environment law (Department of Climate Change, Energy, the Environment and Water, 2024a). 4. Attachment V - Bat and Avifauna Management Plan outlines monitoring protocols and responsibilities, impact triggers for listed and non-listed bird and bat species, and operational procedures following occurrence of impact triggers including reporting requirements. Adaptive management measures to reduce impacts will be considered as part of the Attachment V - Bat and Avifauna Management Plan. 5. Attachment V - Bat and Avifauna Management Plan includes species-specific management strategies for the following species of concern to focus management efforts and improve mitigation effectiveness in response to impact triggers: a. Blue-winged Parrot (*Neophema chrysostoma*) b. White-throated Needletail (*Hirundapus caudacutus*) c. Fork-tailed Swift (*Apus pacificus*) d. Brolga (*Grus rubicunda*) e. Black Falcon (*Falco subniger*) f. Wedge-tailed Eagle (*Aquila audax*) g. Grey-headed Flying-fox (*Pteropus poliocephalus*) h. Southern Bent-wing Bat (*Miniopterus orianae bassanii*) i. Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*) 6. Attachment V - Bat and Avifauna Management Plan also outlines committed financial compensatory measures that would be implemented in response to a significant impact (above the relevant defined impact threshold) to a species listed under the *Environment Protection and Biodiversity Conservation Act 1999* during project operation. 7. Key measures of Attachment V - Bat and Avifauna Management Plan are outlined in EMM BA01-1 through BA01-7. 8. Attachment V - Bat and Avifauna Management Plan will be a sub-plan to the Operations Environmental Management Plan (EMM09).	BA01

10.7.4 Residual impacts

Collisions with wind turbines or powerlines

A collision risk model was developed in accordance with the Interim Brolga Guidelines to quantify the risk of Brolga collision with project wind turbines. Wind turbine avoidance rates were modelled at 90%, 92% and 95% based on international research of cranes (Appendix C1 – ***Brolga Impact Assessment***). This range of avoidance rates was used given the uncertainty of estimating the exact proportion of Brolga flights that will avoid turbines.

The Interim Brolga Guidelines state the objective of **collision risk modelling** 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"*.

Under the 90% (conservative) wind turbine avoidance scenario, between one and ten Brolgas may be affected by collisions over the 30-year life of the project, with an average of 0.176 collisions per year. This equates to potentially one collision every three years, assuming a worst case of 10 collisions over 30 years (Table 10.11).

Further details of the collision risk model are provided in Appendix C1 – ***Brolga Impact Assessment***.

Table 10.11 Results of collision risk modelling

Wind turbine avoidance rate	Collisions per year	Collisions over project life	95% prediction interval[1] over project life
90%	0.176	5.3	1 to 10 birds
92%	0.141	4.2	1 to 9 birds
95%	0.088	2.6	0 to 6 birds[1]

1. A prediction interval is an estimate of an interval in which a future observation will occur, with a certain probability, given what has already been observed.

To assess the impact Victorian Brolga population under various collision risk modelling scenarios, a Population Viability Assessment was completed by Professor Michael McCarthy from the University of Melbourne (included in Appendix C1 – ***Brolga Impact Assessment***). This predicted that the population size would be reduced by between 2.5 (90% avoidance rate) and 1.3 (95% avoidance rate) birds compared with baseline conditions. Under the most conservative collision rate (90% avoidance rate), this represents a reduction of about 0.005% of the Victorian Brolga population.

The Interim Brolga Guidelines require that the impacts on the Victorian Brolga population predicted in the Population Viability Assessment are offset. Using the conservative 90% avoidance rate scenario for wind farm impacts, ten new breeding adult Brolgas should be in the population by the end of the life of the project. A Brolga Compensation Plan will be prepared for the project to ensure that the expected minimum population size remains the same [EMM BR01].

During the project's operation, monitoring protocols and responsibilities will be implemented in accordance with the Attachment V - ***Bat and Avifauna Management Plan*** [EMM BA01], as well as adaptive management measures to reduce impacts.

Attachment V - ***Bat and Avifauna Management Plan*** also outlines committed financial compensatory measures that would be implemented in response to a significant impact (above the relevant defined impact threshold) to an EPBC Act-listed species during project operation.

Habitat avoidance

Wind turbines are a static, fixed source of disturbance and there is evidence to suggest that continued deterrence from the 300-metre zone around a wind turbine is unlikely to occur consistently (refer to Section 10.6.1).

An access track to the project site south of the Hamilton Highway leads partially through a Brolga buffer. The buffered breeding site is located to the north of the Hamilton Highway, and as such is already impacted by traffic travelling along the Highway (see inset in Figure 10.6). No other wind farm infrastructure, including proposed overhead powerlines, are located within Brolga breeding buffers.

Disturbance from construction activities

The Brolga Scientific Panel recommend a minimum indirect disturbance buffer of 300 metres from breeding home ranges (DSE, 2012) to prevent disturbances from construction activities. A site access track south of Hamilton Highway partially intersects a Brolga buffer along an existing farm track (see inset in Figure 10.6). This breeding wetland is located north of Hamilton Highway, and is already impacted by traffic travelling along the Hamilton Highway. No additional disturbance is expected from the access track that is partially located within this Brolga breeding site buffer.

The proposed on-site quarry, if approved, would operate during the construction stage of the project. Airblast overpressure and ground vibration from blasting during quarry operations would be controlled to minimise impacts on sensitive sites (refer to EES Chapter 17 – ***Noise and vibration*** for further discussion on potential noise and vibration impacts and proposed management measures). Brolga breeding wetlands are located at least 1.4 kilometres from the on-site quarry. This distance is considered sufficient that Brolga are not expected to be impacted by blasting impacts and quarry traffic.

Once construction of the project is complete, the reduced level of vehicle traffic and human activity associated with operating the completed wind farm is considered unlikely to persistently disturb fauna in adjacent habitats.

Barrier effects

The design of the project has avoided long rows of turbines. These gaps between turbines effectively mitigate potential barrier effects, regardless of whether an additional wind farm is constructed nearby.

10.7.5 Cumulative impacts

Potential cumulative impacts to the Victorian Brolga population are assessed in Chapter 26 – ***Cumulative effects***.

10.8 Conclusions

The assessment undertaken by Nature Advisory identified Brolga using wetlands within the investigation area for breeding, with 26 wetlands likely to continue providing breeding habitat. Of these wetlands, 10 were located within 2 kilometres of a proposed wind turbine project. It is estimated that there are up to eight breeding pairs within the investigation area.

Within the project site, four wetlands were used by Brolga for breeding between 2018 and 2024:

- Wetland 29420 – August 2019 (incubating) and October 2023 (courtship)
- Wetland 28240 – October 2020 (nesting) and December 2022 (nesting)
- Wetland 23 – September 2020 (nesting) and July/August 2023 (nesting, chicks)
- Wetland 14 – December 2022 (incubating) and September/October 2023 (nesting, chicks).

The assessment found that there is currently no evidence that Brolga use the investigation area as a flocking site, with the nearest known flocking site located approximately 20 kilometres from the investigation area. It is therefore considered unlikely that the project will impact on Brolga flocking sites

To minimise the impact of the project on the Brolga population, habitat-based turbine-free buffers have been applied. These buffers incorporate wetlands with confirmed or valid historical data used for breeding and night-roosting, wetlands providing habitat used for foraging and/or alternative night-roosting within 2 kilometres of breeding site wetlands, non-wetland areas around breeding wetlands and movement corridors between breeding wetlands and other wetlands. These buffers will be established around all the Brolga breeding wetlands and other wetlands that would be used to support a successful breeding attempt within the investigation area of the proposed wind farm.

In accordance with the Interim Brolga Guidelines, a risk-based approach was applied whereby turbine collision risk was modelled. The model predicts that under the most conservative turbine avoidance scenario, where Brolga avoid wind turbines 90% of the time, between one and ten birds may be affected over the 30-year life of the project. A Population Viability Assessment was also completed to assess the impact to the Victorian Brolga population. The assessment estimates that after 30 years, the Brolga population size would be reduced by 2.5 birds, assuming a 90% avoidance rate.

Through the restoration of breeding habitat as part of a Brolga Compensation Plan, additional breeding success is expected to increase the number of young that survive to become breeding adults.