



**NGH**

# **LOTUS CREEK WIND FARM**

## **Ecological assessment report – final**

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Project Number: 20-540



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## ACRONYMS AND GLOSSARY

Term	Definition
ALA	Atlas of Living Australia
BACI	Before-after-control-impact design
BBMP	Bird and Bat Management Plan
BoM	Bureau of Meteorology
BUS	Bird Utilisation Study
CEMP	Construction Environmental Management Plan
CVFMP	Construction Vegetation and Fauna Management Plan
DAWE	Department of Agriculture, Water and the Environment (Cwth)
DBH	Diameter at Breast Height
DES	Department of Environment and Science (QLD)
Development footprint	This is the area that will be directly impacted by wind farm development (i.e., the clearing footprint)
DEWHA	Department of Environment., Water, Heritage and the Arts (now DAWE)
DILGP	Department of Infrastructure, Local Government and Planning (DILGP) (now DSDMIP)
DNRME	Department of Natural Resources, Mines and Energy (QLD)
DoE	Department of Environment (now DAWE)
DSDMIP	Department of State Development, Manufacturing, Infrastructure and Planning (QLD)
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities (now DAWE)
DSITIA	Queensland Department of Science, Information Technology Innovation and the Arts (now DES)
EAR	Ecological Assessment Report (this report)
EH	Essential habitat
EOP	Environmental offsets policy (EPBC Act)
EP Reg	<i>Environmental Protection Regulation 2008</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cwth)
FPC	Foliage Protection Cover
GBO	General biosecurity obligation
GIS	Global Information System
GTRE	Ground-truthed regional ecosystem
GTS	Green Tape Solutions
HBT	Hollow Bearing Tree

Term	Definition
HES	High ecological significance wetland
HEV	High ecological value wetland
MNES	Matters of national environmental significance
MSES	Matters of state environmental significance
MW	Megawatts
MWh	Megawatt hours
NC Act	<i>Nature Conservation Act 1992</i> (Qld)
OEMP	Operational Environmental Management Plan
PMST	Protected matters search tool
Project Area	Refers to the area within which wind turbines, over- and under-ground powerlines, access tracks and other associated infrastructure were considered likely to be located. This area (plus potential Project Area locations) was targeted during ecological surveys.
Project Area (original)	Refers to a previous Project Area which was the subject of EPBC referral 2020/8627.
RE	Regional ecosystem
RSA	Rotor sweep area
RVM	Regulated Vegetation Management
SARA	State assessment and referral agency
SAT	Spot Assessment Technique
SDAP	State development assessment provisions
SEVT	Semi-evergreen vine thicket
Site Boundary	The extent of the properties that the wind farm is located within.
SMP	Species Management Program
SPRAT	Species profile and threats database
SRI	Significant Residual Impact
TARP	Triggered Action Response Plan
TEC	Threatened ecological community
the Project	Lotus Creek Wind Farm project
VM Act	<i>Vegetation Management Act 1999</i> (Qld)
WoNS	Weeds of national significance
WPA	Wetland Protection Area

## EXECUTIVE SUMMARY

Lotus Creek Wind Farm Pty Ltd (a subsidiary of LCWF Projects Pty Ltd) are proposing to develop a wind farm with up to 55 turbines within the Nebo-Connors Range between Mackay and Rockhampton. Lotus Creek Wind Farm is proposed across two properties in the Isaac Regional Council area, which are currently used for cattle grazing. NGH Pty Ltd have been engaged by Lotus Creek Wind Farm Pty Ltd to assess the potential impacts associated with the Project's development on ecological values, including those which are listed under state and/or Commonwealth legislation. This has been done through a desktop review of published literature, conservation advice, online databases and spatial information.

Three seasonal surveys were undertaken in accordance with applicable survey guidelines. A team of suitably qualified ecologists surveyed the site in April/May 2019 (post-wet), October/November 2019 (pre-wet) and September 2020 (pre-wet). Field assessment consisted of flora surveys and vegetation community verification, fauna and fauna habitat surveys, and bird utilisation surveys. Those threatened species and vegetation communities considered the most likely to occur within the Site Boundary were targeted. Key findings of the ecological assessment are summarised below.

1. Matters of National Environmental Significance (*Environment Protection and Biodiversity Conservation Act 1999*) present within the Site Boundary include:
  - Koala (*Phascolarctos cinereus*; Vulnerable) were observed, along with good quality Koala habitat.
  - Greater Glider (*Petauroides volans*; Vulnerable) were observed, along with good quality Greater Glider habitat.
  - Vulnerable Squatter Pigeon (*Geophaps scripta scripta*) were found.
  - The Migratory species Satin Flycatcher (*Myiagra cyanoleuca*), Fork-tailed Swift (*Apus pacificus*) and White-throated Needletail (*Hirundapus caudacutus*; also considered Vulnerable) were observed flying over the site boundary.
  - Endangered cycad (*Cycas megacarpa*) were confirmed present.
  
2. Matters of State Environmental Significance (*Nature Conservation Act 1992, Vegetation Management Act 1999*) within the Site Boundary include:
  - Koala (Vulnerable)
  - Greater Glider (Vulnerable)
  - Squatter Pigeon (Vulnerable)
  - Powerful Owl (*Ninox strenua*; Vulnerable)
  - White-throated Needletail (Vulnerable)
  - Fork-tailed Swift and Satin Flycatcher (Special Least Concern)
  - *Cycas megacarpa* (Endangered)
  - Regional Ecosystems listed as Of Concern:
    - RE 8.3.14 - *Ischaemum australe* and/or *Imperata cylindrica* and/or *Sorghum nitidum* forma *aristatum* tussock grassland on drainage channels in gently undulating upland areas
    - RE 8.12.16 - Deciduous to semi-evergreen microphyll vine thicket +/- *Brachychiton* spp. +/- *Araucaria cunninghamii* emergents, of foothills and uplands (western areas) on Mesozoic to Proterozoic igneous rocks.
    - RE 8.12.23 - *Eucalyptus moluccana* woodland on elevated tablelands on Mesozoic to Proterozoic igneous rocks.
    - RE 11.3.4 - *Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains.

Unmitigated impacts to ecological values as a result of the Project relate predominantly to the removal of habitat. The Project is likely to result in a maximum impact to 310.10 hectares of remnant vegetation. Taking



into account areas of non-remnant vegetation which are also suitable habitat for threatened species, the Project will result in a maximum impact to 345.4 hectares of Koala habitat, 50 hectares of Squatter Pigeon habitat and 0.4 hectares of (State-mapped) Of Concern remnant vegetation.

The avoidance and mitigation measures for the Project follow the development mitigation hierarchy of avoid, mitigate, rehabilitate/restore and offset. The Project design has sought to avoid impacts by:

- Locating turbines outside of Greater Glider habitat.
- Refining and rationalising the development footprint to the minimum necessary to deliver a viable wind project.
- Individual turbine siting using comparative selection by highest energy generation for the lowest vegetation impact.
- Using underground cabling within the road footprint throughout the majority of the Project Area to reduce clearing requirements.
- Where practical, the Project road design has chosen road alignments that use existing cleared areas, public roads or use the shortest distance to access turbine locations in order to minimize vegetation clearance.

Additional avoidance measures will be a priority through future detailed design stages, which will:

- Microsite roads and cable alignments to avoid cycads and hollow bearing trees.
- Reduce clearing of riparian vegetation.
- Reduce clearing widths for linear infrastructure to further minimise impacts on connectivity.

The design of Lotus Creek Wind Farm has balanced ecological and heritage constraints along with the most effective wind resource, transmission ability, and site access. Where impacts to ecological values cannot be avoided, they will be mitigated by measures such as:

- Pre-clearance surveys to identify threatened flora, fauna breeding places, and weeds.
- Salvaging and relocating tree hollows from felled trees (or where natural hollows are not viable, installing constructed nest boxes) to replace hollows with signs of use by Greater Glider.
- The presence of a suitably qualified fauna spotter during clearing and use of sensitive clearing techniques for habitat trees.
- Use of plain (non-barbed) wire on the top strand of new or repaired fencing.
- Pest animal and weed management during construction and operation.
- Bird and bat management during wind farm operation.

The significance of impacts was assessed for matters of national and state environmental significance which are known or likely to occur within the Project Area. It was concluded that there is likely to be significant impacts to Koala and the Of Concern regional ecosystem 11.3.4. Impacts to other matters of environmental significance known or likely to occur within the site are not considered to be significant.

# 1 INTRODUCTION

Lotus Creek Wind Farm Pty Ltd are developing the Lotus Creek Wind Farm (the Project), a new wind farm in central Queensland, which will contribute up to 450 MW of additional renewable power to the national energy grid.

NGH Pty Ltd has been engaged by Lotus Creek Wind Farm Pty Ltd to assess the potential impacts associated with the Project's development on ecological values, including those which are listed as threatened under Queensland State and/or Commonwealth legislation.

## 1.1 PROJECT HISTORY

The Lotus Wind Farm initial design was located in the Clarke-Connors Range and the Nebo-Connors Range and included the installation of 81 wind turbines with an upper capacity of 660 MW. Two ecological surveys were conducted in 2019 to identify ecological constraints within the Project Area. The surveys identified significant areas of high quality habitat for Greater Gliders (*Petauroides volans*) and large areas of woodland containing large, old hollow bearing trees in the eastern portion of the Site. Habitat for Koala (*Phascolarctos cinereus*), Squatter Pigeon (*Geophaps scripta scripta*) and *Cycas megacarpa* was also identified in the original Project Area.

An *Environment Conservation and Biodiversity Conservation Act 1999* (EPBC Act) referral (2020/8627) was submitted on 8 May 2020 for consideration. The referral decision, issued on 6 Jun 2020, was that the action would have clearly unacceptable impacts on threatened species and communities. In response to the Commonwealth Department of Agriculture, Water and the Environment's (DAWE) decision, LCWF redesigned the wind farm to remove turbines and associated infrastructure from Greater Glider habitat and from the Clarke Connors Range as well as reducing the number of turbines in Koala habitat from 81 down to 55 turbines.

An additional ecological survey was undertaken in September 2020 to survey new locations of turbines and access tracks, identify Koala habitat areas, confirm the Greater Glider habitat areas and target threatened species. The survey identified that the new Project Area has a healthy population of Koalas throughout the eucalypt woodlands and in scattered trees in cleared areas. Based on these findings, Lotus Creek Wind Farm Pty Ltd refined the turbine and access road layout, relocating turbines, where possible, to low vegetation density or cleared areas or adjacent to existing roads, and optimised access tracks and other infrastructure to reduce the clearing footprint.

## 1.2 PURPOSE AND SCOPE OF WORK

The overall purpose of this scope of work has been to undertake ecological surveys, impact assessment and reporting to support:

1. The relevant assessment required under State Code 23: Wind farm development (State code 23) and State Code 16: Native vegetation clearing (State code 16) of the State Development Assessment Provisions (SDAP), to support lodgement of a Development Application for the wind farm to the Queensland State Assessment Referral Agency (SARA).
2. A referral to DAWE for potential impacts to Matters of National Environmental Significance (MNES) under the EPBC Act.

The specific scope of the ecological assessment was to identify the ecological values within the Project Area, including undertaking:

- targeted threatened fauna species assessments
- targeted migratory bird assessments

- targeted threatened plant surveys
- bird utilisation surveys (BUS).

The results of these surveys informed the:

- assessment of impacts on matters of state and national environmental significance
- the identification of measures to avoid, minimise, mitigate and offset potential impacts.

## 1.3 PROJECT LOCATION

The wind farm layout, Site Boundary, Project Area and development footprint are shown in Figure 1-2.

### 1.3.1 Site boundary

The **Site Boundary** encompasses three leasehold lots, located approximately 175 km north-west of Rockhampton, between the township of Saint Lawrence on the central Queensland coast and the locality of Lotus Creek to the west, within the Isaac Regional Council local government area (Figure 1-1).

The Connors Range runs south-east to north-west with elevations ranging from 400 to 550 m above sea level, with the highest areas generally in the southeast. The lowest elevations at the site (in the east) are 200 m. Glencoe State Forest abuts the east of the northern section of the Site Boundary on the Collaroy Killarney Road. Road infrastructure within the area includes St Lawrence Croydon Road, Collaroy Killarney Road, Collaroy and Marlborough-Sarina Road. The Site is located on predominantly agricultural land over the Lot on Plan numbers listed in Table 1-1 below.

Table 1-1 Subject lots within the Site Boundary.

Lot	Plan	Shire
3161	PH378	Isaac Regional Council
4	KL210	Isaac Regional Council
799	PH391	Isaac Regional Council

### 1.3.2 Project area

The **Project Area** refers to a 200 m wide buffer on the development footprint within which wind turbines, over- and under-ground powerlines, access tracks and other associated infrastructure may be located. The Project Area will allow micro-siting of infrastructure (up to 100 m from the development area shown herein) during detailed design and give necessary flexibility to further reduce ecological impacts as more information about the site becomes known.

### 1.3.3 Development footprint

The **development footprint** has been proposed as the maximum possible impact area, in order to accommodate future modifications to layout at the detailed design stage. This precautionary approach means that the footprint proposed is slightly greater than the actual footprint.

The development footprint is based on 3D modelling of the site civil works. Clearing for firebreaks has been included within the development area for all built infrastructure other than roads, underground services and fences. Bushfire buffers have been calculated using lidar vegetation height data. The height of trees adjacent to turbines is 10 – 20 m and buffer widths are required to be 1.5 times the height of the tallest adjacent trees. A corresponding 15 – 30 m bushfire buffer has therefore been incorporated into the development footprint.

## **1.4 PROJECT DESCRIPTION**

The Project would comprise of the installation of up to 55 wind turbines with an upper capacity of 450MW that would supply electricity to the national electricity grid.

Key infrastructure components include:

- wind turbines and hardstand infrastructure
- permanent and temporary wind monitoring masts
- battery energy storage
- substations and switchyard
- telecommunication towers
- site offices, workshops, warehouses, staff amenities
- gravel-capped roads
- permanent site entries
- underground power and communication cables
- medium and high voltage overhead powerlines
- new fencing with grids and gates
- temporary facilities including construction compounds, laydown and stockpile areas, site entrances and accommodation construction camp
- mobile concrete batching plant and rock crushing facilities.

### **1.4.1 Project construction**

Construction activities are expected to commence in 2022 subject to approvals and commercial considerations. The construction phase would last for a period of approximately 24 months, with between 250 -350 staff employed during the peak construction period. Local staff, contractors and manufacturers would be utilised wherever possible, subject to suitable qualifications and commercial terms.

Construction activities will broadly consist of:

- Site establishment and preparation, including access roads
- Turbine installation using large mobile cranes
- Permanent meteorological mast installation
- Medium voltage underground cabling interconnecting wind turbine sites
- Construction of substation and control room
- Connection of the wind farm to the existing 275 kV overhead powerline
- Testing and commissioning of the wind farm.

Procedures and management plans for all construction activities would be included in a construction environmental management plan (CEMP) that will be prepared for the site prior to any works commencing.

### **1.4.2 Project operation and maintenance**

Lotus Creek Wind Farm is expected to have an operational life of 30 years.

Operational activities would include the following:

- Monitoring and control of the wind farm. This would be undertaken both by on-site personnel and via a remote-control system accessed from a central off-site facility and providing real time and historical performance information.

- Maintenance activities. General repair and maintenance of all wind farm infrastructure as well as roads, drainage, grass and fences. This would also include occasionally responding to faults in the equipment which would be identified through alarms on the monitoring system.

Night lighting at the site would be minimal and would be for security purposes only. Procedures and management plans for all operational activities would be included in an Operational Environmental Management Plan (OEMP) that would be prepared for the site prior to commissioning.

Lotus Creek Wind farm would employ approximately 15 staff members during the operations period and would utilise local commercial entities (nearby quarry, local water suppliers and subcontractors) as required.

The following services would be available at the wind farm site during operation phase:

- Water – a rainwater tank would be incorporated into the control room design and town water may be connected for control room facilities. If water is required for cleaning or other maintenance activities, it would be trucked to site by a commercial operator.
- Telecommunications – mobile phones will be used and a landline connection may be established in the control room.
- Sewer – an on-site effluent disposal system would be connected to the control room.
- Electricity – electricity would be provided by the wind farm development and the control room may also be connected to mains electricity.

### **1.4.3 Decommissioning**

At the end of the operational phase the wind farm would either be decommissioned or repowered with new equipment.

In the event of decommissioning, all above ground infrastructure would be removed from the site and a rehabilitation plan would be implemented to reinstate habitat and return the land to its pre- development condition. Redundant infrastructure would be recycled or otherwise disposed of at approved facilities. Any ground disturbance resulting from the operation and/or infrastructure removal stage would be rectified and the topsoil of disturbed areas would be re-seeded as per the rehabilitation plan.

If continued operation of the wind farm is the preferred option, a development application would be submitted at that time. It is likely that much of the infrastructure present at the site would be retained and incorporated into the new proposal.

Figure 1-1 Regional context



Figure 1-2 Wind farm layout and development footprint

## 2 PLANNING AND APPROVALS FRAMEWORK

### 2.1 COMMONWEALTH

The EPBC Act establishes the process for environmental assessment and approval of proposed actions that have, will have or are likely to have a significant impact on MNES or on Commonwealth land. MNES include:

- World Heritage Properties.
- National Heritage Places.
- Wetlands of International Importance (listed under the Ramsar Convention).
- Listed Threatened Species and Ecological Communities.
- Migratory Species (listed under international agreements).
- Commonwealth Marine Areas.
- Great Barrier Reef Marine Park.
- A Water Resource, in relation to coal seam gas development and large coal mining development.

A summary of the Project's history of referral under the EPBC Act can be found in Section 1.1.

### 2.2 QUEENSLAND

The Project requires approval from Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) under the *Planning Act 2016*. The Planning Act is the overarching framework for Queensland's planning and development system.

A combined development application for a material change of use (windfarm) and operational works (vegetation clearing) will be lodged with the DSDMIP. The application would be coordinated through the State Assessment and Referral Agency and will include:

- A **material change of use** development application for a wind farm is required to be assessed against State Code 23 and any other applicable state code(s) within the SDAP. Under State Code 23, wind farm developments should be appropriately located, sited, designed and operated to ensure that the development avoids, or minimises and mitigates, adverse impacts on ecological values.
- An **operational works development application** is required to be assessed against the State Code 16. Under State Code 16, operational work for the clearing of native vegetation should demonstrate that the development avoids impacts on vegetation that is a matter of state environmental significance, and where avoidance is not reasonably possible, minimises and mitigates impacts and provides an offset for any acceptable significant residual impacts where appropriate.

#### 2.2.1 Specialist studies

A number of specialist studies have been completed to support the planning application to DSDMIP. Specialist studies have included:

- a) Ecological assessment (this report)
- b) Preliminary bird and bat management plan (attached to this report)
- c) Preliminary vegetation and fauna management plan (attached to this report)
- d) Aviation impact assessment
- e) Electromagnetic interference impact assessment

- f) Road impact assessment and road use management plan and traffic management plan
- g) Stormwater report and an erosion and sediment control plan
- h) Visual impact assessment
- i) Noise impact assessment
- j) Shadow flicker assessment
- k) Draft construction environmental management plan.

## **2.3 CONSULTATION**

Two pre-referral meetings were held with the DAWE to discuss the Project Area which is the subject of this present report. These were conducted on 27 August 2020 and 4 December 2020.

Lotus Creek Wind Farm Pty Ltd met with DSDMIP and representatives from other Queensland State Government agencies on two occasions to receive pre-lodgement advice (25<sup>th</sup> May 2018 and 8<sup>th</sup> October 2019). Lotus Creek Wind Farm Pty Ltd has provided project updates to and has consulted with DSDMIP and other QLD government stakeholders and agencies at key junctures in 2020.

Lotus Creek Wind Farm Pty Ltd have community-focussed information about the Project available through the website <https://epuron.com.au/wind/lotus-creek/>. Lotus Creek Wind Farm Pty Ltd launched a community newsletter in December 2019 with an invitation to provide comment via a feedback form. Community updates have been provided via the website in March and October 2020. Community members can sign up to the mailing list via the website and can provide feedback via the online project feedback form.

Lotus Creek Wind Farm Pty Ltd is in ongoing consultation with the relevant Aboriginal groups for the project site and has consulted with the National Native Title Tribunal at key junctures.

## 3 METHOD

### 3.1 DESKTOP ASSESSMENT

A desktop assessment was first undertaken in March 2019, with the purpose of reviewing relevant environmental documents, databases, maps and legislation (Commonwealth, State and Local) to identify ecological values that may potentially occur within and surrounding the site. The assessment was based on the Site Boundary with a 10 km buffer (Table 3-1) and the results were used to inform the field survey methodology. The desktop assessment was repeated in December 2020. The following resources were reviewed:

- Commonwealth Department of the Environment and Energy Protected Matters Search Tool (PMST) (DAWE 2020d) to identify MNES. Search results from December 2020 are provided within Appendix A.
- Species Profiles and Threats Database (SPRAT) (DAWE 2020a).
- Queensland Department of Environment and Science (DES) WildNet database (DES 2020a) to identify flora and fauna species. The December 2020 search results are provided within Appendix A.
- DNRME Vegetation management regulated vegetation management (RVM), regional ecosystem (RE) and pre-clear regional ecosystem, watercourse and drainage features, wetlands and essential habitat mapping.
- Birddata records from BirdLife Australia Database (BirdLife Australia 2020).
- Atlas of Living Australia database (ALA 2020).
- Journal articles and other literature.
- Published ecological information on threatened flora and fauna species for adjoining areas of land (where possible/available).

The following documents were also reviewed:

- State Code 23: Wind farm development - Planning guideline (Department of Infrastructure, Local Government and Planning 2017)
- State Code 16: Native vegetation clearing – SDAP guidance material (DNRME 2020)
- *Lotus Creek Wind Farm Desktop Ecological Constraints Analysis* (NGH Environmental, 2019). Report prepared by NGH Environmental for Lotus Creek Wind Farm Pty Ltd.

Table 3-1 Desktop assessment search buffer area (using minimum bounding rectangle)

Resources type	Locations	Coordinates
DAWE EPBC Protected Matters Search Tool	North east corner	-22.237; 149.359
DES Wildlife Online records	North west corner	-22.333; 149.105
Atlas of Living Australia	South east corner	-22.515; 149.374
Birdata	South west corner	-22.483; 149.168

### 3.1.1 Likelihood of occurrence – threatened flora and fauna

Threatened flora and fauna species identified as potentially occurring within a 10 km buffer of the Site Boundary (WildNet<sup>1</sup> and/or the EPBC PMST<sup>2</sup>) were assessed for the likelihood that they occur within the Project Area, with the results presented in Appendix B.

The likelihood of occurrence is based on likely and known presence of habitat, proximity of nearest records and mobility of the species (where relevant). The assessment of potential impact is based on the nature of the proposal, the ecology of the species and its likelihood of occurrence.

#### **Likelihood of occurrence:**

- **High:** It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (i.e., for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10 km) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the study area during regular seasonal movements or migration.
- **Moderate:** Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however, may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (i.e., for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state.
- **Low:** It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (20 km). It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (i.e., for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area.

#### **Potential to be impacted:**

- **Low:** The proposal would not impact this species or its habitats.
- **Moderate:** The proposal could impact this species or its habitats however the impacts are considered manageable such that no direct or indirect impacts are likely.
- **High:** The proposal is likely to impact this species or its habitats.

The Project Area is absent of suitable habitat for intertidal waders and therefore wader bird species have not been included in the likelihood of occurrence assessment.

## 3.2 ECOLOGICAL SURVEYS

Ecological surveys involved the following:

- validation of literature review findings
- assessment and verification of the floristic structure and composition of the vegetation communities present
- description of fauna habitat present and recording incidental fauna sightings
- surveying for fauna using call recording devices, harp traps, camera traps, small mammal traps, spotlighting and active survey methods

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<sup>1</sup> WildNet is administered by the Qld DES and is an online database of fauna and flora records.

<sup>2</sup> This online tool is designed for the public to search for matters protected under the EPBC Act. It is managed by the Commonwealth DAWE.

- targeted searches for conservation-significant species (and associated habitat) that may potentially occur within the Project Area i.e., species listed under the EPBC Act and/or Queensland NC Act
- identification of weed species and documentation of vegetation disturbance
- bird utilisation surveys to assess operational impacts of the wind farm.

All surveys were conducted under a valid Animal Ethics licence (reference SA 2018/12/670) and Scientific Purposes Permit (number WA0014242).

### 3.2.1 Survey teams and survey timing

Three seasonal surveys were conducted in accordance with fauna survey guidelines (i.e., Eyre et al. 2019) (Table 3-2). The pre-wet survey timing was chosen to maximise opportunity to observe migratory birds such as White-throated Needletail, for which the mean date of the first sighting in Australia is 22 October (DAWE 2020a).

Table 3-2 Ecological survey timing and survey teams

Seasonal survey	Aspect	Survey team	Ecologists	Survey time (includes travel)
<i>Post wet</i> 31 April to 10 May 2019	Fauna	Senior Ecologist	Kelly Matthews (Green Tape Solutions; GTS)/ Aleksei Atkin (NGH)	11 days
		Ecologist	Jasmine Vink (GTS)	
	Bird utilisation	Senior Ecologist	Eamon O’Meara (Nature Advisory)	7 days
		Ecologist	Martin Kim (NGH)	
<i>Pre wet</i> 29 October to 14 November 2019	Flora	Senior Ecologist	Carla Perkins (GTS) Joe Adair (GTS)	10 days
	Fauna	Senior Ecologist	Aleksei Atkin (NGH)	14 days
		Ecologist	Jasmine Vink (GTS)/ Ben Revell (GTS)	
	Bird utilisation	Senior Ecologist	Eamon O’Meara (Nature Advisory)	8 days
		Ecologist	Natalie Sheppard (NGH)	
	<i>Pre wet</i> 21 September to 27 September 2020	Fauna and flora	Senior Ecologist	Carissa Free (NGH)
Principal Ecologist			Kelly Mathews (GTS)	
Ecologist			Jasmine Vink (GTS)	
Ecologist			Leaf Black (GTS)	

### 3.2.2 Survey conditions

Wet conditions were experienced for much of the post wet surveys in 2019 due to rainfall associated with Cyclone Ann off the Queensland northeast coast. Daily maximum temperatures were around 27°C. Mean minimum temperatures for May were 16.2°C. The post wet May survey was undertaken following good rain in the survey area.



Weather conditions for the pre wet surveys in 2019 were mostly fine, hot and sunny throughout, with a daily maximum temperature around 30°C during November. Mean minimum temperature for November was 19.8°C (Bureau of Meteorology 2019 – St Laurence Observations). Actual temperatures over the survey area were both warmer (max to 36°C) and cooler (min to 14°C) due to the increase in elevation from the St Laurence weather station on the coast. East/south east winds prevailed throughout the pre-wet surveys, varying from almost calm to a fresh breeze. Rainfall was very low. A few drops of rain were experienced in the afternoon during one or two surveys in November but had no impact on viewing conditions.

The November 2019 survey was conducted during a period of extended dry conditions over eastern Australia, with January 2017 to December 2019 being the driest on record for any 36-month period (BOM 2020). The survey conditions for both seasonal surveys met the Eyre et al. (2019) survey guidelines requirement for this location.

The weather conditions during the 2020 September pre wet surveys were mostly fine and warm. Maximum daily temperatures during the surveys ranged from 26.2°C to 34.3°C and daily minimum temperatures ranged from 14.6°C to 22.1°C. Several minor storms occurred on the 24<sup>th</sup> which brought moderate-heavy rain in the evening and overnight. Light showers continued in the morning on the 25<sup>th</sup>. St Laurence Post Office (BoM Station ID 33210) recorded 5.6 mm on 24<sup>th</sup> and 9.9 mm on the 25<sup>th</sup> September.

### 3.2.3 Survey sites

Survey sites were selected to include the range of habitat types and dominant REs available within the Project Area. A range of survey methods were undertaken to identify which species and species groups are likely to utilize the project area and identify ecological sensitive areas and species. A full list of the survey locations can be found in Appendix B. A summary of the number of survey sites undertaken can be found in Table 3-3.

Table 3-3 A summary of the number of survey sites undertaken from 2019-2020.

Survey type	2019	2020
Rapid assessment (flora observation)	34	0
Quaternary surveys	16	38
Harp surveys	17	0
Camera trap sites	21	8
BUS sites	12	
Active searches	10	
Anabat surveys	14	4
Koala SAT surveys	0	20

### 3.2.4 Flora species and vegetation community survey

Based on the results of the desktop assessment, indicative flora survey sites were selected across the Project Area, taking into consideration the mapped boundaries of remnant/non-remnant vegetation status and regional ecosystems, as identified by the State mapping. Where accessible, quaternary surveys were undertaken at indicative flora survey sites, in accordance with the *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Neldner et al. 2019).

Quaternary surveys are intended to provide a rapid means of assessing vegetation structure, floristic composition and status, with the following information collected for each site:

- vegetation structure (height range, median height, estimated cover for each stratum, Specht structural formation) and floristic composition (dominant and common native species within each stratum)
- vegetation status i.e., remnant or regrowth and RE classification
- brief condition assessment, including assessment of disturbance factors
- recorded fauna habitat and other ecological features and signs of fauna presence
- presence of weed species.

The purpose of these surveys was to assess the location, extent and condition of vegetation across the Project Area according to the Queensland regional ecosystem framework and criteria for threatened ecological communities (TECs) listed under the EPBC Act, where applicable.

Vegetation surveys were undertaken either on foot, through remote visual inspection (e.g., by vehicle traverses and/or using binoculars), or by using a drone (DJI Phantom 3 and DJI Phantom 4). Drone inspections were only undertaken for areas that were inaccessible on foot. Figure 3-1 illustrates the location of the flora quaternary survey points and rapid assessment/photo points. Vegetation mapping was then undertaken based on the results of vegetation surveys, drone imagery and aerial photo interpretation of high-resolution orthophotos (DNRME 2019).

Threatened species searches were undertaken using the random meander technique, which involved traversing accessible areas of suitable habitat in a non-standardised manner or through recording of incidental sightings. Where certain identification of potential threatened flora species was not able to be made, samples have been submitted to the Queensland herbarium to confirm identification.

### 3.2.5 Fauna species and habitat survey

Fauna surveys were undertaken at each location identified in Figure 3-1. Field survey timing, techniques and survey effort were undertaken in accordance with the following guidelines:

- EPBC Act survey guidelines for Australia's threatened reptiles (DSEWPC 2011)
- EPBC Act survey guidelines for Australia's threatened birds (DEWHA 2010b)
- EPBC Act survey guidelines for Australia's threatened bats (DEWHA 2010a)
- EPBC Act survey guidelines for Australia's threatened mammals (DSEWPC 2011)
- EPBC Act referral guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) (DAWE 2014)
- Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (Eyre et al. 2019).

The following fauna surveys were undertaken within the Project Area:

- **Active searches** were undertaken to target potentially occurring threatened reptiles within the Project Area. Searches were focussed around preferential habitat for these species and key habitat features, such as dense leaf litter and fallen woody debris, rocky areas and crevices, hollow logs and burrows. These searches included identifying potential breeding and foraging habitat for these species. Active searches included:
  - diurnal searches for sheltering or basking reptiles
  - lifting 1,000 rock, log features and debris rolling and raking per seasonal survey
  - spotlight surveys for nocturnally active species.

Active searches were undertaken by a team of two for a 30-minute period within each fauna habitat site with a total survey effort of 25 hours.

- **Diurnal bird surveys** to target threatened and migratory bird species were conducted within each 2 ha fauna search sites by two observers for 20 minutes. for a total of one hour of bird survey per day in 2019. This results in a total survey effort of 150 hours for all surveys. The survey involved the observer slowly walking through the site, taking a different path on each occasion. Opportunistic records were also taken during the entire fauna survey period, with flora, fauna and BUS teams recording incidental sightings.
- **Small mammal trapping.** Small mammals were targeted using Sherman traps. These are a box design trap with a trigger plate that is triggered by the weight of the mammal. These traps were baited using ‘universal bait’ which is a mixture of peanut butter, oats and honey. 40 traps were deployed each night and checked for mammals each morning before being re-set in the late afternoon. Traps were left in the same area for a minimum of two nights to increase the chances of success.
- **Spotlighting** for nocturnally active mammals, as well as birds and herpetofauna, were undertaken by two persons for a minimum of one hour at each of the fauna habitat sites. Surveys commenced one hour after dusk and involved searching potential habitat on foot or from a vehicle. Areas with hollow bearing trees were targeted to detect arboreal mammals, forest owls and bats emerging from diurnal roosts to forage. Spotlighting was also undertaken along walking and vehicle tracks, as this is a species-specific technique for detecting threatened species.

Spotlighting was undertaken every survey night over the three survey periods with a total of 148 survey hours. This results in an area of approximately 89.1 km being covered through the combined effort of the spotlighting transects.

- **Bat detection.** Acoustic bat detection devices were used to determine the presence/absence and species composition of bats within the Site Boundary. Five Anabat Swift devices were deployed in 2019 and four devices in 2020 across each survey site in suitable flyways within different habitats. Devices were set before dusk and retrieved at the end of the survey period. A total of 208 trap nights were conducted across the three survey periods.

Four harp traps were also set up at a different location every night during both seasonal surveys.

- **Camera trapping.** A total of 228 camera trap nights were conducted using motion sensitive camera traps across the three survey periods. These cameras were baited with a combination of peanut butter and carnivore attractant (sardines, mince or tuna). The camera traps were rebaited where possible throughout the survey period to increase their attractiveness to fauna.
- **Koala Spot Assessment Technique (SAT)** (Phillips and Callaghan 2011) provides an indication of how frequently an area of habitat is utilised by Koalas, giving a measure of Koala activity and habitat importance. This technique was utilised to assess potential presence of Koalas. The technique involves identifying a centre tree as per the following criteria (in decreasing priority):
  - a tree of any species where one or more Koala faecal pellets have been observed; and/or
  - a tree in which a Koala has been observed; and/or,
  - any other tree known or considered to be potentially important for Koalas.

Two observers walked along transects located within suitable Koala habitat looking out for Koalas or evidence of Koalas (centre tree). When a centre tree was identified, 30 surrounding trees were sampled (trees = >100 mm DBH) by undertaking a systematic search for faecal pellets. A SAT score was assigned based on the percentage of trees identified as having evidence of Koalas (e.g. number of trees containing evidence = 15 / 30 =50%).

### **3.2.5.1 Habitat assessments**

Habitat assessments were undertaken across the range of habitats within the Site Boundary. Habitat assessments aimed to characterise the habitat values within each habitat type. At each habitat assessment location the following was recorded:

- abundance of hollows (small, medium and large)
- abundance of logs
- abundance of leaf litter and debris
- abundance of rocks (including boulders and rock piles)
- abundance of food resources (nectar, seeding grasses and fruiting plants)
- abundance of peeling bark
- abundance of dense grass and shrub shelter
- abundance of arboreal and terrestrial termite mounds
- presence of water
- presence of cracking clays
- presence of burrows, basking areas and rock crevices
- presence of scats, bones, nests, tracks or other signs of fauna.

Figure 3-1 Ecological survey sites (north and south)





### 3.2.5.2 Fauna survey effort (excludes BUS surveys)

Field fauna surveys were conducted by two ecologists for each of the post-wet and pre-wet surveys. The first post-wet survey was conducted from 30 April to 10 May 2019 over 11 days. The first pre-wet survey was undertaken from 29 October to 14 November 2019 over 16 days. The second pre wet survey was undertaken from 22 September to 26 September (5 days) by four ecologists (Table 3-2).

A total of 74 field days was conducted for the fauna surveys (Table 3-4). This included active searches for targeted fauna for 220 person hours, harp traps each night for 88 nights, Elliot traps each night for 880 nights, diurnal bird surveys for 150 person hours and spotlighting for 148 person hours. Nineteen remote sensing cameras were deployed for 228 nights and Anabat ultrasonic bat detectors were deployed for 208 nights. Survey effort (Table 3-5) was targeted towards threatened fauna species considered likely to occur (Appendix B).

Table 3-4 Survey time for fauna surveys

Item	Total
Harp traps	88 nights
Elliot traps	880 nights
Bird survey	150 hours
Spotlighting 2019	88 hours
Spotlighting 2020	60 hours
Cameras	228 nights
Bat recorders	208 nights
Active searches	220 hours

Table 3-5 Survey effort for EPBC and NC Act listed threatened fauna species that are considered moderate to high likelihood of occurring

Species name	Common name	Survey method	Survey effort
<b>Birds</b>			
<i>Erythroriorchis radiatus</i>	Red Goshawk	<ul style="list-style-type: none"> <li>Diurnal bird surveys (DEWHA, 2010b)</li> </ul>	<ul style="list-style-type: none"> <li>150 hours of bird survey</li> </ul>
<i>Calyptorhynchus lathami erebus</i>	Glossy Black-cockatoo	<ul style="list-style-type: none"> <li>Diurnal bird surveys (Hourigan 2012)</li> <li>Incidental searches for feeding signs</li> </ul>	<ul style="list-style-type: none"> <li>150 hours of bird survey</li> <li>Incidental</li> </ul>
<i>Falco hypoleucos</i>	Grey Falcon	<ul style="list-style-type: none"> <li>Diurnal bird surveys (DEWHA, 2010b)</li> </ul>	<ul style="list-style-type: none"> <li>150 hours of bird survey</li> </ul>
<i>Geophaps scripta scripta</i>	Squatter pigeon (southern)	<ul style="list-style-type: none"> <li>Diurnal bird surveys (DEWHA, 2010b)</li> </ul>	<ul style="list-style-type: none"> <li>150 hours of bird survey</li> </ul>
<i>Hirundapus caudacutus</i>	White-throated Needletail	<ul style="list-style-type: none"> <li>Diurnal bird surveys (DEWHA, 2010b)</li> </ul>	<ul style="list-style-type: none"> <li>150 hours of bird survey</li> </ul>
<i>Ninox strenua</i>	Powerful Owl	<ul style="list-style-type: none"> <li>No state guideline available.</li> <li>Nocturnal listening for calls (Birdlife Australia, 2020)</li> </ul>	<ul style="list-style-type: none"> <li>150 hours of bird survey</li> </ul>

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Species name	Common name	Survey method	Survey effort
<i>Poephila cincta cincta</i>	Southern Black-throated Finch	<ul style="list-style-type: none"> <li>• Diurnal bird surveys (DEWHA, 2010b)</li> </ul>	<ul style="list-style-type: none"> <li>• 150 hours of bird survey</li> </ul>
<i>Rostratula australis</i>	Australian Painted Snipe	<ul style="list-style-type: none"> <li>• Diurnal bird surveys (DEWHA, 2010b)</li> <li>• Specific searches in and around water.</li> </ul>	<ul style="list-style-type: none"> <li>• 150 hours of bird survey</li> </ul>
Other migratory birds		<ul style="list-style-type: none"> <li>• Diurnal bird surveys (DEWHA, 2010b)</li> <li>• Specific searches in and around water.</li> </ul>	<ul style="list-style-type: none"> <li>• 150 hours of bird survey</li> </ul>
<b>Mammals</b>			
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	<ul style="list-style-type: none"> <li>• Harp trapping; and</li> <li>• Bat detection devices (DEWHA, 2010a)</li> </ul>	<ul style="list-style-type: none"> <li>• 88 nights of trapping</li> <li>• 208 nights of call recording.</li> </ul>
<i>Dasyurus hallucatus</i>	Northern Quoll	<ul style="list-style-type: none"> <li>• Spotlighting in suitable habitat; and camera trapping</li> </ul>	<ul style="list-style-type: none"> <li>• 228 nights of camera trapping</li> <li>• 148 hrs of spotlighting.</li> </ul>
<i>Macroderma gigas</i>	Ghost Bat	<ul style="list-style-type: none"> <li>• Spotlighting; and</li> <li>• Bat detection devices (DEWHA, 2010a)</li> </ul>	<ul style="list-style-type: none"> <li>• 88 nights of trapping</li> <li>• 208 nights of call recording</li> </ul>
<i>Nyctophilis corbeni</i>	Corbens Long-eared Bat	<ul style="list-style-type: none"> <li>• Harp trapping; and</li> <li>• Bat detection devices (DEWHA, 2010a)</li> </ul>	<ul style="list-style-type: none"> <li>• 88 nights of trapping</li> <li>• 208 nights of call recording.</li> </ul>
<i>Petauroides volans</i>	Greater Glider	<ul style="list-style-type: none"> <li>• Spotlighting in suitable habitat.</li> </ul>	<ul style="list-style-type: none"> <li>• 148 hrs of spotlighting</li> </ul>
<i>Phascolarctos cinereus</i>	Koala (combined populations of QLD, NSW and ACT)	<ul style="list-style-type: none"> <li>• Koala Spot Assessment (Phillips &amp; Callaghan 2011)</li> <li>• Spotlighting</li> </ul>	<ul style="list-style-type: none"> <li>• 20 SPOT assessments</li> <li>• 148 hrs of spotlighting</li> </ul>
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	<ul style="list-style-type: none"> <li>• Spotlighting</li> </ul>	<ul style="list-style-type: none"> <li>• 148 hrs of spotlighting</li> </ul>
<b>Reptiles</b>			
<i>Denisonia maculata</i>	Ornamental Snake	<ul style="list-style-type: none"> <li>• Driving roads at night during spotlighting activities.</li> </ul>	<ul style="list-style-type: none"> <li>• 148 hours of spotlighting</li> <li>• 220 hours of active search</li> </ul>
<i>Egernia rugosa</i>	Yakka Skink	<ul style="list-style-type: none"> <li>• Active search</li> <li>• Spotlighting</li> </ul>	<ul style="list-style-type: none"> <li>• 220 hours of active search</li> <li>• 880 Elliot trap nights</li> </ul>
<i>Delma torquata</i>	Collared Delma	<ul style="list-style-type: none"> <li>• Active search</li> </ul>	<ul style="list-style-type: none"> <li>• 220 hours of active search</li> </ul>

### **3.2.6 Identifying habitat for threatened species**

Ecological surveys were undertaken in accordance with relevant guidelines (Section 3.2.5) and habitat for threatened species was identified on the basis of:

- field survey results
- drone footage
- aerial imagery interpretation
- literature review, including SPRAT resources as well as State-mapped vegetation and essential habitat.

Habitat descriptions and the method which these were applied to Lotus Creek Wind Farm are presented in Table 3-6.

Table 3-6 Method to identify habitat for threatened fauna species

MNES habitat	Habitat description (from DAWE 2020a)	Method
Koala	Any forest or woodland (including remnant, regrowth and modified vegetation communities) containing species that are Koala food trees or any shrubland with emergent Koala food trees.	<p>All Eucalyptus or Corymbia dominated remnant or high value regrowth regional ecosystems included. Non-remnant vegetation included where surrounded by remnant vegetation.</p> <p>Habitat includes:</p> <ul style="list-style-type: none"> <li>• Vegetation community 1 (<i>E. crebra</i> woodland) with RE 11.12.1 and RE 11.12.13</li> <li>• Vegetation Community 2 (Riparian vegetation) with RE 11.3.25</li> <li>• Vegetation Community 3 (Mixed eucalypt communities) with RE 8.12.32, RE 8.12.7, RE 8.12.9, RE 11.12.6 and RE 8.12.23</li> <li>• Vegetation community 5 (Wetland/alluvial plain communities with RE 8.12.9.</li> </ul>
Greater Glider	All areas of Eucalypt forests or woodlands that contain hollow-bearing trees.	<p>Low value habitat - Vegetation Community 1 (<i>E. crebra</i> woodland), Vegetation Community 4 (SEVT) and non-remnant vegetation, except within a 100 m buffer to Vegetation Community 3.</p> <p>Moderate value habitat - Areas within a 100 m buffer of Vegetation Community 3 (mixed eucalypt open forest), to account for potential foraging by Greater Glider outside their preferred habitat (i.e., into Vegetation Community 1). Buffers on community 3 which intersect with SEVT were excluded as moderate habitat.</p> <p>High value habitat - Vegetation Community 2 (riparian), Vegetation Community 3 and Vegetation Community 5 (wetland/alluvial plain). Riparian areas have been included as 'high' habitat value due to the potential for hollow bearing trees along waterways.</p> <p>The species present and vegetation condition in 'high' habitat value areas represent preferred Greater Glider habitat. Much of the 'high' habitat value area is within the Clarke-Connors Range, which is recognised (Melzer et al. 2018) as a significant refugia for biodiversity. Much of this area has been avoided by the Development Footprint.</p> <p>Very high value habitat - Within Vegetation Community 3, the 'very high' habitat value is derived from the large numbers of Greater Glider records during ecological surveys (see Ecological Assessment Report; NGH 2020a).</p>
Squatter Pigeon (Southern)	Any remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by <i>Eucalyptus</i> , <i>Corymbia</i> , <i>Acacia</i> or <i>Callitris</i> species, on sandy or gravelly soils (mapped as Queensland land zones 3, 5 or 7) and within 1 kilometre of a suitable, permanent or seasonal waterbody.	All waterways (including SO1 and above) were buffered by 100 m, regardless of whether or not they were vegetated. This approach considers the fact that 97% of Squatter Pigeon records on site were found within approximately 100 m of a waterway, with one record between two waterways (200 m distance). Many were found in Category X vegetation (non-remnant). Landzone 1 was excluded.

### 3.2.7 Bird utilisation surveys

The surveys were consistent with the requirements for a “Level One” bird risk assessment in accordance with ‘Wind Farms and Birds - Interim Standards for Risk Assessment’ issued by the Australian Wind Energy Association (AUSWIND 2005). This approach has been endorsed in the latest Best Practice Guidelines (Clean Energy Australia 2018). The methodology conforms with Queensland State Code 23 relating to wind farm development (DILGP 2017).

Survey sites were selected according to whether they were located on a ridge top or spur and offered a minimum 270-degree viewing, out to 80 m. In some cases, the terrain made this impossible, so the viewing arc was therefore more restricted. Habitat at the survey sites covered both reasonably intact grassy woodland and some mostly cleared sites on ridges and spurs. Habitat data was recorded for each site. Each of the survey points was at least 500 m apart from each other. Survey points were accessed by vehicle as well as on foot, and birds were recorded using binoculars. The sites are shown in Figure 3-1.

The following techniques were used to document bird species at each of the survey sites:

- A complete fix-point bird count of all birds seen and heard in a 20-minute period, from a central point out 80 m and record of the height at which each bird or group of birds (flock) was first seen.
- This involved an observer stationed at a survey point for 20 minutes. The adequacy of using 20 minutes as an interval to record the presence of birds during BUS was investigated in an earlier study at another wind farm site (Nature Advisory Pty. Ltd. unpublished data). This showed that 82 to 100 percent (average 88 percent) of species seen in one hour of surveying were in fact seen in the initial 20 minutes of observation. Based on this result, the period of 20 minutes used in the formal bird utilisation surveys was considered adequate to generate representative data on the bird species in the area during the survey.
- During this period, all bird species and numbers of individual birds observed within 80 m were recorded. The species, the number of birds and the height of the bird when first observed were documented. For species of concern (threatened species, waterbirds and raptors), the minimum and maximum heights were recorded.
- Flight height is presented as below, at or above rotor swept area height (RSA height):
  - A = Below RSA (< 40 m above ground)
  - B = At RSA (40 – 250 m above ground)
  - C = Above RSA (> 250 m above ground).

Each of the points were surveyed eight times (8 replicates) twice each at each of four different times of day. In May, accounting for the sun rising later, surveys were conducted in the morning (9am to 11am), midday (11am to 1pm), early afternoon (1pm to 3pm) and late afternoon (3pm to 5pm). In November, accounting for the sun rising earlier, surveys were conducted in early morning (7 to 9am), late morning (9am to 11am), midday (11am to 1pm) and early afternoon (1pm to 3pm). This ensured even, unbiased coverage of bird activity at each site throughout the day, over the duration of the survey. Additional detail on the methods used for the BUS are in Appendix G.

Table 3-7 BUS survey point schedule

Date/time	09:00-11:00	11:00-13:00	13:00-15:00	15:00-17:00
7-May	3,4,3,4	3,4,3,4	3,4,3,4	3,4,3,4
8-May	5,6,5,6	5,6,5,6	5,6,5,6	5,6,5,6
9-May	7,8,7,8	7,8,7,8	7,8,7,8	7,8,7,8

Date/time	09:00-11:00	11:00-13:00	13:00-15:00	15:00-17:00
10-May	1,2,1,2	1,2,1,2	1,2,1,2	1,2,1,2
Date/time	07:00-9:00	09:00-11:00	11:00-13:00	13:00-15:00
03-Nov	3,4,3,4	3,4,3,4	3,4,3,4	3,4,3,4
04-Nov	9,10,9,10	9,10,9,10	9,10,9,10	9,10,9,10
05-Nov	5,6,5,6	5,6,5,6	5,6,5,6	5,6,5,6
06-Nov	11,12,11,12	11,12,11,12	11,12,11,12	11,12,11,12
07-Nov	7,8,7,8	7,8,7,8	7,8,7,8	7,8,7,8
08-Nov	1,2,1,2	1,2,1,2	1,2,1,2	1,2,1,2

### 3.2.8 Survey limitations

The ability to detect plants and accurately identify them to species level can vary greatly with season, prevailing climatic conditions and the presence of reproductive material (e.g. flowers, fruit and seed capsules). The surveys undertaken as part of this assessment represent a ‘snapshot’ in time and therefore may not provide a true indication of the presence of any given species. For example, some cryptic flora species may only be detected when flowering in conditions that were not present during the current survey. As a result, this survey should not be regarded as conclusive evidence that threatened flora species do not occur at the site. However, every effort was made to detect likely species in their preferred habitat areas and the likely threatened flora species (*Cycas spp.*) are not cryptic.

We have taken a precautionary approach and assumed a species is present unless good reason exists to preclude its use of the site. Information on the ecology and flight paths (for bird and bat species), as well as movement patterns are not available for some species and in this instance, specific impacts cannot be quantified. Additionally, several further species-specific surveys are proposed to confirm the assumptions of this assessment and to make any necessary changes to the Project design, if required, to ensure that impacts are kept below key thresholds.

Night survey work was targeted toward vegetated areas that were safely accessible. Due to the terrain and the target species, most of the spotlighting surveys were conducted from vehicles on tracks that were deemed safe for night driving (not all tracks were considered safe to traverse in the dark).

Not all areas within the proposed development footprint were able to be easily or efficiently accessed for vegetation surveys (either on foot or by vehicle) due mostly to the steepness of the terrain or lack of any existing access tracks in the vicinity of proposed wind farm infrastructure. In these areas, inspection from nearby accessible vantage points utilising high-powered binoculars or drone were used to confirm vegetation types, however some areas were not able to be inspected by drone due to limitations on flight distance. Vegetation status and condition for these areas was extrapolated from other known areas of similar vegetation that had been surveyed in detail.

The field surveys were undertaken in Autumn and followed a relatively low-rainfall wet season. The second survey (pre-wet 2019) took place in Spring after some light rain events across the region. The site had still received less rainfall than is usual at that time of year and consequently there was very little vegetation

flowering and all ephemeral waterways were dry. It was expected that additional fauna would be found on site after a rain event including amphibians, reptiles, bats and birds.

Many species of avifauna and bats are migratory and are only encountered during periods of migration between northern and southern regions during different times of the year. Some species that may utilize the Project Area may not have been present during the survey periods. A precautionary approach has been taken for those migratory species that were not recorded but were likely to be recorded if surveys coincided with their migration through the area.

Four nights of spotlighting in the spring survey were undertaken during a full moon period. The brightness of the moon resulted in a noticeable decrease in fauna sightings and trapping success during this time. Spotlighting survey results within this area of the site may not be representative of the full assemblage of nocturnal species present.

## 4 RESULTS

### 4.1 PROJECT ENVIRONMENT

#### 4.1.1 Existing land use

The dominant land use is cattle grazing while a small area on the northern part of the ridge top is reserved for telecommunication towers. Surrounding properties are a mixture of mostly cleared land for raising cattle, and state forest supporting intact native vegetation to the north of the Site Boundary.

#### 4.1.2 Landforms, geology and soils

The Project Area lies within the Brigalow Belt bioregion, which falls within the Fitzroy Catchment and the Isaac Connors sub catchment in the Isaac Regional Council Local Government Area, Central Queensland.

The Brigalow Belt bioregion is a wide band of acacia wooded grassland that runs between tropical rainforest of the coast and semi-arid interior of Queensland. The Brigalow Belt is characterised by the presence of brigalow (*Acacia harpophylla* vegetation) (Thackway & Creswell 1995). Nebo-Connors Range is adjacent to the eastern portion of the Project Area.

The Project Area is located on the eastern edge of the Fitzroy catchment. The Fitzroy catchment is the largest river catchment flowing to the eastern coast of Australia and the second largest catchment in Australia. The Fitzroy river flow is highly episodic with seasonal bias to high flows in summer. The catchment has recognised land degradation problems, including all forms of soil erosion by water, and soil fertility decline. The Fitzroy catchment is a managed water plan area, where water use is subject to the Fitzroy Basin Water Plan controls (FBA 2019).

The Isaac Region runs from Clairview and St Lawrence on the coast, westward past the settlement of Clermont and extends just beyond the Carmichael River. The shire is sparsely populated and supports an agricultural industry of beef production and cropping. Coal mining and resource operations are also major industries in the region (Isaac Regional Council 2019).

The majority of the Project Area falls within the Connors Volcanic Group, made up of felsic to mafic volcanic rocks; rhyolitic to andesitic flows, high-level intrusive, and volcanoclastic rocks including ignimbrite (Geological Society of Australia Inc. 2019).

The Project Area comprises of three dominant soil types (Atlas of Australian Soils Queensland, DES 2018):

1. In the eastern portion of the site, in sections that are elevated, strongly undulating or occasionally low hilly lands often bounded by steep dissected scarps, the soil type is duplex yellow-grey, hard setting A horizon, A2 horizon conspic bleached acid pedal mottled B horizon.
2. In the center of the site, in sections that are hilly with steep slopes the soil type is duplex yellow-grey, hard setting A horizon, A2 horizon conspic bleached, neut pedal mottled B horizon.
3. In the western portion of the site, in sections that are high hilly lands but with rounded hill crests and only moderately steep slopes the soil type is firm shallow siliceous loams.

#### 4.1.3 Wetlands and waterways

The Project Area is located on the eastern edge of the Fitzroy catchment. The Fitzroy catchment is the largest river catchment flowing to the eastern coast of Australia and the second largest catchment in Australia. The Fitzroy river flow is highly episodic with seasonal bias to high flows in summer. The catchment has recognised land degradation problems, including all forms of soil erosion by water, and soil fertility decline. The Fitzroy



catchment is a managed water plan area, where water use is subject to the Fitzroy Basin Water Plan controls (FBA 2019).

Lotus Creek is a stream order five waterway and runs north-south across the eastern portion of the site. Water features within the site are illustrated in Figure 4-4. There is a series of stream orders one, two and three across the site, including within the development footprint. Waterways were a mixture of creeks with a soft substrate bottom, and rocky gullies with distinct water holes and densely vegetated riparian vegetation. A number of farm dams occur on the site (Plate 4-1).

The majority of the lower stream order watercourses were not running or were holding stagnant water at the time of the pre-wet surveys (November 2019 and 2020). During the post-wet survey (May 2019), many of the smaller waterways had standing (not stagnant) water or were gently flowing.



Plate 4-1 Water features, including a farm dam (left) and waterway (right, with harp traps)

#### **4.1.4 Climate**

The Project Area is within the Hot Humid Summer climate zone, with hot to warm temperatures all year round. Climate in the region is sub-tropical to tropical, with a distinct wet season. The average daily maximum temperature in the region is 27-30 degrees centigrade. Winter nights can occasionally drop below freezing; however, winters are usually warm and dry, with pleasant sunny days. Summers are hot and humid, with most rain falling with occasional thunderstorms. Average annual rainfall is 600-1000 millimetres, mostly falling between January and March (BOM 2019).

## **4.2 VEGETATION COMMUNITIES**

The vegetation communities reflect the location of the Project site adjacent to the Nebo-Connors Range in the Brigalow Belt Bioregion (11).

The Project Area supports the following vegetation communities:

- cleared grassland dominated by perennial pasture and native grass species with sparsely scattered Eucalypts
- narrow-leaved ironbark (*Eucalyptus crebra*) woodland to open woodland with small areas dominated by silver-leaved ironbark (*E. melanophloia*). Associated species within this community include bloodwood species (*Corymbia* spp. including *C. erythrophloia* and *C. intermedia*) and white mahogany (*E. acmenoides*)
- spotted gum (*Corymbia citriodora*) woodland to open forest. Associated species include narrow-leaved ironbark (*E. crebra*) and white mahogany (*E. portuensis*)
- mixed Eucalypt open forest dominated by a range of Eucalypt and bloodwood species (including pink bloodwood *E. intermedia*, brown bloodwood *E. trachyphloia*, white mahogany *E. portuensis* and Queensland peppermint *E. exserta*)
- Queensland blue gum (*E. tereticornis*) woodland to open forest. Associated species include narrow-leaved ironbark (*E. crebra*), poplar gum (*E. platyphylla*), carbeen (*E. tessellaris*), pink bloodwood (*C. intermedia*) and swamp box (*Lophostemon suaveolens*)
- grassland dominated by blady grass (*Imperata cylindrica*) on drainage channels associated with Queensland blue gum woodland in upland areas
- Queensland blue gum (*E. tereticornis*), river she-oak (*Casuarina cunninghamiana*) and tea-tree (*Melaleuca* spp.) woodland fringing drainage lines
- small patches of gum-topped box (*E. moluccana*) woodland
- small patches of deciduous to semi-evergreen vine thicket dominated by broad-leaved bottletree (*Brachychiton australis*) and semi-evergreen vine thicket.

#### 4.2.1 Summary of state regulated vegetation mapping

A review of the regulatory vegetation maps established under the *Vegetation Management Act 1999* (VM Act) identifies the presence of regulated vegetation. In total, 39 REs or RE associations (i.e. REs consisting of a mix of dominant and co-dominant REs) are mapped within the Site Boundary (noting that not all of these may actually occur within the development footprint itself). These REs are identified in Table 4-1 below, including their short description and VM Act status. The distribution of the state mapped REs across the Project Area is shown in Figure 4-1.

Table 4-1 Mapped Regional Ecosystems under the VM Act

Regional ecosystem	Short description	VM Act Status	BD Status (Qld)	EPBC TEC
11.12.1	<i>Eucalyptus crebra</i> woodland on igneous rocks.	LC	NC	No
HVR 11.12.1	<i>Eucalyptus crebra</i> woodland on igneous rocks.	LC	NC	No
HVR 11.12.2	<i>Eucalyptus melanophloia</i> woodland on igneous rocks	LC	NC	No
11.12.2	<i>Eucalyptus melanophloia</i> woodland on igneous rocks	LC	NC	No
11.12.4	Semi-evergreen vine thicket and microphyll vine forest on igneous rocks	LC	NC	No

Regional ecosystem	Short description	VM Act Status	BD Status (Qld)	EPBC TEC
11.3.25	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines	LC	OC	No
HVR 11.3.25	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines	LC	OC	No
11.12.6a	<i>Corymbia citriodora</i> open forest on igneous rocks (granite)	LC	NC	No
11.3.4	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus</i> spp. woodland on alluvial plains	OC	OC	No
HVR 11.3.4	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus</i> spp. woodland on alluvial plains	OC	OC	No
8.12.7a	<i>Corymbia citriodora</i> +/- <i>Eucalyptus portuensis</i> +/- <i>E. drepanophylla</i> (or <i>E. crebra</i> ) open forest on hill slopes and undulating plateaus, on Mesozoic to Proterozoic igneous rocks	LC	NC	No
11.12.13	<i>Eucalyptus crebra</i> , <i>Corymbia</i> spp., <i>E. acmenoides</i> woodland on igneous rocks. Coastal hills	LC	NC	No
8.12.32	<i>Corymbia intermedia</i> +/- <i>E. portuensis</i> +/- <i>E. exserta</i> open forest to woodland with areas of <i>Allocasuarina</i> spp. +/- <i>Banksia integrifolia</i> open forest on high ranges, on Mesozoic to Proterozoic igneous rocks	LC	NC	No
8.12.9	<i>Eucalyptus tereticornis</i> +/- <i>Corymbia intermedia</i> +/- <i>Lophostemon suaveolens</i> woodland on undulating uplands, on Mesozoic to Proterozoic igneous rocks	LC	OC	NO
8.12.23	<i>Eucalyptus moluccana</i> woodland on elevated tablelands on Mesozoic to Proterozoic igneous rocks	OC	OC	NO
8.3.14	<i>Ischaemum australe</i> and/or <i>Imperata cylindrica</i> and/or <i>Sorghum nitidum forma aristatum</i> tussock grassland on drainage channels in gently undulating upland areas	OC	E	NO

VM Act Status: LC – Least Concern; OC – Of Concern. BD Status (biodiversity status) Qld: NC – No Concern at Present; OC – Of Concern; E – Endangered.

Figure 4-1 State-mapped regional ecosystems

## **4.2.2 Ground-truthed regional ecosystems**

Five main vegetation communities were found to be present within the Site Boundary. These vegetation communities are described as:

- Vegetation Community 1: *Eucalyptus crebra* Woodland to Open Woodland
- Vegetation Community 2: Riparian Vegetation
- Vegetation Community 3: Mixed Eucalypt Open Forest communities
- Vegetation Community 4: Semi-Evergreen Vine Thicket (SEVT)
- Vegetation Community 5: Wetland/Alluvial Plains.

These communities are discussed below. Table 4-2 shows the regional ecosystem/s recorded at each quaternary survey location as they are currently mapped (DNRME 2019) and compared to the ground-truthed results.

Figure 4-2 shows the location of each of the ground-truthed vegetation communities. The vegetation communities across the site and outside of the Project Area were confirmed using either drone or high-resolution aerial imagery. Where field-based validation was not possible, the state RE mapping was used to contribute to the overall understanding of vegetation across the entire Site Boundary.

In general, there were no significant differences between the State-mapped and ground-truthed vegetation communities across the Project Area, which gives confidence that this is likely be the base more broadly across the site and the surrounding area.

Habitat condition within the Project Area was variable due to different soil types, disturbance histories, and land management. Habitat condition impacts the availability of micro-habitat resources, such as hollow-bearing trees, and habitat extent and connectivity to other areas. Generally, habitat quality was higher in the eastern portion of the proposed area, and more degraded in the western portion. Areas where habitat types intersect, providing ecotones, on western slopes, gullies, and in riparian vegetation communities, provided the highest quality habitat.

Table 4-2 State-mapped vegetation communities compared with ground-truthed results

Quaternary site	Mapped RE	Results of field survey		VM status (ground-truthed REs)
		Ground-truthed RE/drone & aerial interpretation	Vegetation community	
<b>Spring 2019 survey</b>				
Q1	11.12.1 - Remnant	11.12.1 – Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q2	11.12.2 / 11.12.1 - Remnant	11.3.25 – Remnant	Riparian Vegetation	Least concern
Q3	11.12.2 / 11.12.13 - Remnant	11.12.1 – Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q4	11.12.2 - Remnant	11.12.1 – Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q5	11.12.6a - Remnant	11.12.6a – Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q6	11.12.6a - Remnant	8.12.16 – Remnant/ High Value Regrowth	Semi-Evergreen Vine Thicket	<b>Of concern</b>
Q7	11.12.2 / 11.3.4 - Remnant	11.12.2 / 11.12.1/ 11.3.25 - Regrowth	Mixed Eucalypt Vegetation Communities	Least concern
Q8	11.3.25 - Remnant	11.3.25 - Regrowth	Riparian Vegetation	Least concern

Quaternary site	Mapped RE	Results of field survey		VM status (ground-truthed REs)
		Ground-truthed RE/drone & aerial interpretation	Vegetation community	
Q9	8.12.7a / 8.12.9 / 8.12.23 / 8.3.14 - Remnant	8.12.7– Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q10	8.12.9 / 8.3.14 - Remnant	8.12.9 / 8.3.14– Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q11	8.12.7a / 8.12.9 / 8.12.23 / 8.3.14 - Remnant	8.12.32 – Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q12	8.12.7a / 8.12.9 / 8.12.23 / 8.3.14 - Remnant	8.12.7 – Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q13	8.12.7a / 8.12.9 / 8.12.23 / 8.3.14 (Remnant)	8.12.23 / 8.12.7 – Remnant	Wetland / Alluvial Plain	<b>Of concern</b>
Q14	8.12.9 / 8.3.14 - Remnant	8.12.9 - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q15	8.12.7c - Remnant	8.12.7c - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q16	11.12.6a - Remnant	11.12.6a - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
<b>Spring 2020 survey</b>				
Q1	11.2.1 - Remnant	11.2.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q2	11.12.1/11.12.13 - Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q3	11.12.1/11.12.13 - Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q4	11.12.1- Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern



Quaternary site	Mapped RE	Results of field survey		VM status (ground-truthed REs)
		Ground-truthed RE/drone & aerial interpretation	Vegetation community	
Q5	11.12.6a - Remnant	11.12.6a - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q6	Category R	18.12.7 - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q7	Non-remnant	11.12.6a	Mixed Eucalypt Vegetation Communities	Least concern
Q8	11.12.1 - Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q9	11.12.1/11.12.13 – Non-remnant	11.12.13 – Non-remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q10	11.12.1/11.12.13 - Remnant	11.3.25 - Remnant	Riparian Vegetation	Least concern
Q11	11.12.6a - Remnant	11.12.6a - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q12	11.12.1 - Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q13	11.12.1 - Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q14	8.12.7c - Remnant	8.12.7 - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q15	8.12.7c - Remnant	8.12.7c – Remnant (northern section non-remnant)	Mixed Eucalypt Vegetation Communities	Least concern
Q16	11.12.6a - Remnant	11.12.6a - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q17	11.12.1 - Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern



Quaternary site	Mapped RE	Results of field survey		VM status (ground-truthed REs)
		Ground-truthed RE/drone & aerial interpretation	Vegetation community	
Q18	Non-remnant	Non-remnant		
Q19	11.12.1 - Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q20	18.12.7c - Remnant	18.12.7c - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q21	11.12.1/11.12.13 - Remnant	11.12.6 – Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q22	11.12.1/11.12.13 - Remnant	11.12.6 – Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q23	Non-remnant	8.12.7a - Regrowth	Mixed Eucalypt Vegetation Communities	Least concern
Q24	11.12.1/11.12.13 - Remnant	11.12.13 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q25	11.12.1/11.12.13 - Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q26	Non-remnant	18.12.7c	Mixed Eucalypt Vegetation Communities	Least concern
Q27	18.12.1 - Remnant	18.12.5 - Remnant	Mixed Eucalypt Vegetation Communities	Least concern
Q28	Non-remnant	11.12.1 – Non-remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q31	Non-remnant	Non-remnant	Non-remnant	Non-remnant
Q32	Non-remnant	11.12.13 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern

Quaternary site	Mapped RE	Results of field survey		VM status (ground-truthed REs)
		Ground-truthed RE/drone & aerial interpretation	Vegetation community	
Q33	Non-remnant	11.12.13 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q34	11.12.1 - Remnant	11.12.1 - Remnant	<i>Eucalyptus crebra</i> woodland to open woodland	Least concern
Q35	Non-remnant	11.12.6 - Regrowth	Mixed Eucalypt Vegetation Communities	Least concern
Q36	Non-remnant	Non-remnant		

### Vegetation Community 1: *Eucalyptus crebra* Woodland to Open Woodland

This vegetation community occurs on shallow soils along ridgelines and hill slopes within the eastern and southern extent of the Project Area (Plate 4-2). Due to the level of disturbance (including historical clearing and selective logging/thinning, current land use through grazing and competition through incursion of weeds and non-native pasture species), this community is generally in poor condition.

This vegetation community forms most of the western slopes of the Project site. The canopy layer in this community is dominated by *Eucalyptus crebra*, with variable-barked bloodwood (*Corymbia erythrophloia*), pink bloodwood (*C. intermedia*), white mahogany (*E. acmenoides*) and spotted gum (*C. citriodora*) occurring as associated species. Small areas within this community are dominated by silver-leaved ironbark (*E. melanophloia*), however not to the extent to which it would be delineated as a separate community/regional ecosystem. Carbeen (*Corymbia tessellaris*) and kurrajong (*Brachychiton populneus*) also occur sparsely (Plate 4-2). Canopy height ranges from 15 – 18 m with a foliage projective cover (FPC) of 10 – 30%. Sub-canopy species recorded included *Acacia crassa*, *Breynia oblongifolia*, *Euroschinus falcatus*, *Alphitonia excelsa*, juvenile *Eucalyptus crebra*, *Gomphocarpus physocarpus* and *Lantana camara*\*.

The shrub layer within this community was sparse to non-existent largely due to grazing and prolonged drought conditions in the period leading up to the survey.

This vegetation community is analogous to the following REs:

- RE 11.12.1 - *Eucalyptus crebra* woodland on igneous rocks (Least Concern RE)
- RE 11.12.13 - *Eucalyptus crebra*, *Corymbia* spp., *E. acmenoides* woodland on igneous rocks. Coastal hills (Least Concern RE).

These community are not listed as TECs under the EPBC Act; however they do provide habitat for EPBC-listed threatened species confirmed to be present within the Project Area i.e., Koala, Greater Glider, Squatter Pigeon and *Cycas megacarpa*.



Plate 4-2 *Eucalyptus crebra* woodland community.

### **Vegetation Community 2: Riparian Vegetation**

This vegetation community occurs along fringing levies and banks of streams along watercourses and drainage lines (Plate 4-3). It is dominated by Queensland blue gum (*E. tereticornis*), river she-oak (*Casuarina cunninghamiana*) and tea-tree (*Melaleuca* spp.).

Although generally disturbed due to land use practices, this vegetation community was relatively intact across the Project Area with a moderate degree of connectivity and biodiversity values. Watercourses and drainage lines within the western extent of the Site Boundary were in poorer condition due to more extensive historical land clearing and intense grazing pressure.

Dominant canopy species includes Queensland blue gum (*E. tereticornis*), river she-oak (*Casuarina cunninghamiana*), paperbark tea-tree (*Melaleuca fluviatilis*) with broad-leaved paperbark (*Melaleuca viridiflora*) and flaxleaf paperbark (*Melaleuca fluviatilis*) also associated. Canopy height ranges from 10 – 22 m with a FPC of 10 – 30%. The shrub layer of this community is highly disturbed, in particular due to high levels of incursion by invasive flora species, in particular, lantana (*Lantana camara*).

This vegetation community is analogous to the following RE:

- RE 11.3.25 - *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines. (Least Concern RE).

This community is not listed as a TEC under the EPBC Act; however it does provide habitat for EPBC-listed threatened fauna species confirmed to be present within the Project Area i.e., Koala, Greater Glider, Squatter Pigeon and *Cycas megacarpa*.



Plate 4-3 Riparian vegetation community.

### **Vegetation Community 3: Mixed Eucalypt Vegetation Communities**

Given the size and steep terrain, a large proportion of vegetation within the Project Area was not able to be surveyed. However, most of the vegetation surveyed has been ground-truthed as a heterogeneous community dominated by a range of *Eucalyptus* and *Corymbia* species comprising the following REs:

- RE 8.12.32 - *Corymbia intermedia* +/- *E. portuensis* +/- *E. exserta* open forest with areas of *Allocasuarina* spp. +/- *Banksia integrifolia* open forest on high ranges, on Mesozoic to Proterozoic igneous rocks (VM Status – Least concern)
- RE 8.12.7- *Corymbia citriodora* +/- *Eucalyptus portuensis* +/- *E. drepanophylla* (or *E. crebra*) open forest on hill slopes and undulating plateaus, on Mesozoic to Proterozoic igneous rocks (Least Concern (VM Status – Least concern). This RE includes the vegetation community 8.12.7c which is described as *Eucalyptus drepanophylla* low woodland to open forest (6-20m tall)
- RE 8.12.9 - *Eucalyptus tereticornis* +/- *Corymbia intermedia* +/- *Lophostemon suaveolens* woodland on undulating uplands, on Mesozoic to Proterozoic igneous rocks (VM Status – Least Concern)
- RE 11.12.6 - *Corymbia citriodora* open forest on igneous rocks (granite) (VM Status – Least Concern)
- RE 8.12.23 - *Eucalyptus moluccana* woodland on elevated tablelands on Mesozoic to Proterozoic igneous rocks (VM Status - Of Concern).

These communities are not listed as TECs under the EPBC Act; however they do provide habitat for EPBC-listed threatened fauna species confirmed to be present within the Project Area i.e., Koala, Greater Glider, Squatter Pigeon and *Cycas megacarpa*.

### **Vegetation Community 4: Semi-Evergreen Vine Thicket**

This vegetation community consists of deciduous to semi-evergreen vine thicket with an emergent layer dominated by broad-leaved bottletree (*Brachychiton australis*) and semi-evergreen vine thicket species. Canopy/shrub cover is about 70-85% with height ranging from 5 to 10 m (Plate 4-4). It is generally restricted to hillsides, and typically observed in small pockets within sheltered gullies on western-facing slopes along ridgelines. The dense nature of this community and the fire-retardant properties of the species found within creates a microhabitat that is relatively resistant to high-level disturbance. The community was often found on poor, rocky soil but with high levels of organic matter/leaf litter (Plate 4-4). This community could potentially provide habitat for several threatened species including *Samadera bidwillii*.



This community generally occurs within the northern and southern extent of the Project Area with a significant patch of RE 11.12.4 occurring within the development corridor. This vegetation community is analogous to the following REs:

- RE 11.12.4 – Semi-evergreen vine thicket and microphyll vine forest on igneous rocks (Least Concern RE under the VM Act)
- RE 8.12.16 - Deciduous to semi-evergreen microphyll vine thicket +/- *Brachychiton* spp. +/- *Araucaria cunninghamii* emergents, of foothills and uplands (western areas) on Mesozoic to Proterozoic igneous rocks (Of Concern RE under the VM Act).

These two SEVT REs are not included within the EPBC Act listing for the Semi-evergreen Vine Thickets of the Brigalow Belt North and Nandewar Bioregions TEC.



Plate 4-4 Semi-evergreen vine thicket

### **Vegetation Community 5: Wetland / Alluvial Plain Communities**

This vegetation community consists of woodland to open forest dominated by Queensland blue gum (*Eucalyptus tereticornis*) with narrow-leaved ironbark (*E. crebra*), poplar gum (*E. platyphylla*), carbeen (*E. tessellaris*), pink bloodwood (*C. intermedia*) and swamp box (*Lophostemon suaveolens*) also associated and associated native grassland areas dominated by blady grass (*Imperata cylindrica*). Canopy cover is about 30% with canopy height ranging from 15 to 23 m. This community occurs in poorly drained areas associated with drainage depressions, channels and watercourses in upland areas within the eastern extent of the Project Area. This vegetation community was been found to contain evidence of several threatened fauna and flora species (including Greater Gliders, Koala and *Cycas megacarpa*). This vegetation community is analogous to the following REs:

- RE 8.12.9 – *Eucalyptus tereticornis* +/- *Corymbia intermedia* +/- *Lophostemon suaveolens* woodland on undulating uplands on Mesozoic to Proterozoic igneous rocks (VM Status – Least concern)
- RE 8.3.14 - *Ischaemum australe* and/or *Imperata cylindrica* and/or *Sorghum nitidum* forma *aristatum* tussock grassland on drainage channels in gently undulating upland areas (VM Status – Of Concern).

These communities are not listed as TECs under the EPBC Act. This vegetation community was been found to contain evidence of several threatened fauna and flora species (including Greater Gliders, Koala and *Cycas megacarpa*).



Plate 4-5 Examples of woodland and grassland communities in wetlands and alluvial plains.

Figure 4-2 Ground-truthed vegetation communities (north and south)



## 4.3 FLORA SPECIES

EPBC records (based on a 10 km buffer area of the project Site Boundary) identified the following seven (7) threatened flora species as potentially occurring within the Project Area:

- *Cycas megacarpa*
- *Cycas ophiolitica*
- Bluegrass (*Dichanthium setosum*)
- Black Ironbox (*Eucalyptus raveretiana*)
- *Omphalea celata*
- Lesser Swamp-Orchid (*Phaius australis*)
- Quassia (*Samadera bidwillii*).

Two (2) threatened flora species listed under the NC Act have been recorded within a 10 km buffer (Qld Wildlife Online) – Queensland Bluegrass (*Dichanthium queenslandicum*) and *Cerbera dumicola*. Appendix B assesses the likelihood of these species occurring in the Project Area or being impacted by the Project.

Appendix E presents the full flora species list for the Project Area. There were 93 species noted during surveys, of which six were weeds (see Section 4.5.1) and one was Endangered.

Of the species identified by the desktop searches, only *Cycas megacarpa* was confirmed to be present within the Project Area with seven (7) records noted during the surveys (Plate 4-6). These specimens were recorded north-south along ridgelines associated with the range, in association within REs 11.12.1 and 11.12.6a, however it is likely that additional specimens associated with similar communities across the Project Area are present. The density of *Cycas megacarpa* individuals within the Project Area appears to be very low, with only scattered individuals observed. The majority of observed specimens were in very poor condition, likely due to the current drought and associated insect damage. The location of the cycads is illustrated in Figure 4-3.



Plate 4-6 *Cycas megacarpa* within the Project Area



## **4.5 FAUNA SPECIES**

Fauna studies conducted on site resulted in 242 records of fauna (Appendix D). In summary, the total number for each fauna group included:

- 142 bird species
- 27 species of mammals (excluding microbats) of which five species are introduced
- Sixteen (16) microbat species were physically or aurally identified
- 25 reptile species
- 13 amphibian species, one of which is introduced
- Two snail species
- Two spiders
- Fifteen butterfly species.

Figure 4-3 Threatened flora and fauna survey results (north and south)

### 4.5.1 Birds

A total of 142 bird species were recorded within the Site Boundary during the survey period. This includes opportunistic sightings, species recorded during designated surveys and bird utilisation surveys conducted within representative vegetation communities.

The Project Area supports foraging, nesting and roosting habitat for a variety of bird species. Nesting for hollow-dependent species is abundant in woodland across the site. Hollow-dependant bird species (e.g. Boobook Owls) were recorded during spotlighting activities within and adjacent to woodland areas.

Aquatic areas for birds are limited across the Project Area, restricted to farm dams and ephemeral creeks and drainage lines, which would be seasonal resources. Wetland bird species were not observed on site.

Species common to the site included farmland and woodland species such as Australian Magpie (*Cracticus tibicens*) Torresian Crow (*Corvus orru*), Pied Currawong (*Strepera graculina*), Black-faced cuckoo Shrike (*Coracina novaehollandiae*), Emu (*Dromaius novaehollandiae*) and Red-backed Fairy Wren (*Malurus melanocephalus*). Six nocturnal species, the Spotted Nightjar (*Eurostopodus argus*), White-throated Nightjar (*Eurostopodus mystacalis*), Owlet Nightjar (*Aegotheles chrisoptus*), Southern Boobook Owl (*Ninox novaeseelandiae*), Powerful Owl (*Ninox strenua*) and Tawny Frogmouth (*Podargus strigoides*) were recorded during the study.

The following diurnal raptor species were seen in the Project Area:

- Collared Sparrowhawk (*Accipiter cirrocephalus*)
- Wedge-Tailed Eagle (*Aquila audux*)
- Brown Falcon (*Falco berigora*)
- Brown Goswawk (*Accipiter fasciatus*)
- Nankeen Kestrel (*Falco cencroides*)
- Whistling Kite (*Haliastur sphenurus*)
- Pacific Baza (*Aviceda subcristata*)
- Black Kite (*Milvus migrans*).

Raptors were seen in a variety of landscape positions, including soaring or gliding above proposed wind turbine locations. Several large, unused nests were also found across the Project footprint, however as these nests were not being used at the time of the survey, it was not possible to determine which species they belong to.

Waterbirds are another group of species considered vulnerable to collision with wind turbines. During the fauna survey waterbirds were seen utilising a number of man-made dams across the site. Species recorded include Australasian Grebe (*Tachybaptus novaehollandiae*), Australian Pelican (*Pelecanus conspicillatus*), Blue-billed Duck (*Oxyura australis*), Nankeen Night-heron (*Nycticorax caledonicus*), Green Pygmy Goose (*Nettapus pulchellus*) and Little Pied Cormorant (*Microcarbo melanoleucos*) among others.

Three threatened bird species were recorded on site within the survey period. They included Powerful Owl (*Ninox strenua*) which is listed as Vulnerable under the NC Act, White-throated Needletail (*Hirundapus caudacutus*) which is listed as Vulnerable under the NC Act and Vulnerable and migratory under the EPBC Act, and Squatter Pigeon (*Geophaps scripta scripta*) which is listed as Vulnerable under the EPBC Act and NC Act. Species recorded on site that are listed as Migratory under the EPBC Act included Satin Flycatcher (*Myiagra cyanoleuca*) and Fork-tailed Swift (*Apus pacificus*). Threatened bird sightings are shown in Figure 4-3.

Bird species listed as Marine under the EPBC Act that were recorded on site include Dollarbird (*Eurystomus orientalis*), Rainbow Bee-eater (*Merops ornatus*) and Channel-billed Cuckoo (*Scythrops novaehollandiae*).

## 4.5.2 Mammals

Forty-three (43) species of mammals (including 16 confirmed microbats), of which five (5) species are introduced and two (2) are threatened (Koala and Greater Glider) were confirmed during surveys.

The native species recorded in the study included five macropods, Eastern Grey Kangaroo (*Macropus giganteus*), Whiptail Wallaby (*Macropus parryi*), Agile Wallaby (*Macropus agilis*), Red-necked Wallaby (*Macropus rufogriseus*) and Unadorned Rock Wallaby (*Petrogale inornata*).

Six species of arboreal marsupial were recorded which included Greater Glider (*Petauroides volans*) which are listed as Vulnerable under the EPBC Act and under the NC Act as well as the Koala (*Phascolarctos cinereus*) which are also listed as Vulnerable under the EPBC Act and NC Act. Other species including Sugar Gliders (*Petaurus breviceps*), Common Ring-tailed Possums (*Pseudocheirus peregrinus*) and Common Brush-tailed Possums (*Trichosurus vulpecula*) are listed as Least Concern species.

A total of 101 Koala and 131 Greater Glider sightings were recorded within the Site Boundary across the three survey periods. Koalas were observed in all areas of suitable habitat. Greater Glider sightings were largely concentrated in the east, with 111 sightings on the Clarke-Connors Range, outside of the Project Area and the remainder on the western side of the range in the Nebo-Connors Range. Two of the Greater Gliders observed were deceased, due to collision with a barbwire fence. Only two Greater Gliders were observed within the Project Area. These records were in a non-remnant area adjacent to high quality habitat. It is likely that the individuals occasionally forage and use hollows in the non-remnant area but would rely on the high quality habitat outside the Project Area for the majority of their ecological needs.

Three (3) species of small terrestrial mammal were captured during the survey; Common Dunnart (*Sminthopsis murina*), Grassland Melomys (*Melomys burtoni*) (both NC Act Least Concern) and the invasive House Mouse (*Mus musculus*).

### 4.5.2.1 Microbats

Species captured during harp trapping include Ride's Free-tailed Bat (*Ozimops ridei*), Gould's Wattled Bat (*Chalinolobus gouldii*) (Plate 4-8), Chocolate Wattled Bat (*Chalinolobus morio*), Lesser Long-eared Bat (*Nyctophilus geoffroyi*), Inland Broad-nosed Bat (*Scotorepens balstoni*) and Northern Broad-nosed Bat (*Scotorepens sanborni*). One yellow-bellied sheath-tail bat (*Saccolaimus flaviventris*) was also identified while spotlighting. The remainder of the microbat species were identified through call analysis.

A total of 15,651 sequence files were submitted for bat analysis. A small proportion of these files (50%) in this dataset contained background noise or resulted in poor quality calls that did not provide bat calls for analysis. While some call sequences were recognised as bat calls, the quality was not adequate to assign species identification. The Project's bat call analysis report provides additional detail on call results (Appendix F). Twenty-two devices were placed across the Project Area during the three seasonal surveys (Figure 3-1).

A total of 16 microbat species were confirmed as being present on site, with an additional nine species possibly occurring (Table 4-3). No threatened species were recorded on site.



Plate 4-7 Gould's Wattled Bat captured in the Project Area

Table 4-3 Microbat survey results

Species	EPBC Act	NC Act	Results
<i>Austronomus australis</i>		Least Concern	Definite
<i>Chalinolobus gouldii</i>		Least Concern	Definite*
<i>Chalinolobus morio</i>		Least Concern	Definite*
<i>Chalinolobus nigrogriseus</i>		Least Concern	Definite
<i>Chalinolobus picatus</i>		Least Concern	Definite
<i>Miniopterus australis</i>		Least Concern	Definite
<i>Miniopterus orianae oceanensis</i>		Least Concern	Definite
<i>Myotis macropus</i>		Least Concern	Possible
<i>Nyctophilus</i> sp - <i>N. gouldi</i> - <i>N. bifax</i> - <i>N. corbeni</i>	Vulnerable	Vulnerable	Possible
<i>Nyctophilus geoffroyi</i>		Least Concern	Definite*
<i>Ozimops ridei</i>		Least Concern	Definite*
<i>Ozimops lumsdenae</i>		Least Concern	Definite
<i>Rhinolophus megaphyllus</i>		Least Concern	Definite
<i>Saccolaimus flaviventris</i>		Least Concern	Definite*

Species	EPBC Act	NC Act	Results
<i>Scotorepens balstoni</i>		Least Concern	Definite*
<i>Scotorepens greyii</i>		Least Concern	Probable
<i>Scotorepens sanborni</i>		Least Concern	Definite
<i>Setirostris eleryi</i>		Least Concern	Definite
<i>Taphozous trougtoni</i>		Least Concern	Probable
<i>Vespadelus trougtoni</i>		Least Concern	Probable
<i>Vespadelus vulturnus</i>		Least Concern	Definite

\*direct capture or observation

### 4.5.3 Reptiles

Twenty-five species of reptile were recorded on site during surveys. This included a range of gecko, skink, monitor and snake species. Common species found included Ocellated Velvet Gecko (*Oedura monilis*), Common Dwarf Skink (*Menetia greyii*), Frilled Lizard (*Chlamydosaurus kingii*) and Open Litter Rainbow Skink (*Carlia pectoralis*). Snake species found on site included Common Tree Snake (*Dendrelaphis punctulata*), Eastern Brown Snake (*Pseudonaja textilis*), Yellow-faced Whip Snake (*Demansia psammophis*) and Black-headed Python (*Aspidites melanocephalus*).

No threatened reptiles were found on site incidentally or during active searches. A full list of species recorded during the surveys can be found in Appendix D. EPBC listed threatened reptiles listed potentially occurring in the Site Boundary include the Yakka skink (*Egernia rugosa*) and Ornamental Snake (*Denisonia maculata*). The DES database Wildnet has no records of these species within a 50 km radius of the Project Area and it was considered to be unlikely that they occur within the Project Area (Appendix B).

According to the conservation advice for Ornamental Snake (DAWE, 2020a), the species can be found on floodplains, undulating clay pans and along the margins of swamps, lakes and watercourses. This species has been recorded in woodlands and open woodlands of coolabah, poplar box, and brigalow, and in fringing vegetation along watercourses. They favour moist low-lying areas around freshwater bodies and prefer areas of deeply cracking and alluvial soils. Ornamental Snake habitat is likely to be found in Brigalow (*Acacia harpophylla*), Gidgee (*Acacia cambagei*), Blackwood (*Acacia argyrodendron*) or Coolibah (*Eucalyptus coolabah*)-dominated vegetation communities, or pure grassland associated with gilgais (Brigalow Belt Reptiles Workshop, 2010). None of these habitats were present within the Project Area.

Similarly, the Yakka skink is known to occur in open dry sclerophyll forest, woodland and scrub. Common woodland and open forest types include Brigalow (*Acacia harpophylla*), Mulga (*A. aneura*), Bendee (*A. catenulata*), Lancewood (*A. shirleyi*), Belah (*Casuarina cristata*), Poplar Box (*Eucalyptus populnea*) and White Cypress Pine (*Callitris glaucophylla*). None of these habitats were present within the Project Area.

### 4.5.4 Amphibians

Thirteen species of amphibian were found during surveys within the Project Area. These species are considered common to the region. Habitat for amphibians is limited to ephemeral streams and wetlands, farm dams and few permanent natural waterways. Common species found on site included Eastern Stony Creek Frog (*Litoria wilcoxii*), Bumpy Rocket Frog (*Litoria inermis*), Great Broodfrog (*Pseudophryne majori*) and Eastern Sedge Frog (*Litoria fallax*). No threatened amphibians were found on site and no threatened species

are considered likely or possibly to occur. A full list of species recorded during the surveys can be found in Appendix D.

## 4.6 INVASIVE SPECIES

The *Biosecurity Act 2014* imposes a ‘general biosecurity obligation’ (GBO), which imparts a responsibility on all individuals or organisations to manage biosecurity risks that are under their control and that they know about or should reasonably be expected to know about. Under the GBO, individuals and organisations whose activities present a biosecurity risk must take all reasonable and practical steps to prevent or minimise their activities from causing a biosecurity event.

The Act lists fauna and flora pest species as either a prohibited or restricted biosecurity matter. A prohibited matter is any species which has not yet become established in Queensland and would have significant adverse impacts on human health, social amenity, the economy or the environment if it entered the state. A restricted matter is any species that is already established within Queensland and has significant adverse impacts on human health, social amenity, the economy or the environment. Restricted matters are categorised into seven risk-based categories. Some species can be categorised under a range of different categories. The Act defines specific requirements for notification and management actions for all listed biosecurity matters, including specific requirements for the disposal of restricted matters.

Weed species declared under the Biosecurity Act were recorded at the site. Any on-ground activities associated with the proposed development must ensure that all Category 3 restricted invasive plant species on site are not distributed or that all material be disposed of in accordance with legislative requirements. Matters may be disposed of by:

- a) burying the matter in the ground at a depth that ensures any seeds or vegetative material being disposed of cannot grow; or
- b) transporting the matter directly to a waste facility if the matter is –
  - i. in a sealed container or a covered vehicle; or
  - ii. Covered in a way that prevents the restricted matter from being lost or released during transport; or
- c) sealing the matter in plastic and leaving the matter in the sun until any vegetative material being disposed has decomposed.

### 4.6.1 Weed species

Weed species present at the site include Weeds of National Significance (WoNS), restricted invasive plants listed under the Biosecurity Act and other environmental weeds, with six species confirmed (Table 4-4).

Table 4-4 Weed species identified at the site

Scientific name	Common name	Weeds of National Significance (WoNS) status	Status under Biosecurity Act - Category
<i>Cenchrus ciliaris</i>	Buffel Grass	-	Environmental weed
<i>Gomphocarpus fruticosus</i>	Balloon Cotton	-	Environmental weed
<i>Lantana camara</i>	Lantana	✓	Restricted invasive plant
<i>Opuntia stricta</i>	Common Prickly Pear	✓	Restricted invasive plant – Category 3

Scientific name	Common name	Weeds of National Significance (WoNS) status	Status under Biosecurity Act - Category
<i>Opuntia tomentosa</i>	Velvety Tree Pear	✓	Restricted invasive plant – Category 3
<i>Opuntia streptacantha</i>	Westwood Pear	✓	Restricted invasive plant – Category 3

#### 4.6.2 Pest animals

Seven pest animal species were identified on site (Table 4-5). Predatory pest animal species included Wild Dog and Cat. Records of Wild Dog were concentrated on the Bradford property, whilst Feral Cat were scattered throughout the site (Table 4-5). Both species pose significant threat to native wildlife.

Table 4-5 Pest animal species identified at the site

Scientific name	Common name	Method of sighting	Location	Status under Biosecurity Act - Category
<i>Acridotheres trista</i>	Common Myna	Sighting	Cleared areas within Project Area	None (introduced)
<i>Canis familiaris dingo</i>	Wild Dog	Vocalisations, scat and camera	Bradford property (799 PH391)	Restricted invasive animal
<i>Felis catis</i>	Feral Cat	Sighting and camera	All Project Area	Restricted invasive animal
<i>Oryctolagus cuniculus</i>	Rabbit	Sighting	All Project Area	Restricted invasive animal
<i>Mus musculus</i>	House Mouse	Trapped	All Project Area	None (introduced)
<i>Rhinella marina</i>	Cane Toad	Sighting and camera	Moist microhabitat or areas close to water sources within the Project Area	None (introduced)
<i>Sus scrofa</i>	Pig	Sighting and camera	All Project Area	Restricted invasive animal

## 4.7 BIRD AND BAT UTILISATION

The Projects' bird and bat utilisation report is included at Appendix G, with key findings summarised below.

### 4.7.1 Species composition

A total of 66 bird species were recorded during the two BUS efforts. Species recorded were predominantly farmland and bushland species with some records of raptors. Species composition (diversity) can often differ between months due to seasonal changes in presence and abundance, activity, changes in foraging behaviour and seasonal distribution of birds among various habitats.



The diversity of birds during the 2019 Autumn and Spring surveys was similar with only a degree of seasonal variation. Twenty-four (24) bird species were seen in both Autumn and Spring surveys with 20 species added in the Spring survey that were not recorded in the Autumn survey. In total, 66 bird species were seen during the combined BUS. An additional 29 species were seen elsewhere as incidental observations on the proposed wind farm properties and access roads. Overall, the most abundant species across the combined seasonal counts in order of cumulative frequencies were:

- Pied Currawong
- Noisy Miner
- Australian Magpie
- Grey Fantail
- Rainbow Lorikeet.

#### **4.7.2 BUS**

Analysis of the field data shows that most birds are active in the lower strata between 0 and 20 m height (i.e. ground, and in trees). A small proportion of birds flew at above 40 m particularly White-throated Needletail, Wedge-tailed Eagle, Rainbow Lorikeet, Rainbow Bee-eater, and Torresian Crow. Flight height was considered to be:

- Below RSA (< 40 m above ground)
- At RSA (40 – 250 m above ground)
- Above RSA (> 250 m above ground).

There was minor variation in flight heights across the two seasons and potentially some evidence of migration, i.e., birds that were present in May might be indicative of movements of these species within or beyond the tropics (e.g. Grey Fantail, Rufous Whistler and Silvereye likely have arrived from further south, but also have resident populations in Central Queensland) whereas in November the White-throated Needletail had already arrived from the northern hemisphere on its southward migration. The five most abundant species flying at RSA are detailed below:

- White-throated Needletail
- Rainbow Lorikeet/ Wedge-tailed Eagle (equal observations)
- Rainbow Bee-eater
- Torresian Crow.

These species combined accounted for 5.2% of the total birds observed at the impact survey points.

The majority of birds found to utilise the proposed wind farm site were common, widespread birds. Of the species recorded during the bird utilisation surveys the following species were listed under the EPBC Act:

- White-throated Needletail (Vulnerable and Migratory).
- Satin Flycatcher (Migratory)
- Rainbow Bee-eater (Marine).

No other listed threatened bird species were recorded during the BUS, either at state level under the NC Act or under the Commonwealth EPBC Act.

### **4.8 HABITAT ASSESSMENT**

The eastern range (Clarke Connors Range) is in excellent condition, with large hollows and remnant native vegetation, providing high-quality breeding and foraging resources. This is outside of the Project Area.

With regards to native fauna, the Project Area provides the following habitat resources:

- foraging resources in the form of Acacia, Corymbia and Eucalypts species
- ephemeral watercourses and wetlands with some permanent waterways providing habitat for aquatic fauna and resources for all other fauna
- terrestrial habitat including course woody debris, surface rocks and some small rocky jumbles
- dry grass and leaf litter across the site.

The Site is broadly characterised by undulating landforms. Due to the large wind current occurring at the top of the ridge, these ridges are the preferred locations for most of the wind turbines. The majority of the ridgelines in the eastern portion of the site still contain remnant vegetation with high fauna habitat values. The quality of the habitat on Clarke-Conners Range, outside the Project Footprint, is highlighted by the large number of Greater Glider and Koala records in this area (Plate 4-8). Greater Gliders require large hollows and the number found spotlighting attests to the extremely hollow rich environment. This is also confirmed by the sighting of the Powerful Owl which required large, old hollows to breed, and forages on Greater Glider. The large number of Koalas shows evidence of quality foraging resources and connectivity across the site.



Plate 4-8 Areas of good quality Koala and Greater Glider habitat (outside of the Project Area)

The terrain within the Site Boundary creates several habitat types for flora and fauna. These habitats include:

- The southern section is dominated by remnant Eucalyptus and Corymbia species. This area has a very high number and range of hollows and supports a high biodiversity and number of threatened species including Greater Glider, Koala and Powerful Owl. This area also had the highest microbat trapping success within the more closed forest areas. Grazing pressure and low rainfall have reduced the ground vegetation cover, but this is expected to recover after rainfall.
- Watercourses and ephemeral wetlands are found across the Site. During the Autumn survey, ephemeral wetlands were flooded with frogs breeding in large numbers. There are a number of ephemeral watercourses and some permanent watercourses. The permanent watercourses have Melaleuca and large *Eucalyptus* species along the banks that provide high quality habitat for Koalas, Greater Gliders and other hollow dependant fauna. The water resources provide habitat for frog species and other aquatic fauna. Squatter Pigeons were predominantly recorded within 100 m of a water feature.
- Some areas in the north of the Bradford's property (799 PH391) and through the Acton property (4 KL210) have been previously clear felled or have had the canopy trees ring barked. These areas support a lower density of fauna with fewer canopy trees; however, they still provide grazing resources

for macropods and scattered food trees for Koala. The dead ring barked trees have also formed hollows which provide habitat for microbats and other hollow dependant fauna.

Breeding and foraging habitat exists for a range of native fauna species across the site. Fauna breeding places will be specifically surveyed for at detailed design phase, during pre-clearance surveys.

## 4.9 CORRIDORS AND LINKAGES

The vegetation within the Site Boundary includes mature native canopy trees and large patches of remnant vegetation, thereby providing terrestrial connectivity values through structural ecological linkages.

The majority of the Site is mapped as remnant vegetation. Connectivity is provided by broad patches of vegetation that link north south as well as to the east. Tracks throughout the Site intersect some patches, however these tracks are approximately 3 - 4 m wide and would not prevent movement throughout the landscape for the majority of species. Saint Lawrence Croyden Road runs west to east through the centre of the property. Mobile species such as birds, large mammals (i.e., macropods), and flying-fox would be able to traverse the road, however it may hinder movement across the landscape for less mobile species.

The eastern portion of the Site falls within a state significant corridor buffer that starts near Stanthorpe in southern Queensland, stretching to north Queensland. The centre of the property, from south to north, falls within a regionally significant corridor that stretches for approximately 99 km, north to south (Figure 4-4).

Properties to the south, east and north of the Site Boundary are covered with comparatively dense remnant vegetation along the Clarke-Connors Range, and with sparser remnant vegetation along the Nebo-Connors Range. These areas may support a number of common and threatened species, with Koala and Greater Glider in particular known from the properties to the immediate south of the Site Boundary. Properties to the west have predominantly non-remnant vegetation.

## 4.10 MNES AND MSES THREATENED SPECIES

In summary, seven EPBC Act threatened species and eight NC Act listed species were confirmed within the Project Area (Table 4-6).

Table 4-6 Summary of matters confirmed within the Project Area which are MNES and/or MSES

Matter	Common name	Scientific name	EPBC Act	NC Act
Threatened and/or Migratory fauna species	Koala	<i>Phascolarctos cinereus</i>	Vulnerable	Vulnerable
	Greater Glider	<i>Petauroides volans</i>	Vulnerable	Vulnerable
	White-throated Needletail	<i>Hirundapus caudacutus</i>	Vulnerable, Migratory	Vulnerable
	Squatter Pigeon	<i>Geophaps scripta scripta</i>	Vulnerable	Vulnerable
	Powerful Owl	<i>Ninox strenua</i>	Least Concern	Vulnerable
	Satin Flycatcher	<i>Myiagra cyanoleuca</i>	Migratory	Least Concern
	Fork-tailed Swift	<i>Apus pacificus</i>	Migratory	Special Least Concern
Threatened flora species	Cycad	<i>Cycas megacarpa</i>	Endangered	Endangered

Other MSES within the Project Area include the following Of Concern regional ecosystems:

- RE 11.3.4 - *Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains.

Figure 4-4 Waterways and connectivity

## 5 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The MNES with potential to be impacted by the Project are:

- Listed threatened species and communities
- Listed migratory species.

### 5.1 LISTED THREATENED SPECIES AND COMMUNITIES

Four fauna species considered to be threatened under the EPBC Act were confirmed within the Site Boundary. These are Greater Glider (Vulnerable), Koala (Vulnerable), Squatter Pigeon (Vulnerable), White-throated Needletail (Vulnerable and Migratory).

The Vulnerable Corben's Long-eared Bat (*Nyctophilus corbeni*) was also possibly recorded on site (inconclusive audio recording), however this is unconfirmed as calls from this species cannot be distinguished from other species in the *Nyctophilus* genus.

One threatened flora species was confirmed in the Project Area, a cycad (*Cycas megacarpa*). No listed threatened ecological communities were confirmed or considered likely to occur within the Project Area

Section 8.1 contains the results of an assessment of the potential impacts to each of these flora and fauna species where presences is considered to be likely (Appendix B).

#### 5.1.1 Greater Glider

The Greater Glider (Plate 5-1) is listed as Vulnerable under both the EPBC Act and NC Act. This species is the largest of Australia's gliding mammals (body - 45 cm, tail - 60 cm). Unlike the other gliders, the Greater Glider's gliding membrane stretches between its elbow and ankle, rather than wrist and ankle. They have long fur and big rounded fluffy ears, which makes them look larger than they are. They nest in hollow bearing trees, and are nocturnal, feeding on eucalyptus leaves and flower buds (DAWE, 2020a). They inhabit forest and woodlands in mainland eastern Australia (ALA, 2018). Presence and density of Greater Gliders is related to soil fertility, eucalyptus tree species, disturbance history and density of suitable tree hollows (Kavanagh, 2004, Tyndale-Biscoe and RFC, 1969, Smith et al. 2007).

The severe bushfires of 2019/20 have significantly impacted on the national population of Greater Glider. Between 10 and <30% of known and likely modelled distribution of Greater Glider is within fire affected areas. As a result, Greater Glider have been identified as high priority mammal species recommended for urgent management intervention to support ecological recovery (DAWE, 2020c). The management measure proposed by the Department for Greater Glider is to "avoid clearing that results in habitat fragmentation" (DAWE 2020c). In acknowledgement, the Project Footprint has avoided Greater Glider habitat. Records for Greater Glider are within the mapped high and very high value habitat areas (Table 3-6), except for two records in non-remnant habitat near turbines 19 and 20, which are adjacent to mapped high quality habitat.

#### Lotus Creek Greater Glider population

- Recorded at 131 locations (across all survey periods).
- The majority of the records are on the eastern side of the range where the forests and woodlands are slightly moister; records are largely outside of the new Project Area,. Greater Glider is known to prefer more diverse, taller and moister forests, such as those which occur on the eastern side of the site.

#### Lotus Creek Greater Glider habitat

- Across all survey periods, the majority of records were located in remnant vegetation of three REs:
  - 8.12.7a/8.12.32/8.12.9/8.12.23/8.3.14- mosaic of woodlands dominated by *Corymbia citriodora* with patches of *E. tereticornis*
  - 8.12.7c- *Corymbia citriodora* +/- *Eucalyptus portuensis* +/- *E. drepanophylla* (or *E. crebra*) open forest on hill slopes and undulating plateaus, on Mesozoic to Proterozoic igneous rocks
  - 11.12.6a- *Corymbia citriodora* open forest on igneous rocks (granite).
- Only one animal was recorded in RE 11.12.1, suggesting that this RE is not their preferred habitat.
- The average hollow bearing tree (HBT) density across the habitat assessment locations (which included high, moderate and low habitat value areas) was 16.5 HBT/ha on average, which is significant (this is derived from information collected in Spring 2020).

### Lotus Creek Greater Glider threats

Two Greater Glider were recorded dead on barbed wire fences across the survey periods, and previous research suggests barbed wire fences kill many Greater Gliders where they are erected in suitable habitat.



Plate 5-1 Greater Glider observed during spotlight surveys

### 5.1.2 Koala

The Koala is listed as Vulnerable under both the EPBC Act and NC Act. The Koala is a (mainly) arboreal, medium-sized marsupial with a stocky body, large rounded ears, sharp claws and predominantly grey-coloured fur. The species displays sexual dimorphism (males generally are larger than females). The Koala is a leaf-eating specialist that feeds primarily during dawn, dusk or night. Its diet is restricted mainly to foliage of *Eucalyptus* spp; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. The Koala may, at times, supplement its diet with other species, including *Leptospermum* spp. and *Melaleuca* spp. (DAWE, 2020a). Koala habitat can be broadly defined as any forest or woodland containing species that are known Koala food trees, or shrubland with emergent food trees. The distribution of this habitat is largely influenced by land elevation, annual temperature and rainfall patterns, soil types and the resultant soil moisture availability and fertility. Preferred food and shelter trees are naturally abundant on fertile clay soils (DAWE, 2020a).

It is acknowledged that the severe bushfires of 2019/20 significantly impacted the combined Koala population of Qld, NSW and the ACT, with 12% of the Koala population within the fire extent (DAWE, 2020b). As a result,



Koala has been identified as high priority mammal species recommended for urgent management intervention to support ecological recovery (DAWE, 2020c).

### **Lotus Creek Koala population**

- Koala was recorded at 101 locations by direct sighting or through records of scat (across all survey periods)
- Seven (7) females were recorded with back young during the pre-wet 2020 survey, suggesting the population is self-sustaining.
- The average density based on spotlighting transects (from Spring 2020) is around 0.07 Koalas per ha (note this is a rough estimate and is not statistically valid as would need repeats and stratification of habitats etc. to make the estimate accurate), however 0.07/ha fits within the average density for Central Queensland. The estimated density of koalas in Central Queensland is thought to lie between 0.01 to 2.5 koalas/ha.

### **Lotus Creek Koala habitat**

- Across all survey periods, Koala was recorded in most REs within the study area (some REs were not surveyed, however it is considered likely that Koalas also occur in the ones without records, excluding semi-evergreen vine thicket).
- Majority of records were in non-remnant areas, although this result may not indicate a preference as the non-remnant areas contained better access so were surveyed more intensely.
- Most commonly recorded in the following REs:
  - 8.12.7a- *Corymbia citriodora* +/- *Eucalyptus portuensis* +/- *E. drepanophylla* (or *E. crebra*) open forest on hill slopes and undulating plateaus, on Mesozoic to Proterozoic igneous rocks
  - 11.12.1- *Eucalyptus crebra* woodland on igneous rocks
  - 11.12.13- *Eucalyptus crebra*, *Corymbia spp.*, *E. acmenoides* woodland on igneous rocks. Coastal hills.
- The REs used by koalas were generally dominated by the preferred food trees for koalas in Clarke-Connors Range (*E. crebra*; Melzer et al. (2018)).
- The majority of the proposed development area is mapped as the three REs listed above, and contains an abundance of koala food and habitat trees.
- The habitat quality in the remnant areas is mostly uniform and has little disturbance through weeds, clearing and grazing.
- Some of the non-remnant areas are more heavily grazed (and show the impacts of grazing such as build-up of dung, trampling, damage to trees) but nonetheless still contain remnant Koala habitat trees (which were used).
- Given that Koalas were seen in almost every RE mapped within the development area and the dominance of their preferred food trees across the site, it is considered that the whole site (except the patches of vine thicket) is Koala habitat.

### **Lotus Creek Koala threats**

- Only one record of dog (a scat) was made during the Spring 2020 survey, suggesting a very low density of wild dogs and few predators for Koala.
- Only one Koala was recorded in Spring 2020 with signs of chlamydia, suggesting the population is healthy (conforms with known disease levels for the population, Melzer et al. 2018).

#### **5.1.2.1 Koala habitat assessment**

The EPBC Act Referral Guidelines for the vulnerable Koala' (DAWE 2014) Koala habitat assessment tool was used to determine the sensitivity, value and quality of the Project's development footprint as Koala habitat, and



determine whether it is critical to the survival of the species. The Koala habitat assessment results are shown below in Table 5-1. The inland category was used for this assessment, as the Project development footprint is mapped within the inland zone on the Department of the Environment (2014) *Koala context map - coastal and inland*.

Table 5-1 Koala habitat assessment

Attribute	Scores	Inland	Project Area score
<b>Koala occurrence</b>	+ 2 (high)	Evidence of one or more Koalas within the last 5 years.	<b>Score = +2</b> Adapted SAT surveys and nocturnal spotlighting were carried out in the development footprint over five days and four nights in September 2020. There were 51 records of Koala during the survey period.
	+1 (medium)	Evidence of one or more Koalas within 2 km of the edge of the development footprint within the last 10 years.	
	0 (low)	None of the above	
<b>Vegetation composition</b>	+ 2 (high)	Has forest, woodland or shrubland with emerging trees with 2 or more known Koala food tree species, OR 1 food tree species that alone accounts for >50% of the vegetation in the relevant strata.	<b>Score = +2</b> The development footprint contains woodland with two or more known Koala food tree species: <i>Eucalyptus tereticornis</i> , <i>E. crebra</i> , <i>E. drepanophylla</i> and <i>E. acmenoides</i> .
	+1 (medium)	Has forest, woodland or shrubland with only 1 species of known Koala food tree present.	
	0 (low)	None of the above	
<b>Habitat connectivity</b>	+ 2 (high)	Area is part of a contiguous landscape ≥ 1000 ha.	<b>Score = +2</b> The contiguous landscape patch containing the Project Area is greater than 1,000 ha. This area of habitat is located on Nebo-Conners Range and is part of a contiguous landscape of 250,000 ha of suitable Koala habitat within 30 km of the Project Area.
	+1 (medium)	Area is part of a contiguous landscape < 1000 ha, but ≥ 500 ha.	
	0 (low)	None of the above.	
<b>Key existing threats</b>	+ 2 (high)	Little or no evidence of Koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for Koala occurrence. Areas which score 0 for Koala occurrence and have no dog or vehicle threat present	<b>Score = +1</b> The habitat patch has a degree of dog threat present, however this is not likely to be significant. Whilst

Attribute	Scores	Inland	Project Area score
	+1 (medium)	Evidence of infrequent or irregular Koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for Koala occurrence, OR Areas which score 0 for Koala occurrence and are likely to have some degree dog or vehicle threat present.	undertaking field surveys, NGH ecologists recorded Wild Dog at one location within the Project Area.
	0 (low)	Evidence of frequent or regular Koala mortality from vehicle strike or dog attack in the study area at present, OR Areas which score 0 for Koala occurrence and have a significant dog or vehicle threat present.	
<b>Recovery value</b>	+ 2 (high)	Habitat is likely to be important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	<b>Score = +2</b>  The habitat patch is within a large contiguous landscape patch of good quality and refugia habitat located on the Clark-Conners Range.
	+1 (medium)	Uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	
	0 (low)	Habitat is unlikely to be important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	
<b>Total Score = 9</b>			

The Project Area had a score of 9, which indicates that the habitat is critical for the survival of Koala.

### 5.1.3 Squatter Pigeon (Southern)

The Squatter Pigeon (southern) is listed as Vulnerable under both the EPBC Act and NC Act. Squatter Pigeon (southern) is a medium-sized, ground-dwelling pigeon. Habitat is generally defined as open-forests to sparse, open-woodlands and scrub that are:

- mostly dominated in the overstorey by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species
- remnant, regrowth or partly modified vegetation communities
- within 3 km of water bodies or courses.

Breeding habitat occurs on stony rises occurring on sandy or gravelly soils, within 1 km of a suitable, permanent waterbody (DAWE, 2020a). The Squatter Pigeon (southern) is known to access suitable waterbodies to drink on a daily basis. Waterbodies suitable for the subspecies include permanent or seasonal rivers, creeks, lakes, ponds and waterholes, and artificial dams. It is estimated that approximately 95% of the Squatter Pigeon's (southern) diet consists of seeds. The subspecies mainly forages on seeds which have

fallen to the ground from low vegetation, such as grasses, herbs and shrubs. Squatter Pigeons (southern) commonly forage along the sides of roads or along dusty tracks. The subspecies is also commonly seen foraging in and around stockyards, where they also pick seeds and ticks from the droppings of livestock and drink from stock troughs. Squatter Pigeon recorded in the Project Area were close to stock troughs and cattle feeding areas, and each record was within 100 m of a waterway.

#### **Lotus Creek Squatter Pigeon population**

- Recorded at 15 locations within the proposed Project Area.
- Found in small (1-2 individuals) to larger flocks (up to 8 individuals).

#### **Lotus Creek Squatter Pigeon habitat**

- Around half of the records were within non-remnant vegetation and were particularly focused around cattle feed, water areas and human habitation (presumably due to access to cattle and poultry feed).
- Most of the records in remnant vegetation were located in RE 11.12.6a, which is near a residential house.
- This species is known to occur in degraded habitats such as pastures, stockyards and road reserves where they are in close proximity to wooded areas.

#### **Lotus Creek Squatter Pigeon threats**

- Only one record of dog (a scat) was made during the Spring 2020 survey, suggesting a very low density of wild dogs and few predators for Squatter Pigeon.

### **5.1.4 White-throated Needletail**

The White-throated Needletail is listed as Vulnerable and Migratory under the EPBC Act, and Vulnerable under Queensland's NC Act. It breeds in Siberia and Japan and migrates to Australia in its non-breeding season. It usually arrives in Queensland moving southward in October and northward in March or April (Higgins 1999; Menkhorst et al. 2017).

Although susceptible to mortality it is still quite common, particularly over the forested ranges of the Great Divide (Higgins, 1999). A total of 42 individuals were recorded within the Site Boundary during surveys. It is not expected that numbers of White-throated Needletail passing through Lotus Creek Wind Farm would be great enough to place the overall population at risk, because of the large area of Great Dividing Range that this species would move through during its migration and wintering quarters.

### **5.1.5 Corben's Long-eared Bat**

The presence of Corben's Long-eared Bat (*Nyctophilus corbeni*) cannot be confirmed as calls from this species are not reliably distinguishable from other species of bats within the *Nyctophilus* genus. *N. corbeni* is typically a clutter-foraging low flyer in forest, over water pools and is also found in disturbed forests. Their known distribution is largely restricted to the Murray Darling Basin through Queensland and New South Wales but they do occur in small areas in Victoria and South Australia. The preferred habitat is box/ironbark/cypress woodland in remnant vegetation communities. They are found significantly more in connected and extensive areas of vegetation with a canopy and densely scattered midstorey (TSSC 2015).

On site, areas of marginally suitable habitat do occur throughout the study area. The site is located within the 'possible' distribution of the species with the closest record on Australian Living Atlas located approximately 200 km south (ALA 2020).

Corben's Long-eared Bat was not confirmed during the surveys, however *Nyctophilus geoffroyi* was captured in the harp traps. Calls of Corben's Long-eared Bat are not distinguishable reliably from other sympatric *Nyctophilus* species using Anabat/songmeter detectors and processing with zero-crossing analysis. The calls recorded match those of the Least Concern *N. geoffroyi* and were recorded close to the confirmed record of this species. This makes it likely that the Anabat recording is of the non-threatened *N. geoffroyi*.

*N. corbeni* is considered to have a moderate likelihood of occurrence, and a low likelihood of being impacted by the Project (Appendix C).

### 5.1.6 *Cycas megacarpa*

One threatened flora species was confirmed within the Project Area: *Cycas megacarpa*; listed as endangered under the EPBC Act. *Cycas megacarpa* is found in woodland, open woodland and open forests, often in conjunction with a grassy understory. This species is found in habitat dominated by *Eucalyptus crebra* and *Corymbia citriodora* as well as *Corymbia erythrophloia*, *Eucalyptus melanophloia* and *Lophostemon confertus*.

## 5.2 MIGRATORY SPECIES

Three fauna species listed as Migratory under the EPBC Act were confirmed within the Project Area. These listed Migratory species were White-throated Needletail *Hirundapus caudacutus* (Vulnerable and Migratory), Satin Flycatcher *Myiagra cyanoleuca* and Fork-tailed Swift *Apus pacificus*.

### 5.2.1 White-throated Needletail

White-throated Needletail *Hirundapus caudacutus* (Vulnerable and Migratory) is described above in Section 5.1.4.

### 5.2.2 Satin Flycatcher

The Satin Flycatcher is listed as migratory under the EPBC Act, and six individuals were observed flying over the Project Area. Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Satin Flycatchers are migratory, moving north in autumn to spend winter in northern Australia and New Guinea. They return south in spring to spend summer in south-eastern Australia (DAWE 2020a). They are inconspicuous when on passage, possibly because movements are made singly or in pairs or small loose groups through the tree-tops, possibly at night. Departure times vary between regions. Satin Flycatchers are mainly insectivorous, preying on arthropods, mostly insects. They will occasionally also eat seeds. They are arboreal foragers, feeding high in the canopy and subcanopy of trees, usually sallying for prey in the air or picking prey from foliage and branches of trees, flitting from one perch to another, constantly wagging their tail (DAWE 2020a).

### 5.2.3 Fork-tailed Swift

One Fork-tailed Swift was observed flying over the Project Area. This species is widespread but scattered in the east Queensland, and is typically recorded recorded in eucalypt forests, especially wet sclerophyll forest (DAWE 2020a). Satin Flycatchers are migratory, moving north in autumn to spend winter in northern Australia and New Guinea. They return south in spring to spend summer in south-eastern Australia and generally arrive in south-eastern Queensland in September. This species is under threat from clearing in south-eastern Australia (DAWE 2020a).

## 6 IMPACT ASSESSMENT

An assessment of both the construction and operational impacts of the Project on flora, vegetation communities, and fauna are provided below.

### 6.1 AREA OF IMPACT – VEGETATION CLEARING & TRIMMING

The area of impact is based on the worst-case Project Footprint (see Section 1.3.3 for a description of what this includes).

Not all of the Project Footprint will need to be cleared of vegetation. The footprint has been chosen to encompass areas which are already cleared (7.6 ha, including existing roads), resulting in a total clearing area of 312.8 ha (Table 6-1). Additionally, the Project Footprint includes areas where clearing can be avoided, but trimming will be necessary, with maximum vegetation heights specified by:

- Transmission line: Powerlink’s easement guidelines (Powerlink Queensland Site Selection, Easements and Sites Guideline, Version 6.0. 2018) (see also Figure 6-1).
- St Lawrence Croydon Road: swept path clearance heights according to the Project traffic assessment and manufacturer’s instructions when transporting 90 m long blades.

Within the transmission line and along St Lawrence Croydon Road there is vegetation which will need to be trimmed to a specific height as well as areas of vegetation that are already of the correct height (according to Lidar data) which would need to be monitored and potentially trimmed in future. For example (from Table 6-1), the area of vegetation:

- required to be trimmed to 1 m = 3.7 ha
- required to be trimmed to 2 m = 1.7 ha
- required to be trimmed to 3.5 m = 18.3 ha
- already less than 3.5 m in height that would be monitored and trimmed if required = 32.8 ha.

Table 6-1 Area of impact on vegetation - clearing and trimming amounts (ha)

	Clearing			Trim to 1m			Trim to 2m			Trim to 3.5m		
	<i>Proposed</i>	<i>Existing</i>	<i>Net Impacted</i>	<i>Proposed</i>	<i>Existing &lt; 1m</i>	<i>Net Impacted</i>	<i>Proposed</i>	<i>Existing &lt; 2m</i>	<i>Net Impacted</i>	<i>Proposed</i>	<i>Existing &lt; 3.5m</i>	<i>Net Impacted</i>
Wind Farm	304.8	6.2	298.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
Transmission Line 275kV OH	23.0	0.4	22.6	8.2	4.5	3.7	NA	NA	NA	48.7	30.7	18.0
St Lawrence Croydon Road Upgrades	3.7	1.1	2.6	NA	NA	NA	5.2	3.6	1.6	NA	NA	NA
<b>Subtotals</b>	<b>331.5</b>	<b>7.6</b>	<b>323.9</b>	<b>8.2</b>	<b>4.5</b>	<b>3.7</b>	<b>5.2</b>	<b>3.6</b>	<b>1.6</b>	<b>48.7</b>	<b>30.7</b>	<b>18.0</b>

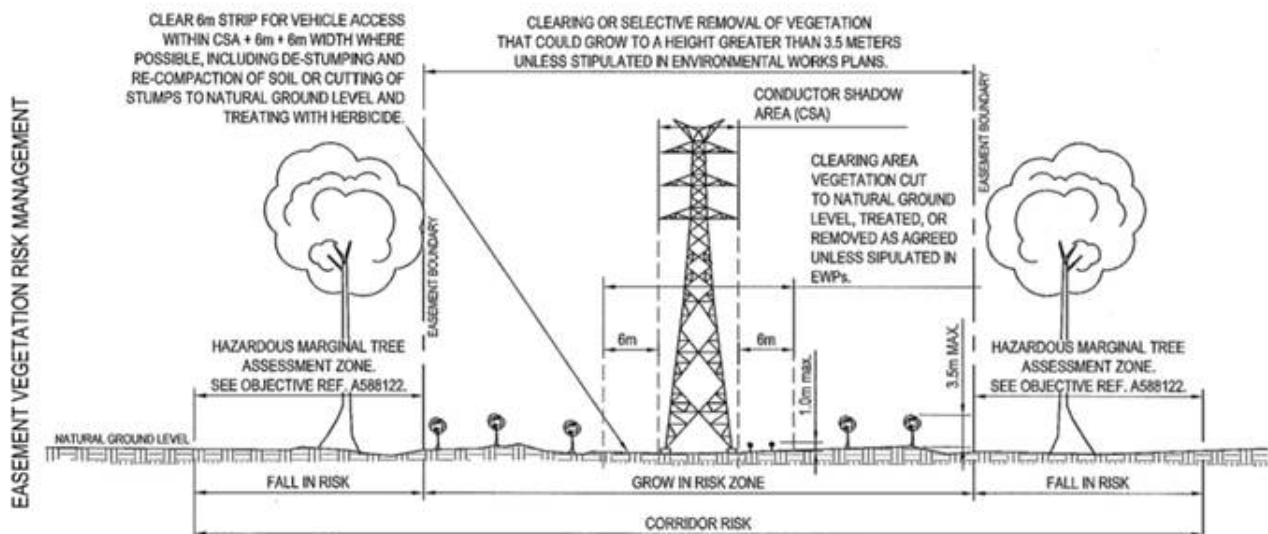


Figure 6-1 Vegetation clearing and trimming within the transmission line alignment (from Powerlink Queensland Site Selection, Easements and Sites Guideline, Version 6.0. 2018).

## 6.2 SUMMARY OF IMPACTS ON FLORA SPECIES

### 6.2.1 Construction impacts

Construction impacts to flora are expected to include:

- increased competition from weed species which may be introduced to the Project Area or spread to new locations as a result of the Project
- clearing of or damage to EPBC Act listed cycad species; *Cycas megacarpa*, within the development footprint
- increased threat of fires being ignited through construction activities such as welding activities, hot exhausts from vehicles and machinery, and sparks from slashers.
- erosion and sedimentation
- the clearing of up to 322.7 ha of remnant vegetation and trimming of 22.6 ha.

### 6.2.2 Operational impacts

Ongoing operational impacts are restricted mainly to the threat of potential invasion and spread of weeds which could change the species composition within remnant vegetation communities, and consequently reduce the overall biodiversity values of these areas.

Operational weed management measures will be implemented to mitigate these potential impacts (refer to Section 7). No other operational impacts on vegetation communities are anticipated.

## 6.3 SUMMARY OF IMPACTS ON VEGETATION COMMUNITIES

The assessment of the impacts of the Project on Queensland's Regional Ecosystems was conducted on the current (version 10.6) State Regulated Remnant Vegetation Maps (DNRME, 2019) as there was found to be little difference between the state-mapped and ground-truthed vegetation communities (see Section 4.2.2).

### **6.3.1 Construction impacts**

#### **Impacts based on State mapped vegetation**

The impacts of the Project on State-mapped vegetation communities has been calculated below using the maximum area of vegetation clearing within the development footprint. This considers the maximum area to allow vehicle movement and the construction of overhead powerlines and is therefore the 'worst-case scenario'.

Applying the maximum clearing impact, the Project will result in the removal of a up to 310.1 ha of remnant vegetation including trimming, 1.7 ha of high value regrowth and a total of 0.4 ha of State-mapped Of Concern RE. A more detailed assessment of the significance of the impacts of this removal is provided in the Significant Residual Impact (SRI) assessments in Section 8.2.2, including the specific REs to be impacted.

### **6.3.2 Operational impacts**

Ongoing operational impacts are restricted mainly to the threat of potential invasion and spread of weeds which could change the species composition within remnant vegetation communities, and consequently reduce the overall biodiversity values of these areas.

Operational weed management measures will be implemented to mitigate these potential impacts (refer to Section 7). No other operational impacts on vegetation communities are anticipated.

## **6.4 SUMMARY OF IMPACTS ON FAUNA SPECIES**

### **6.4.1 Construction impacts**

Impacts to fauna and their habitats that may occur during construction of the Project include:

- habitat clearance associated with the Project. The consequences of this impact may include:
  - direct loss of native fauna habitat
  - injury and mortality to fauna during clearing of fauna habitat, including hollow-bearing trees, bird nest, and ground-dwelling fauna denning sites
  - removal of actual and potential breeding sites through disturbance to hollows, fallen timber, dead wood and bush rock
  - introduction and spread of noxious weeds and pathogens that may negatively affect native flora and fauna
  - reduced connectivity for wildlife movement
- increased risk from introduced predators through greater access created by roads and potential increases in abundance due to access to human waste (if not removed)
- fauna collisions with construction vehicles
- threat of fire being ignited through construction activities such as:
  - welding activities
  - slashing and grading roads
  - hot exhausts from vehicles and machinery
- noise, lighting and vibration which may disturb breeding and roosting fauna.

#### **Impacts on threatened fauna habitat**

Impacts to MNES fauna species have been calculated on based on the (maximum) area of habitat that will be cleared by the Project. MNES habitat was identified using the approach described in Section 3.2.6. Clearing impacts have been considered within the development footprint and compared with the available habitat in the



site, and within a 30 km radius (Table 6-1). These values inform the assessment of significance (Section 8.1). Figure 6-1, Figure 6-2 and Figure 6-3 illustrate the extent of MNES habitat and potential impacts from the Project.

Table 6-2 Comparison of MNES habitat area within the development footprint and landscape area

MNES	Suitable habitat within the development footprint	Suitable habitat within the Site Boundary		Suitable habitat within the landscape area (30 km)	
	ha	ha	% impacted	ha	% impacted
Koala	345.5	48,393.2	0.72	251,203	0.13
Greater Glider (moderate and high quality)	1.0	10,158	0.01%	80,017	0.001
Squatter Pigeon	43.1	17,515	0.25%	156,292	0.03



Figure 6-2 Potential impacts to Koala habitat

Figure 6-3 Potential impacts to Greater Glider habitat

Figure 6-4 Potential impacts to Squatter Pigeon habitat

## 6.4.2 Operational impacts

The operation of wind turbines presents a risk to a range of birds and bats. The main risk is mortality through collision with moving turbine blades (blade-strike), although alienation (behavioural avoidance of suitable habitat near infrastructure) is also an important issue to consider. A summary of the general impact risks to birds and bats from collisions and habitat avoidance is provided below, followed by a summary of the bird and bat species considered likely to be at risk from the Lotus Creek Wind Farm project.

### Collision impacts on birds and bats

Birds and bats flying within or close to the RSA are at risk of collision impacts. This is the area of air space defined by the rotation of the turbine blade. As well as direct collision with infrastructure, the rotating blades produce a wake with turbulence, eddies and blade-tip vortices; the wake is principally behind the turbine (Sandersee 2009). The extent of the wake is influenced by factors including blade design and landscape location. The wake extends behind the turbines at least three blade-diameters (Holland 2008), attenuating with distance. The lateral extent of the wake appears to be less than a blade length (Maalouf et al. 2009), but this is not well studied. In summary, the wind turbine primarily presents a collision risk to birds and bats that fly within RSA height. An additional risk occurs for species that are affected by the wake. Therefore, the ground clearance of the RSA relative to the flying height of bird species is a key consideration.

The earliest large-scale wind farms, such as Altamont Pass in California, experienced high levels of avian collision mortality, mainly of migrating raptors. Turbine design, pre-development survey's, consideration of impacts and wind farm layouts have since substantially progressed. While bird and bat fatalities continue to be recorded at modern wind farms, these are at substantially lower rates (EPHC 2010).

Within a wind farm project design layout generally, there is potential for some turbines to result in higher collision risk to bird and bat species (Thelander 2004; Kunz et al. 2007). These higher risk turbines are defined in areas where bird and bat collisions are considered more likely to occur due to proximity to:

- Steep topography: gully heads, ridge lines, deep valleys and escarpments. These areas can concentrate migrating birds along relatively narrow pathways. They also provide updraughts utilised by swifts, swallows, martins, gulls and raptors.
- Wetlands: marsh, pond, lake, stream, and/or river. Higher concentrations of birds and bats would be encountered near water sources. Water bodies may also provide staging areas for migrating waterbirds.
- Dense vegetation areas: woodland, forest, tree lines, tree clusters supporting habitat resources such as hollow-bearing trees. Narrow flight corridors usually occur through gaps between habitat patches.

Species considered to be at risk from impacts associated with collisions with turbine blades during the operation of the Lotus Creek Wind Farm project are discussed further below.

### Alienation impacts

Operational wind turbines may cause changes in bird and bat behaviour. Where such behaviour includes avoiding nesting or foraging resources or diverging around the broad area where turbines are located, this is termed an 'alienation' or 'barrier' effect. The turbines, in these instances, act to 'sterilise' otherwise suitable areas of habitat or movement pathways. Alienation may affect local sedentary birds in their daily traverses for foraging, roosting and breeding sites or may cause migratory birds to shift migratory flyways. Birds and bats may be forced to change their flight behaviour to avoid collisions with turbines, subsequently impacting on their breeding and foraging success (Drewitt and Langston 2006). Alienation of hunting habitat for raptors such as Wedge-tailed Eagle may be of particular concern (Smales 2006) for local populations. The distance over which disturbance effects can extend from a wind farm varies considerably. A distance of 600 m is often reported as the zone of disturbance around turbines, however this ranges from 80 m (for a grassland songbird), to 800 m (for waterfowl) and 4 km (for seabirds) (Sharp 2010). Barrier effects have been

demonstrated at offshore wind farms in Europe, however there is little evidence at onshore farms (EPHC 2010; Hull 2013a).

Siting and configuration of turbines is the primary factor influencing alienation impacts; inappropriate layout (such as lines of turbines between important habitat features) can create a barrier effect, resulting in habitat loss or fragmentation (Brett Lane and Associates 2009). Turbines are generally placed to maximise wind values and to minimise turbulence from topographic features and other turbines. In practice, this means there are usually large and variable spaces between turbines (Smales 2006). Rows of turbines throughout the Project Area could in effect act as multiple barriers to the movement of birds and bats, particularly if spaced too closely together.

### **Species at risk from wind farm operation impacts**

The summary provided below of the species considered to potentially be at risk from the Lotus Creek Wind Farm focusses primarily on risks associated with collision impacts. Whilst habitat avoidance may be a potential impact arising from the operation of the wind farm, it is not possible at this stage to identify which particular species may be at risk from this type of impact, although generally it is those species that either are habitat specialists (i.e., they only occupy specific types of habitats) and/or species that rely on habitats that are scarcely distributed, with important habitat features present within the Project footprint. To ascertain species at risk of habitat avoidance impacts requires establishment of a comprehensive set of baseline data under a BACI (Before After Control Impact) survey design. It is noted however that the particular habitat types found within the development footprint are abundant and widely distributed in the locality, within and surrounding the site, and as such, the level of risk of alienation impacts to bird and bat species arising from the wind farm operation is considered to be low.

#### **Birds**

Generally speaking, birds at risk of collision are those that frequent the RSA (Hull et al. 2013b). Not all species of bird are at equal risk of collision with turbines. Generally, the identified groups at higher risk are (Kunz et al. 2007; Kingsley and Whittam 2003):

- **Raptors:** Soaring birds use landform features such as elevation, ridges and slopes to cruise and take ascendance. Further, they are generally higher order species, meaning they are less abundant and therefore more susceptible to population level impacts.
- **Passerines:** Passerines have been among the most frequently reported fatalities at wind farms in Europe, America and Australia. Breeding birds in the vicinity of wind farms may be at greater collision risk if displaying aerial courtship. Migrating and nomadic passerines typically fly at altitudes of 150 m or higher.
- **Waterbirds:** waterbird (i.e., grebes, cormorants, ducks, waders, cranes, rails, crakes, gulls, shorebirds) fatalities have been reported worldwide at wind farms close to staging, breeding and wintering areas. Note that no waterbirds were observed within the Project Area, however it is expected that they would periodically utilise the site.

In addition, wind farm sites may be frequented by scavenger species (e.g. crows, raptors), attracted by crops, livestock or carrion, resulting in an increased risk of collisions with turbines.

However, publicly available carcass monitoring data from Australian wind farms, which is restricted mainly to several facilities in Tasmania, have found *no single foraging or taxonomic guild* to predominate amongst mortalities. Species colliding with wind farms include *carnivores, scavengers, nectivores and ground- and aerial-feeders* (Woehler 2018). In Victoria, the species most often discovered in mortality surveys are, in descending order, Australian Magpie, Brown Falcon and Nankeen Kestrel (Smales pers. comm. May 2016).

Australian carcass monitoring results reviewed by Hull (2013a) suggest that approximately 20% of the bird assemblage present at the wind farm are involved in collisions; common species were found to be at most risk of colliding with turbines rather than rare or threatened species, based on their higher abundance.

However, De Lucas et al. (2008) found no clear relationship between species abundance and species mortality (overseas study).

In assessing the risk of the operation of the Project to birds, experience has been drawn from the preparation of Bird and Bat Risk Assessments at other wind farm projects (for example Silverton Wind Farm and Yass Valley Wind Farm). Higher risk bird species are typically identified based on the presence of suitable habitat within the development envelope for each species, as well as the (normal) flight height and character, movement behaviours (as either sedentary, nomadic or migratory), dispersal capability and typical population density for each species. For example, species that are either rare or threatened, or are known to fly high above the tree canopy at heights that would place them within the RSA, or have flight behaviours that would put them in conflict with turbines (such as using updrafts along ridge slopes to gain soaring height), including having a heavy or cumbersome flight behaviour, or species that are known to be migratory, could be considered at risk from the wind farm.

In addition to the above risk factors, some species, such as the Wedge-tailed Eagle and Whistling Kite are attracted to carrion, and often scan more open or cleared areas, such as roadsides, for carcasses. The cleared open areas of turbine hardstands (and often immediately surrounding areas) can also be areas where eagles, kites and the like could be attracted to if a carcass was spotted in the area. This can draw birds to the turbine which therefore increases the risk of collisions with turbines.

Given the above considerations, and based on the bird species recorded at the site, the bird species considered to potentially be at some risk from turbine collisions include the following (sighted during the BUS):

- Raptors, including the:
  - Wedge-Tailed Eagle (*Aquila audax*)
  - Brown Goshawk (*Accipiter fasciatus*)
  - Brown Falcon (*Falco berigora*)
- Migratory species, including primarily high-flying species such as the White-throated Needletail.

The main species likely to be affected by turbine strike are the Wedge-tailed Eagle, with 93.3% of observed flights of this species at RSA height. The number of raptors was low in relation to the total number of birds recorded during the survey. However, raptors formed approximately 15.7% of birds seen at RSA height. Based on the utilisation rate by other raptors (Nankeen Kestrel and Brown Falcon) at the impact points, risks to these species is likely to be low (Brown Falcon) to moderate (Brown Goshawk). It is not expected however that wide regional populations of these common raptor species would be affected by the wind farm proposal. White-throated Needletail is known to forage at RSA height and is therefore susceptible to mortality.

Birds were not prone to flying at RSA heights at one point more than others, indicating that risk to birds is likely to be uniformly distributed over the Project.

The overall risk of the wind farm operation resulting in high mortality rates to the above species is considered to be low. These species should however remain high-risk species for ongoing monitoring and management purposes.

It is expected that some common species, including the Pied Currawong (the most abundant species on site), will feature in mortality counts, however given that species such as this are common in the area, and that many individuals will likely learn to avoid turbines, any mortalities are not expected to result in a significant risk to the long- term viability of any resident populations.

Notwithstanding the low risk to bird species from operational impacts, a Bird and Bat Management Plan (BBMP) will be prepared to monitor and provide management strategies to reduce the likelihood of occurrence of mortalities.

## **Bats**

Bats, and more specifically microbats, are the second largest group of vertebrates to be impacted by collision impacts at wind farms worldwide (Cryan and Brown 2007, Kunz et al. 2007). In terms of blade-strike, Australian species that appear to be most at risk are those that forage well above canopy height (i.e., in open airspace) and move through their environment at high speeds, such as the White-striped Freetail Bat. These species are more likely to travel at the RSA. Collisions result either where the individual fails to detect the moving blades or is unable to manoeuvre around them.

Another group of microbats that appears to be at high risk from wind farms, based on international studies, are those that migrate (Baerwald et al. 2008). Migrating bats are thought to travel high in the air column on 'auto-pilot'. That is they appear to rely less on echolocation when migrating, instead navigating using alternative spatial senses or orographic features such as mountain ranges (Baerwald et al. 2008, Popa-Lisseanu and Voight 2009). Consequently, migrating bats may fail to detect wind turbines.

Based on the above, two groups of Australian bats can be identified as higher risk from blade-strike impacts:

- Non-migrating, high-flying microbats
- Migrating, high-flying microbats, particularly those of conservation concern.

Given the above considerations, and based on the bat species recorded at the site, the bat species considered to potentially be at some risk from the wind farm is:

- White-striped free-tailed bat (*Austronomus australis*)
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*)
- Troughton's Sheath-tailed Bat (*Taphozous troughtoni*).

The Yellow-bellied Sheath-tail-bat is listed as a common species and was recorded numerous times across the site, in both survey seasons. The species is widespread across Australia, although in some localities in Australia may occur at low abundances. Given the extensive areas of similar and potentially suitable habitat surrounding the site, it is unlikely that the species would be restricted to the site, and therefore would be unlikely to have any high-use or migratory flight paths through the Project Area. The overall risk of the wind farm operation resulting in high mortality rates to the above species is considered to be low, however this species should remain a high-risk species for ongoing monitoring and management purposes.

Additionally, given the extensive areas of similar suitable habitat surrounding the site, it is unlikely that there would be any alienation impacts from habitat avoidance/sterilisation that would substantially negatively affect a local population of the identified bat species at the site.

The South-eastern Long-eared Bat was potentially detected in the Project Area. It is thought to be a low flying species but it may occasionally fly at RSA height, increasing the potential for it to come into contact with turbine blades. It may inhabit a range of areas across the Project site and utilises a variety of habitats. Information on mortalities of this species due to collision with turbine blades is unavailable or non-existent and BL&A has not encountered mortalities of this species at other wind farms monitored in NSW. If this species was present at the Project site, it is unlikely to be a regular occurrence. Current population estimates are unavailable for the species so the loss of a few individuals' impact on the population is unknown. Therefore, the species consequences from the Project site has been conservatively designated as **low**, as a precaution.

## 7 PROPOSED AVOIDANCE AND MITIGATION MEASURES

The recommended avoidance and mitigation measures for the Project are detailed in the following section. The proposed measures are in accordance with the development mitigation hierarchy, which aims for a result of 'no net loss' of biodiversity through implementing, in the following order, avoidance, mitigation, rehabilitation/restoration and offsetting (Figure 7-1). The goal of 'no net loss' is to enable appropriate development without associated biodiversity losses (Gardner et al. 2013).

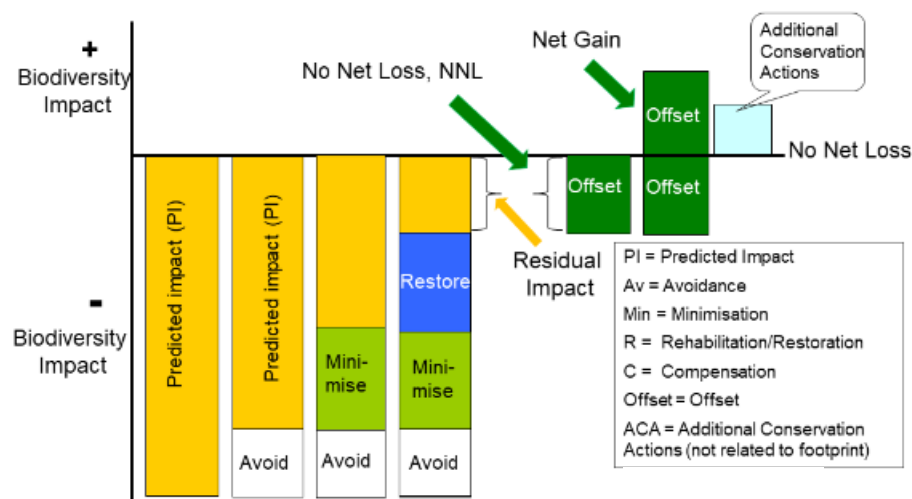


Figure 7-1 The mitigation hierarchy (from Forest Trends Association, 2020)

### 7.1 AVOID AND MINIMISE

The Project has been designed to:

- avoid impacts to Greater Glider habitat, which is also high-quality habitat for Koala (see Figure 7-2)
- minimise impacts to the Clarke-Connors Range bioregion
- minimise impacts to Koala (and other MNES, such as Squatter Pigeon) habitat due to:
  - Smaller project (from 81 turbines down to 55 turbines; and from 620 ha (original Project Area [2020/8627]; down to maximum impact of 345.4 ha)
  - Reduced project footprint: refinement of detail in design
  - Individual turbine siting assessment: comparative selection by energy generation vs impact
  - Siting turbines as close to existing or proposed tracks as possible
  - Siting the transmission line adjacent to the existing state road (Figure 7-2)
  - Siting turbines in areas of lower density non-juvenile Koala habitat trees (Figure 7-2).



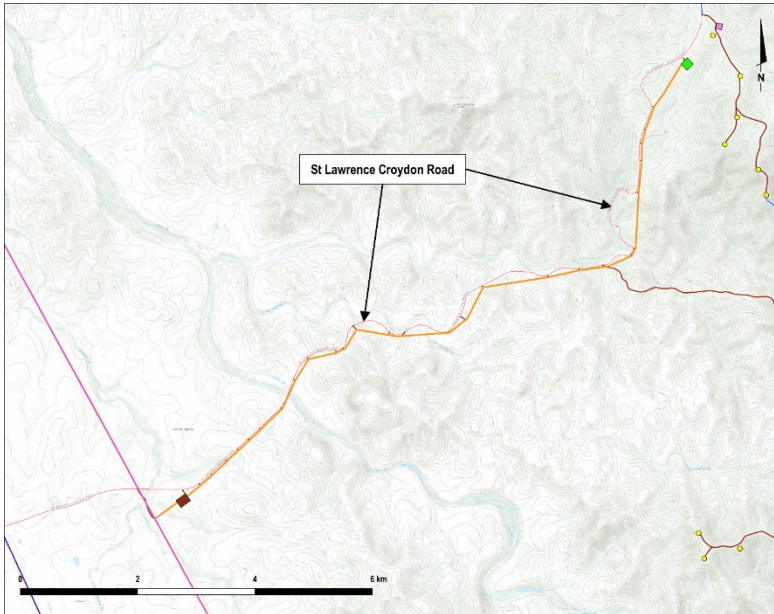


Figure 7-2 Example of how the transmission line has been aligned with an existing cleared area (state controlled road)

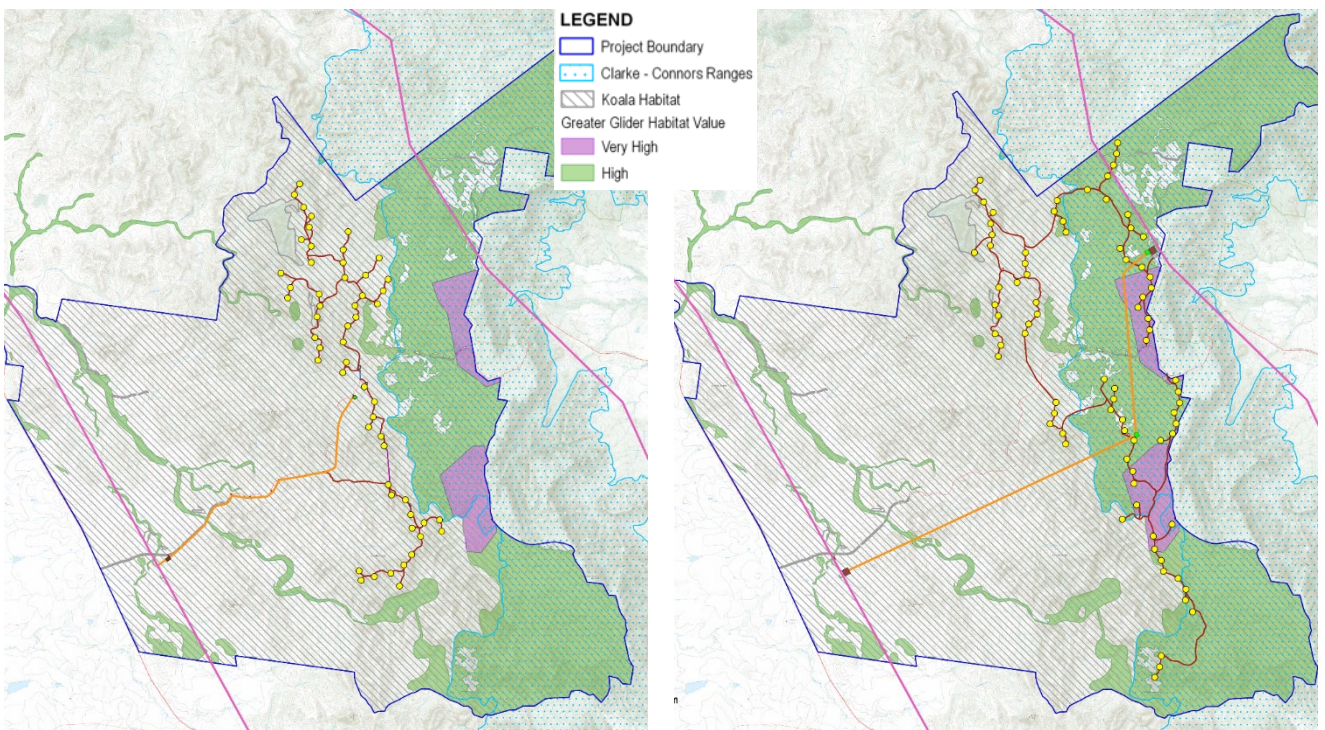


Figure 7-3 Summary of how the Project has been redesigned to avoid or minimise Greater Glider habitat - current footprint (left) vs original footprint (EPBC 2020/8627; right)

Non-juvenile Koala habitat trees (NJKHT) are defined as Koala habitat trees (*Angophora*, *Corymbia*, *Eucalyptus*, *Lophostemon* or *Melaleuca* species) which are more than 4 m high or has a trunk with a circumference more than 31.5 cm at 1.3 m above the ground (DES 2020b). Lidar data has been analysed to identify all vegetation which is height classes greater than 5 m, and wind farm infrastructure has been preferentially located in areas with a lower density of non-juvenile Koala habitat trees to minimise removal of this resource.

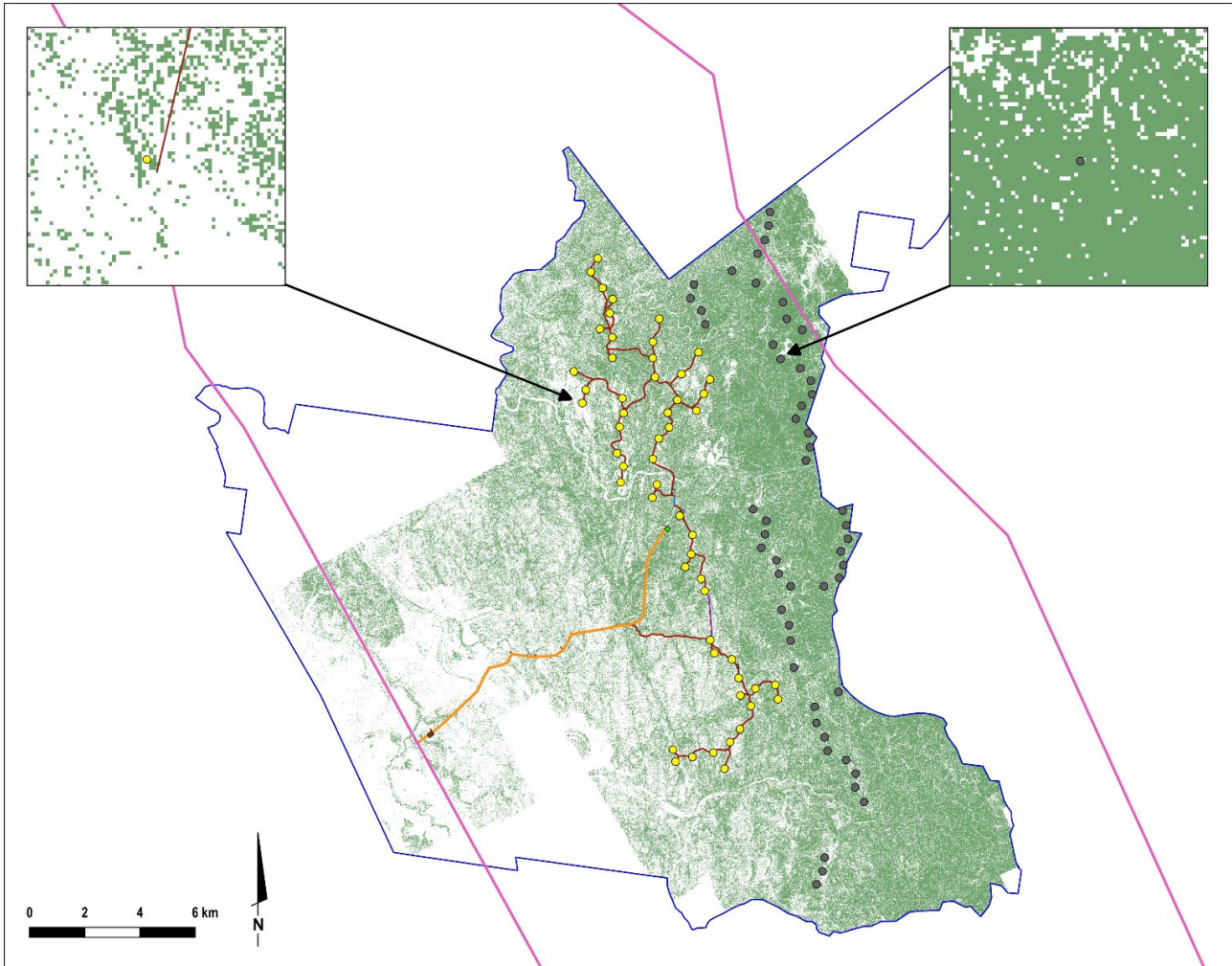


Figure 7-4 Illustration of how the Project has been redesigned to minimise the loss of Koala habitat trees

## 7.2 PROPOSED MITIGATION

Construction phase management measures will be described in greater detail in the **Vegetation and Fauna Management Plan**, which will be developed following the detailed design stage for the Project. Operational impacts relating to birds and bats will be managed through a project **Bird and Bat Management Plan**, developed with reference to the final project design. Measures proposed to avoid, minimise or mitigate impacts to flora and fauna species and their habitat are detailed in Table 7-1, below. The effectiveness of the mitigation measures have been well-established through demonstrated application in comparable wind farm developments and studies (van der Ree 1999, Thompson and Thompson 2015).



Table 7-1 Proposed measures to avoid, minimise and mitigate impacts to flora, fauna and habitat

Threat	Action	Benefit	Timeframe
<b>Avoid</b>			
Loss of habitat	The Project will avoid most Greater Glider habitat and the Clarke-Connors Range	<ul style="list-style-type: none"> <li>No impacts on Greater Gliders.</li> <li>No impacts on the area with the highest ecological value on the Site.</li> </ul>	Pre-approval
Loss of habitat	Locate turbines close to existing roads	<ul style="list-style-type: none"> <li>Reduces clearing impacts</li> <li>Reduces potential offset requirements</li> </ul>	Pre-approval
Loss of habitat	Site turbines in areas of lowest tree density	Demonstrates considerate design which has aimed to avoid impacts to biodiversity.	Pre-approval
Loss of habitat	Access road route options will be optimised so that they, in order of preference: <ul style="list-style-type: none"> <li>incorporate existing roads and tracks where possible</li> <li>traverse existing cleared areas (with micro-aligning the track to miss as many trees as possible)</li> <li>are as short as feasible</li> <li>reduce road widths to as small as possible where the roads go through remnant vegetation</li> </ul>	Reduces clearing impacts	Pre-approval
Loss of habitat	Use of underground cabling within the road footprint throughout the majority of the Project Area.	Reduces clearing requirements	Pre-approval
Loss of habitat	Refine the bushfire buffers depending on the vegetation community where infrastructure is located.	Reduce ecological impacts	Pre-construction
<b>Minimise</b>			
Loss of habitat	Where possible, retain shrub layer and ground cover. Clearing will be managed through removal of vegetation in (structural) layers – i.e., the trafficable area will need to be cleared and hardened, but wider, buffer areas should not be hardened, to allow native shrubs / ground layer to regenerate, whilst removing tree layer. This allows for small animal movement through the understory while providing	Encourages rehabilitation, will cause less residual significant impact	Construction

Threat	Action	Benefit	Timeframe
	access for wind towers / blades etc over the maintained lower vegetation.		
Loss of habitat and erosion and water quality impacts	Reduce clearing of riparian vegetation.	This will limit potential impacts to water quality from sediment and erosion of waterways during construction and will also have the added benefit of reducing the potential for removal of large hollow-bearing trees present within this area.	Pre-construction and construction
<b>Mitigate</b>			
Loss of habitat	Prior to the commencement of work, a physical vegetation clearing boundary at the approved clearing limit will be clearly demarcated and implemented. The delineation of such a boundary will include the use of temporary fencing, survey pegs, or similar. Areas outside the demarcated clearing boundaries are considered 'no go' zones.	Protection of vegetation and habitat close to the development footprint from construction impacts.	Construction
Loss of habitat	Development of a <b>Rehabilitation Plan</b>	Ensures that cleared areas are progressively rehabilitated and maximise the ecological benefit from the rehabilitation approach.	Construction
Loss of habitat	Pre-clearance survey of Cycads and weeds between two and four weeks before felling.	Allows for relocation of Cycads and management of weeds before construction	Pre-construction
Injured/dead wildlife	Fauna spotters on site (typically one per clearing front) for pre-clearance surveys and spotting during clearing	Identifies breeding places, threatened species, weeds, etc up to two weeks prior to clearing; allowing for additional controls to be implemented where there is an unexpected find or management trigger. During clearing, minimises risk of injury/mortality	Construction
Loss of habitat	Boulders and small rock piles that have been found to support a listed threatened fauna species will be salvaged and re-created in nearby areas outside the development footprint, where feasible.	Maintains habitat for fauna species that rely on rock piles.	Construction

Threat	Action	Benefit	Timeframe
Injured/dead wildlife	Two-staged clearing to give fauna a chance to move out of the development footprint	Minimises risk of killing animals, particular important in areas likely to support threatened species	Construction
Injured/dead wildlife	Sensitive clearing techniques (i.e., use of a grabber to slowly lower habitat trees)	Minimises risk of killing animals, particular important in areas likely to support threatened species such as Koala	Construction
Loss of habitat	Commitment to salvage and re-install natural hollows	This action is specific to any clearing within a 50 m buffer to high value Greater Glider habitat.	Construction
Injured/dead wildlife	Cherry picker on hand to check hollows and enable gliders (and other hollow dwelling species) to be captured and relocated prior to clearing	This action is specific to any clearing within a 50 m buffer to high value Greater Glider habitat.	Construction
Loss of habitat	Arborist as part of the fauna spotter team, to salvage and relocate hollows (will utilise cherry picker, and will also need to be an experienced tree climber)	This action is specific to any clearing within a 50 m buffer to high value Greater Glider habitat.	Construction
Injured/dead wildlife Increased disease risk due to stress (i.e., chlamydia in Koala)	Fauna spotter teams will include staff with wildlife health experience, who can identify suffering individuals and transport to wildlife vet for treatment.	Important for project for two reasons: 1) Site is remote, so difficult to deliver injured wildlife to a carer in a timely manner. 2) Risk of increased disease (especially in Koala), which can be partially mitigated by this action	Construction
Injured/dead wildlife Increased disease risk due to stress (i.e., chlamydia in Koala)	Donation to local wildlife carers (for every injured animal rescued during clearing). Will be per animal or lump sum.	Costly for carers to rehabilitate an injured animal and most carers do this on a purely volunteer basis.	Construction
Increased presence of predators	Responsive management program throughout both construction and operation, which may include shooting, trapping and baiting.	Site appears to have relatively low numbers of predators. However, opening it up with more roads makes it easier and quicker for predators such as wild dogs to move around, and if wildlife	Construction and post-construction

Threat	Action	Benefit	Timeframe
		are grounded when crossing cleared areas, they are more at risk of predation.	
Bushfire risk reduction	Reduce frequency and intensity of prescribed burns (one of three primary conservation actions (Glider) from SPRAT conservation advice; and hot crown fires are a Koala mortality risk - see National Koala Conservation and Management Strategy 2009–2014).	Addresses a topical and significant national threat - catastrophic bushfire	Construction and post-construction
Bushfire risk reduction	Early engagement with Queensland Fire and Emergency Services to incorporate mutually beneficial outcomes into project design - i.e., access tracks which also support fire-fighting access.	Addresses a topical and significant national threat - catastrophic bushfire	Pre-approval
Disturbance of wildlife	Night works will be minimised. When undertaking night works, lights (during nightworks and operation where necessary) will be directed away from vegetation and adjacent habitats.	Will reduce disruption to animal's nocturnal foraging, breeding activities. Will reduce disturbance of diurnal animals sleeping patterns.	Construction
Entanglement/death	Replacing boundary fencing in key locations (TBC closer to construction) to better facilitate movement – work will include the replacement the top strand of barbed-wire with plain wire (80% of entanglements are known to occur on the top strand of a barbed-wire fence).	Two Greater Gliders were observed dead on fences, also an issue for bats. This action will be an overall biodiversity improvement. Any new fencing would need to have plain wire top strand(s).	Construction
Cattle grazing	Cattle will be excluded from areas of the wind farm where there are regenerating koala habitat trees (so cattle don't trample/eat). - Removal of grazing, or a regime of lower impact grazing with lighter stocking rates, would improve site condition.	Improved natural regeneration, more koala habitat	Post construction
Predation, barrier to movement	As per excluding cattle - establishment of fenced and rehabilitated vegetated corridors/stepping stones in non-vegetated patches within the project site.	Improved natural regeneration, more koala habitat Longer term, provide refuge from predators	Construction, post-construction
Loss of habitat	Proactive land management of the whole site(s) – Project Area as well as an offset site, including weed control, feral animal control, active fire management and management of grazing will benefit threatened as well as all native species.	Improved natural regeneration	Construction, post-construction

## 7.3 CONSTRUCTION MANAGEMENT

A **Construction Environmental Management Plan** will be developed for the Project and submitted to DSDMIP prior to commencement. This will include measures such as (not exhaustive):

- Dust and erosion from stockpiling activities to be managed to avoid escape into adjacent habitats that may smother vegetation or other important habitats or lead to impacts on water quality and aquatic habitats.
- Where an unacceptable risk to soils and vegetation exists, bulk earthworks will be avoided during, and immediately following heavy rainfall.
- Trenches will be backfilled as soon as possible to minimise the chance of fauna becoming trapped. Trench sections left open overnight would be inspected early in the morning and any trapped fauna removed. The use of ramps or ladders to facilitate trapped fauna escape is recommended (dependent on the size of trench needed).
- Project vehicles and machinery, material laydowns, and stockpiling must remain within the Project disturbance footprint. Construction materials will not be stored on site for extended periods of time (e.g., periods of several months) as local fauna may take up residence and be injured when the materials are eventually moved.
- Topsoil will be stockpiled and protected separately for rehabilitation works. Where relevant (e.g., cable trenching, separate subsoils layers and topsoils layers will be replaced in their natural configuration to assist revegetation.
- Spill management and response measures will be developed to prevent contaminants affecting surrounding environments.
- Speed restrictions will apply onsite for safety and to reduce risk of fauna collision.

## 7.4 WEED AND PEST ANIMAL MANAGEMENT

A **Weed and Pest Animal Management Plan** will be developed prior to commencement (as part of the vegetation and fauna management plan). Measures will include the following:

- Identification and mapping of significant weeds occurring in construction areas prior to disturbance. This will support a clear determination of ‘clean’ and ‘infested’ construction zones to assist in weed management.
- The control of significant weeds recorded within the disturbance footprint; treat or remove weeds progressively prior to construction commencing in each area.
- All Category 3 restricted invasive plant species on site are not distributed or that all material be disposed of in accordance with legislative requirements.
- Preventative measures for the spread or introduction of weeds from offsite areas or between sites (particularly into “clear” zones).
- Monitoring of control and preventative measures and ongoing adaptive management to suppress weeds.
- Laydown sites for excavated spoil, equipment and construction materials would be weed-free or treated for weeds prior to use.
- Pest animal monitoring and responsive management program, which may include shooting, trapping and baiting (with consideration of Powerful Owl’s susceptibility to secondary poisoning).

## 7.5 OPERATION STAGE

A range of mitigation measures will be implemented to ensure that impacts on biodiversity during the operation stage of the Project are avoided and then minimised where they cannot be avoided. The



mitigation measures that would be employed during the operation stage of the Project to reduce the impacts on flora and susceptible fauna include:

- Development of a **Bird and Bat Management Plan** to determine if the Project is having any (unacceptable) impacts on bird and bat population and to identify appropriate adaptive mitigation measures. This plan will include, at a minimum, details on:
  - bird and bat monitoring regime
  - management of carcasses to reduce attractants to raptors within the vicinity of turbines
  - development and implementation of trigger levels and potential management measures if the wind farm is found to be having a significant negative effect on bird or bat populations
- Continuation of weed and pest animal management.
- Continuation of rehabilitation monitoring and management from the construction stage to ensure that site rehabilitation and weed management objectives are met.

## **7.6 MEASURES TO RESTORE/REHABILITATE**

Rehabilitation measures will be detailed in a **Vegetation and Fauna Management Plan**, and will include the following:

- Ensure areas disturbed during construction that are no longer required for operations (hardstand and road batters, cabling routes and temporary facilities) are stabilised and rehabilitated progressively during construction and preferably re-vegetated with appropriate species (native in native dominated areas) as soon as practical.
- Areas of remnant vegetation within a defined distance of a stream order 2 or higher watercourse will be rehabilitated following construction.
- Landscape plantings and/or seeding within disturbed areas will be comprised of local indigenous species with the primary objective of addressing erosion and sedimentation issues, but also to be consistent with the biodiversity values of the existing surrounding vegetation (e.g., species selections are to be consistent with the surrounding vegetation community composition, as well as meeting requirements for supplementation of feed tree species for threatened fauna such as Koala).
- Detail appropriate planting techniques for the different areas of the site, in consideration of climatic conditions (sterile cover crops may be required as an intermediate step to ensure early stabilisation of disturbed areas).
- Include monitoring to meet clear targets, regarding ground cover establishment.

## 8 DETERMINATION OF SIGNIFICANT RESIDUAL IMPACTS

### 8.1 ASSESSMENT OF IMPACT – MNES

#### 8.1.1 Overview and methodology

An assessment of the SRI has been undertaken in accordance with the Matters of National Environmental Significance - Significant impact guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999* (DAWE, 2013) and EPBC Act Policy Statement 3.21 – Industry guidelines for avoiding, assessing and mitigating impacts on EPBC ACT list migratory shorebird species (DAWE, 2017). The methods included in the guideline are designed to assist in deciding whether or not a prescribed activity will, or is likely to have, a significant residual impact on a matter of MNES.

#### 8.1.2 Assessment of significant impact on Critically Endangered or Endangered species

One Endangered species (EPBC Act) was confirmed within the Project Area; *C. megacarpa*.

*Under the significant impact criteria for endangered species, an action will likely have a significant impact if there is a real chance or possibility that it will:*

- i. *lead to a long-term decrease in the size of a population*
- ii. *reduce the area of occupancy of the species*
- iii. *fragment an existing population into two or more populations*
- iv. *adversely affect habitat critical to the survival of a species*
- v. *disrupt the breeding cycle of a population*
- vi. *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*
- vii. *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*
- viii. *introduce disease that may cause the species to decline, or*
- ix. *interfere with the recovery of the species.*

##### 8.1.2.1 *Cycas megacarpa*

Table 8-1 Assessment of significance of impacts on Endangered species: *C. megacarpa*

<b><i>Cycas megacarpa</i> - confirmed</b>
<b>Lead to a long-term decrease in the size of a population</b>
<i>C. megacarpa</i> were recorded at seven locations during ecological surveys. Individuals at these locations were scattered, with minimal to no signs of recruitment. As not all development footprints were surveyed on foot, additional cycads may be recorded within the development footprint prior to or during clearing. Given the size of the properties and the fact that cycad numbers were generally low within the development footprint, it is considered unlikely that the Project will lead to the long-term decrease of the population.

**Cycas megacarpa - confirmed**

**Reduce the area of occupancy of the species**

The cycads were found scattered across the Project Area, with no cycads recorded within the development footprint. There is anecdotal evidence that cycads have been actively removed from cattle farms along the Clarke-Connors range over generations as they are toxic to cattle.

It is considered unlikely that the Project will reduce the area of occupancy for this species.

**Fragment an existing important population into two or more populations**

The population found across the study area is scattered, in poor condition and showing low rates of succession. This population is not likely to be important given the low numbers and wide distribution of the species so fragmentation will not result in the creation of two or more populations.

**Adversely affect habitat critical to the survival of a species**

As stated, the population found on site is small, scattered and showing very little succession. Larger and higher quality populations of this species are located outside of the Project Area to the south. The population found on site is not located on habitat considered critical to the survival of the species.

**Disrupt the breeding cycle of a population**

As stated, the population is showing very little succession. There is very little information available relating to the method of pollination and seed dispersal of this species. Beetles from the genus Hapalips and Ulomoides have been recorded in megacarpa males (Forster et al 1994). There is also little known about seed dispersal for this species. The seeds are highly toxic (Banack and Cox 2003) and their size makes them difficult for vertebrates to disperse.

It is considered unlikely that the Project will disrupt the breeding cycle of this species.

**Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

Cycads were recorded at seven locations within the Site Boundary. None are currently located within the clearing footprint. However, it is likely that more individuals are present within the Site Boundary and will be recorded during clearing. Given the low density recorded across the site and the ability to micro-site turbines and roads to avoid populations, it is likely that the number to be removed will be relatively low and it would be unlikely that the Project will result in a decline in the species.

**Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat**

No invasive fauna or flora species are listed as a known threat to this species. Areas infested with lantana (*Lantana camera*) could compete with and smother individual Cycads. Pest management measures will be developed for the site with mitigation measures in place to ensure pest species populations do not increase

**Cycas megacarpa - confirmed**

and spread further over the landscape. Weed and seed protocols will be put into place to reduce the likelihood of spreading invasive flora species.

With these mitigation measures in place it is deemed unlikely that the Project will result in invasive species establishment that will be harmful to this species.

**Introduce disease that may cause the species to decline**

No diseases are listed as a current threat to these cycads in Queensland.

It is unlikely that the Project will introduce diseases causing the population to decline.

**Interfere with the recovery of the species**

Currently no cycads have been recorded within the development footprint. Mitigation measures including an erosion and sediment control plan will be implemented to reduce the likelihood of indirect impacts.

**Conclusion**

The population of *C. megacarpa* found within the Site Boundary is in poor condition and shows low rates of succession. No *C. megacarpa* have been confirmed within the Project Area, and pre-clearance surveys will identify any individuals that are present in the development footprint. Detailed design and micro-siting will avoid individual cycads. Based on low density recorded during surveys, it is anticipated that only low numbers of *Cycas megacarpa* would be directly impacted as a result of the Project.

Due to the low impact that the Project will have on the habitat for this species and the proposed mitigation measures, it is considered that no significant residual impact will occur on this species.

**8.1.3 Assessment of significant impact on Vulnerable species**

Vulnerable species (EPBC Act) which were confirmed, or considered likely to occur within the Project Area includes the following:

- Koala
- Greater Glider
- Squatter Pigeon
- White-throated Needletail.

*Under the significant impact criteria for threatened species listed as vulnerable, an action will likely have a significant impact if there is a real chance or possibility that it will:*

- i. lead to a long-term decrease in the size of an important population of a species*
- ii. reduce the area of occupancy of an important population*
- iii. fragment an existing important population into two or more populations*
- iv. adversely affect habitat critical to the survival of a species*
- v. disrupt the breeding cycle of an important population*
- vi. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

- vii. result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- viii. introduce disease that may cause the species to decline, or
- ix. interfere substantially with the recovery of the species.

Assessments of significance on the Koala, Greater Glider, Squatter Pigeon and White-throated Needle-tail have been undertaken and are presented below in Table 8-2 through to Table 8-5.

### 8.1.3.1 Koala

The assessment of significance for Koala has been carried out with an appreciation for the wider impacts that this Vulnerable species has recently been subject to (Section 5.1.2). Management intervention measures are primarily focussed within or adjacent to burnt areas and are therefore not directly applicable to the Lotus Creek Wind Farm Project site. Dickman et al. (2020) suggest that a key action following the fires will be to re-assess the conservation status of affected species to properly reflect a change in extinction risk.

Table 8-2 Assessment of significance of impacts on Vulnerable species: Koala

<b>Koala (<i>Phascolarctos cinereus</i>) - confirmed</b>
<b>Lead to a long-term decrease in the size of an important population</b>
<p>Koalas were found to be present in all suitable habitat within the Site Boundary, with 101 recorded (heard or seen) during two survey periods. Seven (7) females were recorded with back young during the pre-wet 2020 survey, suggesting the population is self-sustaining. The overall number of Koala found across the site is considered to be significant for this bioregion. Based on these results, all vegetation containing non-juvenile Koala trees within the Project Area is assessed as having a high potential for use by Koala.</p> <p>Within the Site Boundary (defined by the property/lot boundaries of the involved landholders) there is an estimated 48,393.2 ha of suitable Koala habitat. An estimated maximum clearing extent of up to 345.5 ha of Koala habitat is expected as a consequence of the proposal. This will result in a loss of 0.72 % of the area available within the site. Large areas of good quality and refugia habitat outside of the Project Area will be retained and are expected to be capable of supporting the existing Koala population.</p> <p>It is expected that the surrounding habitat would be able to absorb any displaced Koalas from the Project Area. Melzer et al. (2018) note that there are no recorded instances in Queensland where Koalas have failed to disperse from a habitat patch, resulting in overpopulation.</p> <p>The Project is located at the edge of a much larger and well-connected Koala habitat, which forms a contiguous landscape over the ridgeline with patchy connectivity in the flats through agricultural lands. Koalas are known to be widespread across the Clarke-Connors Range (adjacent to the Project Area) (Melzer et al., 2018). Within a 30 km radius of the Project Area, there is more than 250,000 ha of suitable Koala habitat available. Considered at that scale, only 0.13 % of suitable Koala habitat will be removed by the Project.</p> <p>Melzer and Tucker (2011) conducted a systematic survey of woodland near St Lawrence and estimated that population density is 0.12 Koala/ha, with approximately 1,440 Koalas around the St Lawrence stretch of the Bruce Highway (to the east of the Project Area). The Koala population in the Isaac LGA is thought to have declined by 30 to 37% over the past decade, predominantly due to land clearing (Melzer, Santamaria unpublished; in Melzer et al, 2018). Published population densities for Koala in central Queensland range from 0.01 to 2.5 Koala per hectare (Melzer &amp; Houston, 2001). Ecological surveys undertaken for the Clarke Creek Wind Farm further south of the Project Area confirmed these values. Approximately half of the Project Area falls within the Brigalow Bioregion, which is thought to have a (relatively) low carrying capacity for Koalas</p>

(rather than being poor quality) when compared to an average density range of 3.8 to 8 Koala per hectare in northern NSW (Melzer & Houston, 2001).

The following mitigation measures will be implemented as part of the Project:

- Avoid causing permanent changes to the natural pool-riffle sequence (size and spacing) within the low- flow channel as these channels provide water sources for Koala.
- Locate site facilities away from important ecological resources where possible (e.g. wetlands, important upland habitats, sensitive species populations).
- Minimise the number of stream crossings when locating access tracks. When stream crossings cannot be avoided, use fill ramps rather than stream bank cutting if possible.
- Development and implementation of a Fauna Management Plan detailing protection measures to minimise impacts on Koala. This will include, but not limited, to:
  - Details of design consideration
  - Details of mitigation measures during vegetation clearing such as preclearing survey and fauna spotter to supervise clearing works
  - Performance criteria to assess effectiveness of mitigation measures
  - Main goals for management
  - Design, preclearance and post construction management actions
  - Performance threshold and corrective actions
  - Monitoring.
- Undertake pre-clearing surveys by a licensed spotter-catcher to identify presence of Koala in vegetation to be removed.
- A licensed spotter-catcher will accompany and direct clearing crews when clearing vegetation in order to ensure disturbance to threatened or other significant fauna is minimised.
- Vegetation clearing will be conducted in a staged manner to allow fauna to move off the site.
- Koalas will be managed in accordance with the current QLD NC Act and regulation as follow:
  - Leaving a 30 m buffer of vegetation around the Koala tree in addition to a corridor of vegetation to the nearest vegetated area.
  - Not felling any tree that has the potential to fall on or near the tree the Koala is residing in.
  - Monitoring the Koala location and its visible stress levels. If the Koala is appearing visibly stressed and agitated, move the clearing front away from the animal.
  - Allow the Koala to self-relocate of its own volition.
  - Koalas are not to be interfered with unless they have been injured.
- Development and implementation of a pest management measures which will include a feral predator monitoring and control program, particularly for wild dogs, to reduce the risk of predation of Koalas over the site, and to manage any wild deer which pose a risk to regenerating Koala habitat.

Project design has been refined to minimize vegetation clearing including using Lidar data to identify areas of low density NJKHT and preferentially locating wind farm elements in these areas. Irrespective, a maximum of 345.5 ha of Koala habitat will require removal. Clearing would occur in mostly linear strips, which would impact sections of individual home ranges of Koalas occupying habitat within the Project Area. Some areas of habitat will also be rehabilitated following construction reducing the impact on Koala long term Whilst sections of individual home ranges may be impacted, the linear nature of clearing would be unlikely to significantly reduce the population size. The Project is not expected to contribute to a long-term decrease in the size of the local population.

The Project will impact on 0.72 % of Koala habitat within the Site Boundary, which equates to only 0.13 % of available habitat within a 30 km radius. The ability for Koala to disperse across the landscape will not be significantly decreased by the Project (see discussion below), and therefore genetic diversity, breeding opportunities and dispersal function are likely to be maintained.

**Reduce the area of occupancy of an important population**

The Project will remove and trim up to 345.5 ha of suitable Koala habitat. A large proportion of the clearing will be in linear form (e.g., construction of internal roads through existing track, etc) rather than a single large area. A portion of the cleared areas will be rehabilitated using Koala food trees, which will be detailed in the rehabilitation plan (Section 7.6).

Clearing activities associated with the Project will occur within existing disturbed areas as well as within good quality Koala habitat (Eucalyptus woodland) in which Koalas were sighted. Provision will be made to minimise impacts on Koala as much as possible, including those measures discussed above. The majority of watercourses which provide foraging habitat for this species will be retained and connectivity between suitable habitat will be maintained within and surrounding the Project Area.

Notwithstanding the above mitigation measures, the clearing of Koala habitat cannot be fully avoided and the Project is expected to reduce the area of occupancy of an important population. Accordingly, an offset is expected to be necessary in order to compensate for the loss of this habitat. The offset site(s) will, at a minimum, match the quality of the habitat impacted by the proposed action, and be managed and resourced over a defined period of time so that its habitat quality is maintained and is improved to meet the habitat quality requirements for the offset site.

**Fragment an existing important population into two or more populations**

Large remnant vegetation patches occur in the eastern section of the site, which provide opportunities for long-term Koala habitat and movement across the Nebo-Connors Range. The areas of Koala habitat in the eastern portion will be avoided.

The Project will result in localised loss of habitat from areas immediately adjacent to the existing tracks, but also from the construction of new tracks/roads through the ridge lines. Project design has sought to minimize clearing widths by including underground powerlines, rather than the standard above ground.

Construction activities may disturb Koalas and have a short-term impact on their movement. This impact will be mitigated by education and awareness campaigns for site personnel and visitors, signage, and enforced speed limits. While roads and turbine hardstand could disrupt movement during operation, access to these will be restricted to private use only (for farmers and wind farm staff) and will have strict speed limits. With these measures in place, it is not expected that the roads will pose a physical barrier to Koala movement. Koalas will be able to move across roads without being injured or killed due to the low number and slow movement of vehicles, particularly at night when Koalas are more likely to move (although daytime movements are also undertaken by Koala), and when there would be almost no vehicle movements unless in the event of an emergency or urgent maintenance matter.

Genetic testing within the Clarke-Connors Range area has shown that the Koala population is a single relatively homogeneous genotype, and barriers (such as the Bruce Highway) have not interrupted gene-flow in the past (Melzer et al. 2018). It is therefore unlikely that access tracks for the wind farm will negatively affect gene flow.

Ecological connectivity for this species will therefore not be impacted by the development. Therefore, it is not expected that the Project will result in fragmentation of the existing Koala population.

**Adversely affect habitat critical to the survival of a species**



The development footprint contains good quality habitat critical to the survival of the Koala. The areas proposed to be cleared contain known Koala food trees and 51 Koalas were observed in the Project Area during one survey period. Within the Site Boundary (defined by the property/lot boundaries of the involved landholders) there is an estimated 48,393.2 ha of suitable Koala habitat. An estimated maximum clearing extent of up to 345.5 ha of Koala habitat is expected as a consequence of the proposal. This will result in a loss of 0.72 % of the area available within the site. Large areas of good quality and refugia habitat outside of the Project Area will be retained and are expected to be capable of supporting the existing Koala population. Within a 30 km radius of the Project Area, there is more than 250,000 ha of suitable Koala habitat available.

**Disrupt the breeding cycle of an important population**

Koalas are seasonal breeders, with peak births occurring in November and December. The gender ratio in most populations is 1:1, but whereas 50% of all adult females can be expected to raise a young each year, only about a quarter of all adult males will produce young in any season (DAWE, 2014). Most births occur between November and March and young gain independence at around 12 to 18 months of age (AMBS, 2012). The factors that govern Koala dispersal, breeding and home-ranging include the social relationships between individuals, the size, density, and reproductive health of the population, and the proximity and connection to neighbouring populations (AMBS, 2012).

In turn these factors depend on the tree species available locally, the tree size, the amount of plant secondary metabolites, the terrain, the soil, and the many components of successful water balancing (Moore et al., 2005). These factors vary from region to region and from individual to individual, thereby resulting in different patterns of dispersal and home-range features in different areas.

Koalas can locate each other even at very low population densities (Moore et al., 2005). Melzer et al. (1994) considered that extremely low-density populations appeared to be breeding well as long as connectivity between suitable habitat is maintained. This is confirmed by Thompson (2006), who recognised that block size, habitat fragmentation, connectivity and disturbance levels in nearby areas contribute to the quality of Koala habitat and therefore the breeding activity. The net migration into a breeding area is then critical.

Seven (7) females were recorded with back young within the Project Area in Spring 2020, suggesting the population is self-sustaining. As mentioned in the previous section, it is unlikely that the Project would further impact on the connectivity or habitat fragmentation relevant to Koala and therefore, the breeding cycle is unlikely to be affected by the Project.

**Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

The Site Boundary area (defined by the property/lot boundaries of the involved landholders) is estimated as having approximately 48,502 ha of suitable Koala habitat. The estimated maximum clearing extent of Koala habitat is up to 345.5 ha. This will result in a loss of 0.72 % of the area available within the Site Boundary. Large areas of good quality and refugia habitat will be retained, both on site and in the broader region. Within a 30 km radius of the Project Area, there is more than 250,000 ha of suitable Koala habitat available.

Large remnant vegetation patches occur within the Project Area and the vegetation is well connected to other areas of suitable vegetation for Koala. The Project will result in localised loss of habitat from the construction of future roads which may introduce new barriers to Koala movement. However, traffic on the road will mainly occur during the construction stage of the wind farm and will be limited during the operation stage, meaning that roads will not create a barrier.

The Project is not expected to impact the hydrology of the Project Area and appropriate controls will be put in place for waterway barrier works and earthworks. Erosion and sediment control measures will be implemented to prevent impacts to hydrology, which may in turn impact on Koala habitat.

The impact of vehicles on Koala within the Project Area will be mitigated and managed (by signage, reduced speed limits, and contractor education). Considering the above, it is unlikely that the Project would further contribute to isolation of the existing Koala habitat.

The clearing of Koala habitat cannot be fully avoided and accordingly, an offset will be provided to compensate the loss of this habitat. The offset site(s) will, at a minimum, match the quality of the habitat impacted by the proposed action, and managed and resourced over a defined period of time so that its habitat quality is maintained or improved to meet the habitat quality requirements for the offset site.

**Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**

A large number of invasive flora and fauna species have been recorded on site. Weed and pest management measures will be developed for the site which will outline mitigation and monitoring measures to reduce the likelihood of spreading and increasing the number of invasive flora and fauna found on site. Measures such as not feeding any wildlife, disposing of rubbish appropriately and weed and seed protocols will be implemented.

Melzer et al. (2018) note that feral deer are an emerging threat to Koalas of the Clarke-Connors Range, as they trample understorey vegetation and ring bark small trees, interfering with natural regeneration of eucalypt communities.

Predation by dogs is one of the key threats facing Koala (TSSC, 2012), however Melzer et al. (2018) suggest that this is not a significant threatening process within the Clarke-Connors Range region. However, the data used in the Melzer (2018) study came from Koalas being rescued within the urban center (six Koalas were attacked by domestic dogs) and limited amount of study was undertaken on private land. There was one record of Wild Dog within the Project Area, suggesting a very low density of Wild Dogs and few predators for Koala. There is potential for their impact on Koala to increase because of the Project. Clearing vegetation may require Koala to become grounded as they move through the landscape, where they are more susceptible to dog attack. Predators (such as dogs) also hunt more efficiently in cleared areas.

Active pest animal management through the Project will address the risk from feral dogs. If feral deer are observed, they will be included in a management program in order to improve natural regeneration of Koala habitat.

**Introduce disease that may cause the species to decline**

Two diseases are known to affect Koalas which are Chlamydia and Koala retro virus. While the majority of Koala observed in the Project Site appeared healthy, approximately 5% showed signs consistent with chlamydia.

Chlamydia is harmless in populations with unlimited resources, but manifests in times of stress, which happens when habitat is reduced (AKF, 2016). The Koala population within the Clarke-Connors Range has been found to be healthy, unstressed, and with low frequency of chlamydia (Melzer et al, 2018).

The proposed clearing of vegetation may cause some stress to existing Koala located within the Project Area. However, the site will clear approximately 0.72 % of the vegetation available to Koala on site and vegetation connectivity to adjacent vegetation patches will remain intact. It is unlikely that the proposed clearing will stress existing Koalas and increase the occurrence of chlamydia within the area.

Mitigation measures will be put in place to reduce or manage the risk of disease for Koala. Measures involving washing down vehicle and equipment that may carry vegetation pathogens known to affect Koala food trees will be enforced. Quarantine and biosecurity procedures will be maintained throughout the life of the action's impact and a procedure will be in place for Koalas which are found to be affected by disease to manage the spread of disease through the site from wind farm activities

Additional mitigation measures include those designed to reduce stress to Koalas during vegetation clearing, including the use of a fauna spotter during all clearing activities. The fauna spotter team will include staff with wildlife health experience, who can identify suffering individuals and transport them to a wildlife vet for treatment.

The Project is unlikely to introduce a disease that may cause the population to decline.

### **Interfere with the recovery of the species**

Habitat within the Project Area forms part of a large contiguous landscape patch of good quality and refugia habitat, and is therefore likely to be important for achieving the interim recovery objectives outlined in the EPBC Act referral guidelines, listed below (DAWE 2014):

- Protect and conserve the quality and extent of habitat refuges for the persistence of the species during droughts and periods of extreme heat, especially in riparian environments and other areas with reliable soil moisture and fertility.
- Maintain the quality, extent and connectivity of large areas of Koala habitat surrounding habitat refuges.

Riparian habitat refuges for Koala would be mostly retained. Riparian vegetation will be avoided wherever possible. Impacts to riparian vegetation will occur where infrastructure waterway crossings are necessary. Clearing for infrastructure crossings would be linear, with scope for micro-siting. Clearing for hardstands and turbines would avoid riparian vegetation.

Detailed design will seek to further reduce the amount of Koala habitat directly impacted by the Project. The area to be cleared represents a maximum of 0.72 % of the available habitat within the Site Boundary, which would constitute a reduction in the extent of Koala habitat. Whilst the area of habitat will be reduced by 0.72 %, connectivity would be maintained. Koalas would be able to disperse into the 48, 047.7 ha of habitat that will be retained within the Site Boundary. This habitat is well connected to the surrounding habitat within the Clarke-Connors Range.

The Project is unlikely to interfere substantially with the recovery of the species.

### **Conclusion**

The Project's impacts will result in the direct clearing of approximately 345.5 ha of suitable habitat for Koala. This is considered a reduction in the extent of habitat at a local and regional scale.

However, the Project has considered design and proposed mitigation measures in order to:

- Avoid impacts to the Clarke Connors Range, where there is high-quality Koala habitat
- Manage impacts to Koalas by minimising clearing, locating equipment in less sensitive areas, sensitive construction procedures including pre-clearance checks and staged clearing methods
- Restore the quality of the local habitat by working with existing landowners to improve degraded areas, minimise threats
- Improve access for fire fighting to help prevent and manage the devastating species impacts of bushfire events
- Support ongoing research and community efforts to support in koala conservation through the provision of data and funding (other compensatory measures; see Section 9.1.4).

A pest animal management program will be enacted to control predators (wild dogs) and will include wild deer (if present) which may impact on Koala habitat regeneration.

The clearing of Koala habitat cannot be fully avoided and therefore a significant residual impact is anticipated. Accordingly, an offset will be provided to compensate the loss of this habitat. The offset site(s) will, at a minimum, match the quality of the habitat impacted by the proposed action, and managed and resourced over a defined period of time so that habitat quality is maintained or improved to meet the habitat quality requirements for the offset site.

### 8.1.3.2 Greater Glider

**Table 8-3 Assessment of significance of impacts on Vulnerable species: Greater Glider**

<b>Greater Glider (<i>Petauroides volans</i>) - confirmed</b>
<b>Lead to a long-term decrease in the size of an important population</b>
<p>Greater Glider were recorded at 131 locations across all survey periods. Records for Greater Glider align with the high/very high value habitat described in Section 3.2.6, Table 3-6. Greater Glider is known to prefer diverse, taller and moister forests. Preferred habitat is predominantly in the eastern side of the range, largely outside the Project Area. There is 10,158 ha of Greater Glider habitat within the Site Boundary, based on remnant and regrowth vegetation which aligns with TSSC (2016). A total of 80,017 ha of Greater Glider habitat occurs within a 30 km radius of the Project Area. The Project will mostly avoid habitat identified as high value habitat, and will avoid very high value Greater Glider habitat.</p> <p>The Project is not expected to lead to a long-term decrease in the size of an important population.</p>
<b>Reduce the area of occupancy of an important population</b>
<p>There is 10,158 ha of suitable habitat present within the Site Boundary. The development footprint mostly avoids the moderate and high value Greater Glider habitat, and avoids very high value habitat (Section 3.2.6). Records of Greater Glider align with the high and very high habitat identified within the Site Boundary.</p> <p>A small number of Greater Glider were recorded in non-remnant areas adjacent to good quality habitat. Some of these areas will be impacted by development footprint but these are not considered to be important habitat for the species within the Site Boundary. Clearing in these areas may impact part of the home range of a few individuals but this is unlikely to reduce the occupancy of the local population.</p>
<b>Fragment an existing important population into two or more populations</b>
<p>It is expected that on occasion individual Greater Gliders would intermittently move from the broader areas of high and very high value habitat that occur to the east of the development footprint into the areas of low or moderate habitat within the Project Area. One obstruction to movement of Greater Glider within the Project Boundary is the use of barbed wire. Two Greater Gliders were recorded dead on a barbed wire fences and previous research suggests barbed wire fences kill many Greater Gliders where they are erected in suitable habitat. A review of appropriate fencing design (e.g. used of disks attached to the top wire to increase visualization of the barb wire) will be undertaken, to avoid or minimize barb wire or ensure the top wire is a plain wire where possible.</p> <p>Considering the above, it is not expected that the Project will result in any fragmentation of habitat.</p>
<b>Adversely affect habitat critical to the survival of a species</b>

**Greater Glider (*Petauroides volans*) - confirmed**

There is 10,158 ha of suitable habitat present within the Site Boundary. The new turbine layout mostly excludes the high value habitat and avoids very high value habitat identified for Greater Glider. Records of Greater Glider align with the high and very high habitat identified within the Site Boundary.

The Project will retain habitat critical to the survival of a species

**Disrupt the breeding cycle of an important population**

The Project will mostly avoid high and will avoid very high value Greater Glider habitat. It can therefore be reasonably expected that gene flow for this species will still occur across the landscape and population. It is unlikely the development will disrupt the breeding cycle.

**Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

The Project will mostly avoid high and will avoid very high value Greater Glider habitat. The species is not expected to decline as a result of the Project.

**Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**

Invasive flora and fauna species have been recorded on site. Weed and pest management measures will be developed for the site which will outline mitigation and monitoring measures to reduce the likelihood of spreading and increasing the number of invasive flora and fauna found on site. Measures such as not feeding any wildlife, pest animal control measures, disposing of rubbish appropriately and weed and seed protocols will be implemented.

It is not expected that the Project will increase the number or populations of invasive species if appropriate mitigation measures are followed.

**Introduce disease that may cause the species to decline**

Chlamydia has been recorded in Greater Gliders in the past (Bodetti et al., 2003). Although not debilitating, the disease has the potential to decrease the vigor of the population.

Stress is a main factor in an animal's susceptibility to Chlamydia (Maloney 2007). The Project will mostly avoid high and will avoid very high value habitat. It is therefore unlikely that stress levels in Greater Gliders will increase.

It is not expected that disease that causes a decline in the species will be introduced by the Project.

**Interfere with the recovery of the species**

There is 10,158 ha of suitable habitat present within the Site Boundary and the Project will mostly avoid high and will avoid very high value Greater Glider habitat.

The Project is not expected to interfere with the recovery of this species.

**Conclusion**

**Greater Glider (*Petauroides volans*) - confirmed**

The 131 Greater Glider records over two survey seasons indicates a relatively large population in the area. The Project will mostly avoid high and will avoid very high value Greater Glider habitat and is not expected to have a significant impact on the population of Greater Gliders within or surrounding the Project Area. Sensitive clearing procedures will be put into place where the Project is within 50 m of Greater Glider habitat. Although the Project is not expected to significantly increase the risk of bushfire, it will also improve access for firefighting during bushfire events, helping to conserve Greater Glider habitat outside of the Project Area.

**8.1.3.3 Squatter Pigeon**

Table 8-4 Assessment of significance of impacts on Vulnerable species: Squatter Pigeon

**Squatter Pigeon (southern) (*Geophaps scripta scripta*) – confirmed**

**Lead to a long-term decrease in the size of an important population**

Squatter Pigeon were recorded at 15 locations within the Project Area. A total of 41 Squatter Pigeons were recorded over three survey periods within and adjacent to the Project Area. The general habitat description for Squatter Pigeons is open forests or sparse, open woodlands and scrub within 1 km of waterbodies (DAWE, 2020a). Within the Project Area, all Squatter Pigeon records were within approximately 100 m of a waterway.

A maximum of 50 ha of suitable habitat for this species will be removed for the Project. As this clearing is linear, there will be large tracts of habitat surrounding the clearing for Squatter Pigeons to disperse into. Mitigation measures, such as the use of a fauna spotter, will be implemented to reduce potential impacts to resident fauna through death or injury. Breeding places will be identified during pre-clearance surveys. An exclusion zone will be established around any active Squatter Pigeon breeding place until young have fledged.

Important populations of Squatter Pigeon are considered to be the small, isolated and sparsely distributed sub-populations that occur south of the Carnarvon Ranges in Central Queensland (DAWE, 2020a). The Project Area is further to the north and is therefore not considered an important population.

It is unlikely that the Project will lead to a long-term decrease in the size of an important population.

**Reduce the area of occupancy of an important population**

The population inhabiting the Project Area is not considered an important population, which occur south of the Carnarvon Ranges in Central Queensland (DAWE, 2020a).

A maximum impact to 50 ha of habitat will occur. The clearing extent is unlikely to reduce the area of occupancy due to the extensive areas of habitat being retained for Squatter Pigeons to disperse into. The total area of suitable habitat within the Site Boundary is 17,515 ha, which means that less than 1% of available habitat will be removed as part of the Project (Figure 6-3 and Table 6-1). Within a 30 km radius of the Site Boundary there is approximately 156,292 ha of suitable Squatter Pigeon habitat.

**Fragment an existing important population into two or more populations**

The Project will impact a maximum of 50 ha of suitable Squatter Pigeon habitat. It is expected that Squatter Pigeons will disperse from the development footprint into surrounding habitat without obstruction. Roads and



access tracks are unlikely to cause fragmentation of the population, with widths of roads and access tracks throughout the site kept to 30 m wherever practicable and will have strict speed limits in place. Therefore, the impact on movement of this species across the landscape will be minimised.

It is unlikely that the Project will cause fragmentation of a population into two or more populations.

**Adversely affect habitat critical to the survival of a species**

The majority of clearing required in Squatter Pigeon habitat is for linear infrastructure. There will be large tracts of suitable Squatter Pigeon habitat surrounding the cleared areas for their dispersal.

It is unlikely that the Project will affect habitat critical to the survival of a species.

**Disrupt the breeding cycle of an important population**

Suitable breeding habitat will be retained within the Project Area, and it is not expected that the population will experience fragmentation due to the Project. Squatter Pigeons will be able to cross cleared areas and disperse into surrounding habitat. Breeding places will be identified during pre-clearance surveys. An exclusion zone will be established around any active Squatter Pigeon breeding place until young have fledged.

This species can breed throughout most of the year, with success influenced by abundance of food resources (DAWE, 2020a).

It is unlikely that the Project will significantly disrupt breeding opportunities for Squatter Pigeons within the Project Area.

**Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

The Project will impact a maximum of 50 ha of Squatter Pigeon habitat. Impacts to Squatter Pigeon will be limited due to the large areas of suitable habitat surrounding the development footprints for Squatter Pigeons to disperse into. It is considered unlikely that this species will decline.

**Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**

Invasive flora and fauna species can threaten Squatter Pigeon populations (DAWE, 2020a). Feral cats and foxes are likely to have the greatest impact on populations. Habitat degradation by the establishment of invasive Buffel Grass can also fragment populations (DAWE, 2020a).

Invasive flora and fauna species have been recorded on site. Weed and pest management measures will be developed for the site which will outline mitigation and monitoring measures to reduce the likelihood of spreading and increasing the number of invasive flora and fauna found on site. Measures such as not feeding any wildlife, pest animal control measures, disposing of rubbish appropriately and weed and seed protocols will be implemented.

It is not expected that the Project will increase the number or populations of invasive species if appropriate mitigation measures are followed.

**Introduce disease that may cause the species to decline**

It is unlikely that the Project will introduce disease that will cause decline in Squatter Pigeons.



<b>Interfere with the recovery of the species</b>
The Project will retain large areas of suitable habitat for Squatter Pigeons. Weed and pest animal measures will be implemented to mitigate their impact on Squatter Pigeons. Given the above considerations, the Project is not expected to interfere with the recovery of this species.
<b>Conclusion</b>
A maximum of 50 ha of suitable Squatter Pigeon habitat would be removed by the Project. Large areas of suitable habitat (approximately 17,515 ha) will be retained surrounding the development footprint for Squatter Pigeon to disperse into. With the implementation of mitigation measures such as weed and pest animal control measures and the use of a fauna spotter during clearing, there is not expected to be significant impact on the population of Squatter Pigeons in or surrounding the Project Area.

### 8.1.3.4 White-throated Needletail

Table 8-5 Assessment of significance of impacts on Vulnerable species: White-throated Needletail

<b>White-throated Needletail (<i>Hirundapus caudacutus</i>) - confirmed</b>
<b>Lead to a long-term decrease in the size of an important population</b>
<p>A total of 42 White-throated Needletails were observed flying within the Site Boundary. As they are mainly aerial in Australia, it is expected that a small impact may occur from birds colliding with turbines. It is not expected that numbers of White-throated Needletail passing through Lotus Creek Wind Farm would be great enough to place the overall population at risk, as these birds use a range of habitats and are widespread in eastern Australia (DAWE 2020a).</p> <p>Management measures which will assist to protect White-throated Needletail will include operational monitoring and analysis, including carcass searches, to enable detection of any mortality (an impact trigger, which enacts a decision-making framework to determine appropriate mitigation).</p> <p>Management, including monitoring and mitigation measures will be provided in a detailed bird and bat management plan with consideration of detailed project design.</p>
<b>Reduce the area of occupancy of an important population</b>
White-throated Needletail are aerial foragers. The Project is unlikely to impact their foraging resources. They do not breed in Australia (DAWE 2020a). The Project is not expected to reduce the area of occupancy of the population.
<b>Fragment an existing important population into two or more populations</b>
As they are mainly aerial in Australia, up to heights of more than 1000 m (DAWE 2020a), the Project is not expected to obstruct movement of this species within the Site Boundary or to surrounding areas. The Project is unlikely to fragment an existing population.
<b>Adversely affect habitat critical to the survival of a species</b>

Although almost exclusively aerial in Australia (occasionally roosting in dense foliage in the canopy or in tree hollows), they are most often recorded above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland (DAWE 2020a).

It is unlikely that the vegetation clearing resulting from the Project will affect the survival of this species due to the large area of Great Dividing Range that this species moves through during its migration and wintering quarters. The Great Dividing Range is between 160 km to <300 km in width. The proposed wind farm site represents an insignificant area within the species migratory path.

**Disrupt the breeding cycle of an important population**

The White-throated Needletail does not breed in Australia. The Project is unlikely to disrupt the breeding cycle of the population.

**Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

In Australia, the White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. They have on occasion however, been recorded roosting in forests and woodlands (DAWE 2020a). The majority of the site (properties where the wind farm will be located) will remain as suitable habitat for this species. There will be no obstruction to White-throated Needletails accessing retained habitat or habitat within the surrounding area.

White-throated Needletails are well known to forage at RSA height and are at risk of collision with wind turbine blades. It is not expected that numbers of White-throated Needletail passing through Lotus Creek Wind Farm would be great enough to place the overall population at risk.

This is a widespread and locally common species found along the eastern coast of Australia, into Tasmania, and also through parts of Asia (DAWE 2020a). They do not breed in Australia so there is no risk that breeding habitat will be disturbed by the Project. It is expected that a small impact may occur with birds colliding with turbines. This impact is expected to be minor as these birds utilise a range of habitats and are widespread. It is unlikely that the Project will cause the species to decline.

**Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**

There are no known invasive species that would be harmful to this species and therefore, the proposed windfarm is unlikely to result in the introduction of any such invasive species.

**Introduce disease that may cause the species to decline**

The Project is unlikely to introduce a disease that may cause this species to decline.

**Interfere with the recovery of the species**

The Project will retain large areas of suitable habitat for potentially roosting White-throated Needletails. There is not expected to be any obstruction to movement within the Site Boundary or between surrounding areas. Although there will be risk of collision with wind turbine blades, it is not expected that numbers of White-throated Needletail passing through Lotus Creek Wind Farm would be great enough to place the overall

population at risk. Given the above considerations, the Project is not expected to interfere with the recovery of this species.

### **Conclusion**

As they tend to forage at RSA height, White-throated Needletails are at risk of mortality due to collision with wind turbine blades. The numbers of White-throated Needletails passing through Lotus Creek Wind Farm is not expected to be great enough for collisions to cause decline of this species. There is not expected to be significant impact on the population of White-throated Needletails in or surrounding the Project Area.

Management measures which will assist to protect White-throated Needletail will include operational monitoring and analysis, including carcass searches, to enable detection of any mortality (an impact trigger, which enacts a decision-making framework to determine appropriate mitigation). Management, including monitoring and mitigation measures will be provided in a detailed bird and bat management plan once the Project is in detailed design stage (post approval).

#### **8.1.4 Assessment of significant impact on Migratory species**

The three Commonwealth Migratory species confirmed within the Project Area are:

- White-throated Needletail
- Satin Flycatcher
- Fork-tailed Swift.

*Under the significant impact criteria, an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:*

- *substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species*
- *result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or*
- *seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.*

*An area of 'important habitat' for a migratory species is:*

- a. *habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or*
- b. *habitat that is of critical importance to the species at particular life-cycle stages, and/or*
- c. *habitat utilised by a migratory species which is at the limit of the species range, and/or*
- d. *habitat within an area where the species is declining.*

*Ecologically significant proportion: Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species-specific behavioural patterns (for example, site fidelity and dispersal rates).*

*'Population', in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.*

An assessment of the significance of the impact of the Project on the migratory species identified at the site against the above criteria is provided in Table 8-6 to Table 8-8 below.

### 8.1.4.1 White-throated Needletail

Table 8-6 Assessment of significance of impacts on Migratory species – White-throated Needletail

<b>White-throated Needletail (<i>Hirundapus caudacutus</i>) – Confirmed</b>
<b>Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species</b>
<p>A total of 42 White-throated Needletails were observed flying over the Project Area. The White-throated Needletail is an aerial forager and well known to forage at rotor-swept area (RSA) height. Although susceptible to mortality it is still quite common, particularly over the forested ranges of the Great Divide (Higgins, 1999).</p> <p>It is not expected that numbers of White-throated Needletail passing through Lotus Creek Wind Farm would be great enough to place the overall population at risk due to the large area of Great Dividing Range that they would move through during their migration and wintering quarters. The Great Dividing Range is between 160 km to &lt;300 km in width. The proposed wind farm site represents an insignificant area within the species migratory path.</p> <p>This is a widespread and locally common species found along the eastern coast of Australia, into Tasmania, and also through parts of Asia. They do not breed in Australia so there is no risk that breeding habitat will be disturbed by the Project. It is expected that a small impact may occur with birds colliding with turbines. This impact is expected to be minor as these birds utilise a range of habitats and are widespread (DAWE 2020a).</p>
<b>Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species</b>
<p>There are no known invasive species that would be harmful to this species and therefore, the proposed windfarm is unlikely to result in the introduction of any such invasive species.</p>
<b>Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.</b>
<p>The White-Throated Needletail migrate along the Great Dividing Range, therefore, the proposed windfarm site represents a small proportion of the species' migratory path. While it was commonly thought that this species did not land in Australia, recent studies suggest that it roosts in trees (DAWE, 2020a). This species does not breed in Australia. White-throated Needletail is an aerial feeder, and forage opportunities are unlikely to be limited by Lotus Creek Wind Farm development.</p> <p>Large areas of habitat will remain available within and surrounding the Site Boundary, which will provide sufficient habitat (i.e., rest) for this mobile migratory species in the region. No migratory pathways or high use flight corridors of these species are known or predicted to occur through the wind farm site that would be disrupted or result in an increased risk of collision with turbines.</p>
<b>Conclusion</b>
<p>Due to their foraging at RSA height, White-throated Needletails are at risk of mortality due to collision with wind turbine blades. The numbers of White-throated Needletails passing through Lotus Creek Wind Farm is not expected to be great enough for collisions to cause decline of this species. There is not expected to be significant impact on the population of White-throated Needletails in or surrounding the Project Area.</p>

Management measures which will assist to protect White-throated Needletail will include operational monitoring and analysis, including carcass searches, to enable detection of any mortality (an impact trigger, which enacts a decision-making framework to determine appropriate mitigation). Management, including monitoring and mitigation measures will be provided in a detailed bird and bat management plan once the Project is in detailed design stage (post approval).

### 8.1.4.2 Fork-tailed Swift

Table 8-7 Assessment of significance of impacts on Migratory species – Fork-tailed Swift

<b>Fork-tailed Swift (<i>Apus pacificus</i>) – Confirmed</b>
<b>Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species</b>
<p>One Fork-tailed Swift was observed within the Project Area. This species is a non-breeding visitor to all states and territories in Australia. They are almost exclusively aerial (DAWE 2020a). It is unlikely that the Project will impact an area of important habitat for the Fork-tailed Swift.</p> <p>Management measures which will assist to protect Fork-tailed Swift will include operational monitoring and analysis, including carcass searches, to enable detection of any mortality (an impact trigger, which enacts a decision-making framework to determine appropriate mitigation). Management, including monitoring and mitigation measures will be provided in a detailed bird and bat management plan, with consideration of detailed project design.</p>
<b>Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species</b>
<p>There are no known invasive species that would be harmful to this species and therefore, the proposed windfarm is unlikely to result in the introduction of any such invasive species.</p>
<b>Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species</b>
<p>Fork-tailed swifts do not breed in Australia but can be found in every state. This species is almost entirely aerial ranging from 1-300m in height and probably higher (DAWE 2020a). They forage aerially, following low pressure systems. Their diet consists of various insects. Due to foraging at RSA height, Fork-tailed Swifts are at risk of mortality due to collision with wind turbine blades. The numbers of Fork-tailed Swifts passing through Lotus Creek Wind Farm is not expected to be great enough for collisions to cause decline of this species. It is unlikely that the life cycle of a population of this species will be disrupted by the Project.</p>
<b>Conclusion</b>
<p>As they typically forage at RSA height, Fork-tailed Swifts are at risk of mortality due to collision with wind turbine blades. The numbers of Fork-tailed Swifts passing through Lotus Creek Wind Farm is not expected to be great enough for collisions to cause decline of this species. There is not expected to be significant impact on the population of Fork-tailed Swifts in or surrounding the Project Area.</p> <p>Management measures which will assist to protect Fork-tailed Swift will include operational monitoring and analysis, including carcass searches, to enable detection of any mortality (an impact trigger, which enacts a decision-making framework to determine appropriate mitigation).</p>

Management, including monitoring and mitigation measures will be provided in a detailed bird and bat management plan, with consideration of detailed project design (i.e., post approval).

### 8.1.4.3 Satin Flycatcher

Table 8-8 Assessment of significance of impacts on Migratory species – Satin Flycatcher

<b>Satin Flycatcher (<i>Myiagra cyanoleuca</i>) – Confirmed</b>
<b>Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species</b>
<p>Six Satin Flycatcher was observed within the Project Area during the three survey periods. Satin Flycatchers move north in autumn to spend winter in northern Australia and New Guinea. They inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (DAWE 2020a). The Project will retain large areas of suitable habitat surrounding development footprint for Satin Flycatcher to disperse into. Isolation or fragmentation of habitat will be unlikely as movement within the site or between surrounding areas will not be obstructed.</p> <p>Management measures which will assist to protect Satin Flycatcher will include operational monitoring and analysis, including carcass searches, to enable detection of any mortality (an impact trigger, which enacts a decision-making framework to determine appropriate mitigation). Management, including monitoring and mitigation measures will be provided in a detailed bird and bat management plan, with consideration of detailed project design.</p> <p>Satin Flycatchers are widespread throughout eastern Australia (DAWE 2020a). It is unlikely that the Project will substantially modify an area of important habitat for Satin Flycatcher.</p>
<b>Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species</b>
<p>Feral cats may have some impact on populations. Feral cats have been recorded on site. Weed and pest management measures will be developed for the site which will outline mitigation and monitoring measures to reduce the likelihood of spreading and increasing the number of invasive flora and fauna found on site. Measures such as not feeding any wildlife, pest animal control measures and disposing of rubbish appropriately will be implemented.</p> <p>It is not expected that the Project will result in the establishment of invasive species that are harmful to Satin Flycatcher if appropriate mitigation measures are followed.</p>
<b>Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.</b>
<p>They inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (DAWE 2020a). Rotor strike is a potential impact of the Project. The numbers of Satin Flycatchers moving through Lotus Creek Wind Farm is not expected to be great enough for collisions to disrupt the lifecycle of this species.</p> <p>The Project will retain large areas of suitable habitat surrounding development footprint for Satin Flycatcher to disperse into. Movement within the site or between surrounding areas will not be obstructed. Satin Flycatchers are widespread throughout eastern Australia and it is unlikely that the Project will disrupt the lifecycle of an ecologically significant proportion of the population.</p>

**Conclusion**

Satin Flycatchers are widespread throughout eastern Australia. The Project will retain large areas of suitable habitat surrounding development footprint for Satin Flycatcher to disperse into. There is not expected to be significant impact on the population of Satin Flycatchers in or surrounding the Project Area.

Management measures which will assist to protect Satin Flycatcher will include operational monitoring and analysis, including carcass searches, to enable detection of any mortality (an impact trigger, which enacts a decision-making framework to determine appropriate mitigation). Management, including monitoring and mitigation measures will be provided in a detailed bird and bat management plan, with consideration of detailed project design (i.e., post approval).



## **8.2 CUMULATIVE IMPACTS**

Clearing of native vegetation is a key threatening process and is considered a major factor in the loss of biological diversity. Small losses of vegetation communities and fauna habitat, which may be insignificant at a project level, may accumulate over time to cause a significant reduction in the regional extent. This project will result in maximum impact to 310.1 ha of remnant vegetation, 1.7 ha high value regrowth and 33.5 ha non-remnant vegetation and will therefore contribute towards this threatening process. The proposed clearing is linear in nature, limiting impacts on connectivity. Clearing has avoided areas where cleared expanses represent a significance barrier to movement. For example, Greater Glider movement is restricted by the species' ability to achieve glide distance between trees, whereas Koala are more mobile and routinely traverse across cleared ground. Accordingly, areas of Greater Glider habitat have been excluded from the Project Area.

Avoidance and mitigation measures will be implemented to minimise potential impacts on native flora and fauna, and offsets will account for significant residual impacts.

At the time of reporting, there are a number of renewable projects within the region which have received planning approval however are yet to commence construction. Clarke Creek Solar Farm (Pacific Hydro Pty Ltd) is approximately 40 km south on Marlborough-Sarina Road. This is a 315 MW solar farm across 940 ha on largely disturbed pasture, avoiding remnant vegetation and potential habitat for threatened species (RPS 2017). The Broadsound Solar Farm (Broadsound Solar Farm Pty Ltd) will yield 392 MW of energy and is planned for development across 1,370 ha approximately 50 km from Lotus Creek Wind Farm. Ecology & Heritage Partners (2017) identify that the Project will retain remnant vegetation and that no impacts to significant ecological values are expected to occur.

Neither of these two solar farm developments were deemed to be a controlled action through the EPBC Act referral process and ecological impacts are expected to be minimal. These projects are therefore not considered to contribute to cumulative impacts with the proposed Lotus Creek Wind Farm.

Clarke Creek Wind Farm (Goldwind Australia/Lacour Energy) is a 195-turbine wind farm with both Queensland state and EPBC Act approvals. Clarke Creek Wind Farm is immediately to the south of Lotus Creek Wind Farm, and will (most relevantly) result in the clearing of habitat for Greater Glider and Koala, which will be offset as an EPBC condition of approval (NGH Environmental & Green Tape Solutions 2018). Significant and large areas of suitable habitat will be retained across the Clarke Creek and Lotus Creek wind farm sites. This will maintain opportunity for wildlife to move through the landscape and support existing populations of the threatened species. When turbines are operating, collision impacts to bird and bat species will be managed by the Project's respective bird and bat management plans.

Information sharing between wind farm operators in the region about fauna mortality from turbine collisions would contribute to a holistic assessment of the significance of any impacts. This could be facilitated through review of publicly available annual reports, which are required to be published as an EPBC Act condition of approval.

At a national level, the severe bushfires of summer 2019/20 have significantly impacted on the population of Greater Glider and Koala. This was considered in the assessment of significance for both of these EPBC and NC Act threatened species (Section 8.1.3).

## 9 OFFSETS

### 9.1 OFFSETS FOR MNES

Under the EPBC Environmental Offsets Policy (EOP), (DSEWPC 2012) the use of offsets to compensate for adverse impacts to ecological values is appropriate in some circumstances. In cases where offsetting of adverse impacts on ecological values is considered possible and appropriate, the principles of this policy will apply with regard to determining what constitutes a suitable offset.

It is likely that offsets will be required to compensate for significant residual impact to Koala.

An assessment of suitable offset sites is underway, with the final sites and the total offset areas dependent on the final wind farm design and amount of actual clearing required to be undertaken, as it may be less than the 345.4 ha currently proposed. To manage the uncertainties in the Project and the time to secure offsets the following is proposed:

- Finalise an approved **offset management plan** prior to commencement of construction, which contains expected offset areas, but which retains flexibility in case land is unavailable, or more economic land becomes available.
- Agree the offset sites and offset areas within 2 years of the commencement of construction.
- Legally securing the offset land area within 2 years of the commencement of construction.

#### 9.1.1 Offsetting principles under the EPBC EOP

The proposed offsets will meet the principles and contribute to achieving an 'overall conservation outcome that improves or maintains the viability' of Koala and habitat.

The offset amount will be determined through consideration of the:

- attribute to be impacted (Koala habitat)
- quality of the habitat (e.g., bio-condition assessments)
- size of the impact (residual impact – determined after avoidance and mitigation measures).
- determination of offsets.

Following an understanding of possible offset properties, and the area/ and or habitat required, an initial desktop analysis was undertaken to review the following:

How the offset properties align with the EPBC Offset Principles?

- Mapped vegetation/ and or values of the offsets
- Aerial photo interpretation
- Connectivity in the landscape
- Any environmental assessment or existing data on the properties

Calculation of offsets using the offset calculator. The following are required to be assessed and entered into the calculator:

1. Annual Probability of Extinction
2. MNES attributes
3. Start Quality of Offset Area – site condition, site context and species stocking rate (as defined using same methods as impact assessment)
4. Future Quality without the Offset
5. Future Quality with the Offset
6. Time over which loss is averted
7. Time until ecological benefit

8. Risk of loss (%) with offset and without offset
9. Confidence in result (%)
10. Net present value (adjusted hectares) and % of impact offset provides a calculation of the amount of offset which has been reached.

The offset area requirement will be confirmed as part of the offset management plan post-approval, once the final impacts are determined after completion of the micro-sited design.

### 9.1.2 Indicative direct offset areas for Koala

Potential offset areas for Koala has been assessed based on the following methodology and assumptions:

- Calculations have used state-mapped remnant and regrowth vegetation communities. The field surveys carried out in 2019 and 2020 found that ground-truthed vegetation closely resembled that mapped by the Department of Natural Resources and Mines (Queensland). For the purpose of these preliminary offset calculations, it has been assumed that state-mapped REs are largely accurate.
- It has been assumed that 'like-for-like'/similar or better habitat values/quality means remnant vegetation that meets DAWE's habitat descriptions and/or known associations.
  - Koalas: REs that conform to the 'forest or woodland with koala food trees' description, which corresponds with all woody vegetation across the Project Area, with the exception of mapped vine thicket communities.
- The latest RE mapping (Vegetation Management Regional Ecosystem map v11), field data, aerial images and drone images were used to assess the condition of the vegetation across the entire area of interest.

A number of bio-condition assessments were carried out on the Bradford property to determine habitat quality and gather information which can be used in the EPBC Act offset calculator. There are additional suitable areas, shown below in Table 10-1, which are mapped as non-remnant that would also meet remnant status or near-remnant status. These areas could be included in an offset area with rehabilitation. The offset areas will offer:

- Additionality. Reduced risks (from predators, weeds, bushfire); improved habitat quality, selective removal of cattle grazing.
- Protection.
- Mix of good quality habitat which currently supports the target species, and lesser quality habitat with the potential for improvement.

Table 9-1 Potential offset areas available on each property

Lot/plan	Property	Koala (ha)
4 KL210	Acton (subject property)	9,902
799 PH391, 3161 PH378	Bradford (subject property)	19,286
6 KL189	Gedda (immediately to north of the Project)	20,898
Total area available (ha)		<b>50,087</b>

### **9.1.3 Advanced offset option**

Advanced offsets involve protecting and improving habitat before any impact occurs, providing increased environmental benefit. Early implementation of management actions can improve the quality at the offset site, demonstrating the proven success of an offset at the assessment stage. Advanced offsets generally increase the *confidence in result* score and decrease the *time until ecological benefit* score used in offset calculations, thereby reducing the magnitude of the offset required. LCWF will explore the option of establishing an advanced offset.

### **9.1.4 Other compensatory measures**

'Other compensatory measures', or indirect offsets, may be proposed as part of the offsets package. These measures need to relate to the impacted MNES and typically include funding or research programs. Relevant measures for this project may include (but not be limited to):

1. Contribution to research funding for priority actions.
2. Proactive land management of both the Project Area and offset area, including weed control, feral animal control, active fire management and management of grazing; which will collectively benefit threatened as well as Least Concern native species.

## **9.2 OFFSETS FOR MSES**

### **Land-based environmental offsets**

Under the *Environmental Offsets Act 2014* (DES 2020b), land-based environmental offsets compensate for impacts on significant environmental matters on a site by securing land at another site and managing that land over a certain period to replace the lost significant environmental matters.

### **Financial settlement offset**

A financial settlement offset is a payment for a residual impact on a prescribed environmental matter. The financial offset required for each matter is calculated in accordance with the Financial Settlement Offset Calculation Methodology, outlined in the Queensland Environmental Offsets Policy.

### **9.2.1 Offsets for impacts on protected wildlife habitat**

Land-based offsets for significant residual impacts on Koala will be addressed using the EPBC calculator in accordance with the EOP.

## 10 CONCLUSION

Lotus Creek Wind Farm Pty Ltd are proposing to develop a wind farm with up to 55 turbines within the Nebo-Connors Range, between Mackay and Rockhampton.

Three seasonal ecological surveys have been conducted over 2019 and 2020 to assess the potential for the Project to impact on ecological values. These surveys resulted in seven matters of national environmental significance being confirmed within the Project Area: Koala, Greater Glider, White-throated Needletail, Squatter Pigeon, Satin Flycatcher, Fork-tailed Swift and *Cycas megacarpa*. The assessment of impacts of the Project on each of these species has considered the survey results as well as a desktop review of published literature, conservation advice, online databases and spatial information.

Unmitigated impacts from the Project relate predominantly to habitat loss. The Project has followed the development mitigation hierarchy of avoid, mitigate, rehabilitate and finally, offset. The Project has gone through a number of design iterations in order to avoid areas of ecological significance and reduce the overall clearing footprint. This has included refining the Project Area to preferentially locate infrastructure in already cleared areas (including adjacent to existing roads) and in areas of relatively low vegetation density, and planning for cabling underground across the majority of the Project Area. The Project will avoid impacts to the Clarke-Connors Range, where there is habitat for Greater Glider, high quality habitat for Koala, and Of Concern remnant vegetation.

The Project is likely to result in a maximum impact to 310.1 ha of remnant vegetation. Koala habitat occurs across the majority of the Site, with a maximum impact to 345.4 ha of Koala habitat (remnant, regrowth and non-remnant vegetation). The Project has sought to locate turbines in areas with a lower density of non-juvenile Koala habitat trees and will impact on a maximum of 0.72 % of Koala habitat within the Site Boundary, which equates to 0.13 % of available Koala habitat within a 30 km radius.

Where impacts to ecological values cannot be avoided, they will be minimised through a detailed design phase, as well as by micrositing roads and cable alignments to avoid features such as Cycads and hollow bearing trees. Bushfire buffers have been specified with regard to the adjacent vegetation height (based on Lidar data), to ensure the clearing footprint is minimised as much as possible. Equipment will be located in less sensitive areas and construction procedures will include pre-clearance surveys and staged clearing methods. Fauna spotter catchers will be present for clearing. Weeds and pest animals will be managed in an adaptive program that responds to monitoring results. The quality of the local habitat will be restored by working with existing landowners to improve degraded areas as well as be restoring areas disturbed during construction. The risk of bushfires will be managed by improving access and collaborating with local rural fire managers to develop bushfire management practices. Lotus Creek Wind Farm Pty Ltd will also support ongoing research and community efforts to support koala conservation through the provision of monitoring data and funding.

The Project would result in significant residual impacts to the Koala, as the clearing of Koala habitat cannot be fully avoided and therefore a significant residual impact is anticipated. Accordingly, an offset will be provided to compensate the loss of this habitat. The offset site(s) will, at a minimum, match the quality of the habitat impacted by the proposed action, and managed and resourced over a defined period of time so that habitat quality is maintained or improved to meet the habitat quality requirements for the offset site. Residual impacts to other matters of national environmental significance confirmed within the site are not considered significant.

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# **APPENDIX A    DESKTOP SEARCH RESULTS**

## **A1 Protected matter search tool (EPBC)**



# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 03/12/20 05:30:26

[Summary](#)

[Details](#)

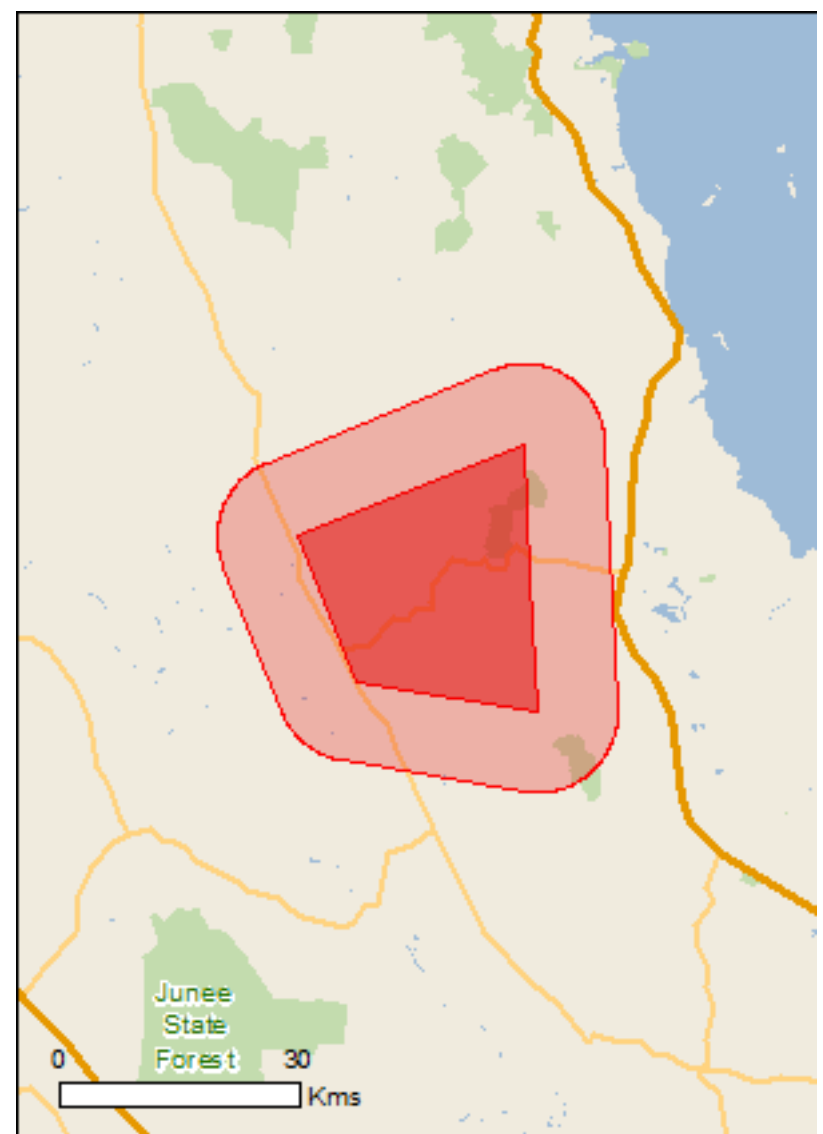
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

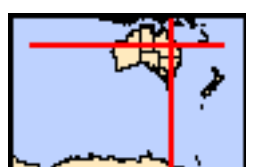
[Acknowledgements](#)



This map may contain data which are  
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[Coordinates](#)

Buffer: 10.0Km



# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance:</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Area:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	5
<a href="#">Listed Threatened Species:</a>	31
<a href="#">Listed Migratory Species:</a>	16

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

<a href="#">Commonwealth Land:</a>	None
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	22
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Australian Marine Parks:</a>	None

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

<a href="#">State and Territory Reserves:</a>	1
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	18
<a href="#">Nationally Important Wetlands:</a>	None
<a href="#">Key Ecological Features (Marine)</a>	None



# Details

## Matters of National Environmental Significance

### Listed Threatened Ecological Communities

[\[ Resource Information \]](#)

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
<a href="#">Brigalow (Acacia harpophylla dominant and co-dominant)</a>	Endangered	Community known to occur within area
<a href="#">Broad leaf tea-tree (Melaleuca viridiflora) woodlands in high rainfall coastal north Queensland</a>	Endangered	Community may occur within area
<a href="#">Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin</a>	Endangered	Community likely to occur within area
<a href="#">Poplar Box Grassy Woodland on Alluvial Plains</a>	Endangered	Community likely to occur within area
<a href="#">Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions</a>	Endangered	Community likely to occur within area

### Listed Threatened Species

[\[ Resource Information \]](#)

Name	Status	Type of Presence
<b>Birds</b>		
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Erythrotriorchis radiatus</a> Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Falco hypoleucos</a> Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Geophaps scripta scripta</a> Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
<a href="#">Neochmia ruficauda ruficauda</a> Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Poephila cincta cincta</a> Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
<a href="#">Rostratula australis</a> Australian Painted Snipe [77037]	Endangered	Species or species

Name	Status	Type of Presence
<b>Mammals</b>		
<a href="#">Chalinolobus dwyeri</a> Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Dasyurus hallucatus</a> Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
<a href="#">Macroderma gigas</a> Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Nyctophilus corbeni</a> Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
<a href="#">Petauroides volans</a> Greater Glider [254]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)</a> Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pteropus poliocephalus</a> Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Xeromys myoides</a> Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat likely to occur within area
<b>Plants</b>		
<a href="#">Cycas megacarpa</a> [55794]	Endangered	Species or species habitat known to occur within area
<a href="#">Cycas ophiolitica</a> [55797]	Endangered	Species or species habitat known to occur within area
<a href="#">Dichanthium queenslandicum</a> King Blue-grass [5481]	Endangered	Species or species habitat likely to occur within area
<a href="#">Dichanthium setosum</a> bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Eucalyptus raveretiana</a> Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Marsdenia brevifolia</a> [64585]	Vulnerable	Species or species habitat may occur within area
<a href="#">Omphalea celata</a> [64586]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Phaius australis</a> Lesser Swamp-orchid [5872]	Endangered	Species or species habitat may occur within area
<a href="#">Samadera bidwillii</a> Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area
<b>Reptiles</b>		

Name	Status	Type of Presence
<a href="#">Delma torquata</a> Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
<a href="#">Denisonia maculata</a> Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Egernia rugosa</a> Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
<a href="#">Elseya albagula</a> Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
<a href="#">Rheodytes leukops</a> Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat known to occur within area

### Listed Migratory Species [ [Resource Information](#) ]

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
<b>Migratory Marine Birds</b>		
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<b>Migratory Marine Species</b>		
<a href="#">Crocodylus porosus</a> Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
<b>Migratory Terrestrial Species</b>		
<a href="#">Cuculus optatus</a> Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
<a href="#">Monarcha melanopsis</a> Black-faced Monarch [609]		Species or species habitat known to occur within area
<a href="#">Monarcha trivirgatus</a> Spectacled Monarch [610]		Species or species habitat likely to occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat may occur within area
<a href="#">Myiagra cyanoleuca</a> Satin Flycatcher [612]		Species or species habitat likely to occur within area
<a href="#">Rhipidura rufifrons</a> Rufous Fantail [592]		Species or species habitat likely to occur within area
<b>Migratory Wetlands Species</b>		
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat may occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat may occur within area
<a href="#">Gallinago hardwickii</a> Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Pandion haliaetus</a> Osprey [952]		Species or species habitat likely to occur within area

## Other Matters Protected by the EPBC Act

### Listed Marine Species [\[ Resource Information \]](#)

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
<b>Birds</b>		
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat may occur within area
<a href="#">Anseranas semipalmata</a> Magpie Goose [978]		Species or species habitat may occur within area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat known to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat may occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat may occur within area
<a href="#">Chrysococcyx osculans</a> Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
<a href="#">Gallinago hardwickii</a> Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
<a href="#">Haliaeetus leucogaster</a> White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Monarcha melanopsis</a> Black-faced Monarch [609]		Species or species habitat known to occur within area
<a href="#">Monarcha trivirgatus</a> Spectacled Monarch [610]		Species or species habitat likely to occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat may occur within area
<a href="#">Myiagra cyanoleuca</a> Satin Flycatcher [612]		Species or species habitat likely to occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Pandion haliaetus</a> Osprey [952]		Species or species habitat likely to occur within area
<a href="#">Rhipidura rufifrons</a> Rufous Fantail [592]		Species or species habitat likely to occur within area
<a href="#">Rostratula benghalensis (sensu lato)</a> Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
<b>Reptiles</b>		
<a href="#">Crocodylus porosus</a> Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

## Extra Information

State and Territory Reserves	[ <a href="#">Resource Information</a> ]
Name	State
Burwood	QLD



## Invasive Species

[ [Resource Information](#) ]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
<b>Birds</b>		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
<b>Frogs</b>		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
<b>Mammals</b>		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
<b>Plants</b>		
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area



# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Coordinates

-22.237 149.359,-22.333 149.105,-22.483 149.17,-22.515 149.374,-22.237 149.359

# Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- [-Other groups and individuals](#)

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

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## **A2. Wildlife Online (Queensland)**



# Queensland Government

## Wildlife Online Extract

Search Criteria: Species List for a Specified Point

Species: All

Type: All

Status: Rare and threatened species

Records: All

Date: All

Latitude: -22.4294

Longitude: 149.2485

Distance: 40

Email: natalie.s@nghconsulting.com.au

Date submitted: Thursday 03 Dec 2020 04:31:40

Date extracted: Thursday 03 Dec 2020 04:40:02

The number of records retrieved = 26

### **Disclaimer**

As the DSITIA is still in a process of collating and vetting data, it is possible the information given is not complete. The information provided should only be used for the project for which it was requested and it should be appropriately acknowledged as being derived from Wildlife Online when it is used.

The State of Queensland does not invite reliance upon, nor accept responsibility for this information. Persons should satisfy themselves through independent means as to the accuracy and completeness of this information.

No statements, representations or warranties are made about the accuracy or completeness of this information. The State of Queensland disclaims all responsibility for this information and all liability (including without limitation, liability in negligence) for all expenses, losses, damages and costs you may incur as a result of the information being inaccurate or incomplete in any way for any reason.

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Accipitridae	<i>Erythrotriorchis radiatus</i>	red goshawk		E	V	2
animals	birds	Burhinidae	<i>Esacus magnirostris</i>	beach stone-curlew		V		9/1
animals	birds	Cacatuidae	<i>Calyptorhynchus lathami erebus</i>	glossy black-cockatoo (northern)		V		2
animals	birds	Charadriidae	<i>Charadrius leschenaultii</i>	greater sand plover		V	V	4
animals	birds	Charadriidae	<i>Charadrius mongolus</i>	lesser sand plover		E	E	6
animals	birds	Columbidae	<i>Geophaps scripta scripta</i>	squatter pigeon (southern subspecies)		V	V	8
animals	birds	Estrildidae	<i>Neochmia ruficauda ruficauda</i>	star finch (eastern subspecies)		E	E	1
animals	birds	Falconidae	<i>Falco hypoleucos</i>	grey falcon		V		1
animals	birds	Meliphagidae	<i>Epthianura crocea macgregori</i>	yellow chat (Dawson)		E	CE	3
animals	birds	Rostratulidae	<i>Rostratula australis</i>	Australian painted snipe		E	E	2
animals	birds	Scolopacidae	<i>Numenius madagascariensis</i>	eastern curlew		E	CE	44
animals	birds	Scolopacidae	<i>Limosa lapponica baueri</i>	Western Alaskan bar-tailed godwit		V	V	29
animals	birds	Scolopacidae	<i>Calidris tenuirostris</i>	great knot		CR	CE	11
animals	birds	Scolopacidae	<i>Calidris ferruginea</i>	curlew sandpiper		CR	CE	5
animals	birds	Scolopacidae	<i>Calidris canutus</i>	red knot		E	E	4
animals	insects	Lycaenidae	<i>Jalmenus eubulus</i>	pale imperial hairstreak		V		2
animals	mammals	Emballonuridae	<i>Taphozous australis</i>	coastal sheathtail bat		NT		1
animals	mammals	Phascolarctidae	<i>Phascolarctos cinereus</i>	koala		V	V	42
animals	mammals	Pseudocheiridae	<i>Petauroides volans</i>	greater glider		V	V	2
animals	reptiles	Chelidae	<i>Rheodytes leukops</i>	Fitzroy River turtle		V	V	9
animals	reptiles	Chelidae	<i>Elseya albagula</i>	southern snapping turtle		CR	CE	1
animals	reptiles	Elapidae	<i>Denisonia maculata</i>	ornamental snake		V	V	2
plants	land plants	Apocynaceae	<i>Cerbera dumicola</i>			NT		1/1
plants	land plants	Celastraceae	<i>Denhamia megacarpa</i>	large-fruited denhamia		E		6/6
plants	land plants	Poaceae	<i>Dichanthium queenslandicum</i>			V	E	1/1
plants	land plants	Solanaceae	<i>Solanum adenophorum</i>			E		1/1

#### CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992*. The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999*. The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).

This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.

This number is output as 999 if it equals or exceeds this value.

## APPENDIX B SURVEY SITES

Survey site number	Survey Type	Survey period	RE	Habitat
AB1_20	Anabat	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
AB3_20	Anabat	Pre wet 2020	Non-remnant	Non-remnant
AB2_20	Anabat	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
AB4_20	Anabat	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
CAM8_20	Camera	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
CAM3_20	Camera	Pre wet 2020	Non-remnant	Non-remnant
CAM4_20	Camera	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
CAM7_20	Camera	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
CAM5_20	Camera	Pre wet 2020	Non-remnant	Non-remnant
CAM1_20	Camera	Pre wet 2020	Non-remnant	Non-remnant
CAM2_20	Camera	Pre wet 2020	Non-remnant	Non-remnant
CAM6_20	Camera	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS19_20	Quaternary flora survey	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
QS12_20	Quaternary flora survey	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
QS15_20	Quaternary flora survey	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
QS4_20	Quaternary flora survey	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
QS13_20	Quaternary flora survey	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
QS34_20	Quaternary flora survey	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
QS28_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS21_20	Quaternary flora survey	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS1_20	Quaternary flora survey	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
QS36_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS16_20	Quaternary flora survey	Pre wet 2020	11.12.6a	Mixed eucalypt open forest communities
QS11_20	Quaternary flora survey	Pre wet 2020	11.12.6a	Mixed eucalypt open forest communities
QS33_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS31_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS7_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant

Survey site number	Survey Type	Survey period	RE	Habitat
QS35_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS5_20	Quaternary flora survey	Pre wet 2020	11.12.6a	Mixed eucalypt open forest communities
QS38_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS17_20	Quaternary flora survey	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
QS2_20	Quaternary flora survey	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS22_20	Quaternary flora survey	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS24_20	Quaternary flora survey	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS14_20	Quaternary flora survey	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
QS10_20	Quaternary flora survey	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS37_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS8_20	Quaternary flora survey	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS6_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS27_20	Quaternary flora survey	Pre wet 2020	8.12.7a/8.12.32/8.12.9/8.12.23/8.3.14	Mixed eucalypt open forest communities
QS9_20	Quaternary flora survey	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS25_20	Quaternary flora survey	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS32_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS3_20	Quaternary flora survey	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
QS18_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS26_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
QS20_20	Quaternary flora survey	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
QS23_20	Quaternary flora survey	Pre wet 2020	Non-remnant	Non-remnant
SAT1_20	SAT	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
SAT2_20	SAT	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
SAT3_20	SAT	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
SAT4_20	SAT	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
SAT5_20	SAT	Pre wet 2020	Non-remnant	Non-remnant
SAT6_20	SAT	Pre wet 2020	Non-remnant	Non-remnant
SAT7_20	SAT	Pre wet 2020	Non-remnant	Non-remnant
SAT8_20	SAT	Pre wet 2020	Non-remnant	Non-remnant



Survey site number	Survey Type	Survey period	RE	Habitat
SAT9_20	SAT	Pre wet 2020	11.12.6a	Mixed eucalypt open forest communities
SAT10_20	SAT	Pre wet 2020	Non-remnant	Non-remnant
SAT11_20	SAT	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
SAT12_20	SAT	Pre wet 2020	8.12.7a/8.12.32/8.12.9/8.12.23/8.3.14	Mixed eucalypt open forest communities
SAT14_20	SAT	Pre wet 2020	Non-remnant	Non-remnant
SAT13_20	SAT	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
SAT16_20	SAT	Pre wet 2020	11.12.1/11.12.13	Eucalyptus crebra woodland to open woodland
SAT17_20	SAT	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
SAT15_20	SAT	Pre wet 2020	11.12.1	Eucalyptus crebra woodland to open woodland
SAT19_20	SAT	Pre wet 2020	Non-remnant	Non-remnant
SAT18_20	SAT	Pre wet 2020	Non-remnant	Non-remnant
SAT20_20	SAT	Pre wet 2020	Non-remnant	Non-remnant
HAB1_20	Fauna habitat	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
HAB2_20	Fauna habitat	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
HAB24_20	Fauna habitat	Pre wet 2020	8.12.7c	Mixed eucalypt open forest communities
HAB4_20	Fauna habitat	Pre wet 2020	11.12.2	Eucalyptus crebra woodland to open woodland
HAB8_20	Fauna habitat	Pre wet 2020	11.12.6a	Mixed eucalypt open forest communities
HAB16_20	Fauna habitat	Pre wet 2020	8.12.7a/8.12.9/8.12.23/8.3.14	Mixed eucalypt open forest communities
HAB12_20	Fauna habitat	Pre wet 2020	11.12.6a	Mixed eucalypt open forest communities
HAB3_20	Fauna habitat	Pre wet 2020	11.12.1/11.12.6a	Eucalyptus crebra woodland to open woodland
HAB6_20	Fauna habitat	Pre wet 2020	11.12.1/11.12.6a	Eucalyptus crebra woodland to open woodland
HAB14_20	Fauna habitat	Pre wet 2020	11.12.1/11.12.6a	Eucalyptus crebra woodland to open woodland
HAB17_20	Fauna habitat	Pre wet 2020	11.12.1/11.12.6a	Eucalyptus crebra woodland to open woodland
HAB18_20	Fauna habitat	Pre wet 2020	11.12.2/11.12.13	Eucalyptus crebra woodland to open woodland
HAB19_20	Fauna habitat	Pre wet 2020	11.12.2/11.12.13	Eucalyptus crebra woodland to open woodland
HAB20_20	Fauna habitat	Pre wet 2020	11.12.2/11.12.13	Eucalyptus crebra woodland to open woodland

Survey site number	Survey Type	Survey period	RE	Habitat
HAB15_20	Fauna habitat	Pre wet 2020	11.12.2/11.12.1	Eucalyptus crebra woodland to open woodland
HAB5_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
HAB7_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
HAB9_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
HAB10_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
HAB11_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
HAB21_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
HAB25_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
HAB22_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
HAB23_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
HAB13_20	Fauna habitat	Pre wet 2020	non-rem	non-rem
RA5_19_20	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA11_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
AB10_19	Anabat	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
CAM12_19	Camera trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
QS9_19	Quaternary survey	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
QS10_19	Quaternary survey	Pre wet 2019	8.12.9	Mixed eucalypt open forest communities
RA14_19	Rapid assessment	Pre wet 2019	8.12.9	Mixed eucalypt open forest communities
AS4_19	Active search	Pre wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland
AB5_19	Anabat	Pre wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland
H1_19	Harp trap	Post wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland
H2_19	Harp trap	Post wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland
BUS4_19	BUS survey	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
AB13_19	Anabat	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
CAM16_19	Camera trap	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
H16_19	Harp trap	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities

Survey site number	Survey Type	Survey period	RE	Habitat
RA20_19	Rapid assessment	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
RA21_19	Rapid assessment	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
RA24_19	Rapid assessment	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
RA25_19	Rapid assessment	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
RA26_19	Rapid assessment	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
RA27_19	Rapid assessment	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
QS4_19	Quaternary survey	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
AS8_19	Active search	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
AS9_19	Active search	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
BUS1_19	BUS survey	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
BUS2_19	BUS survey	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
BUS6_19	BUS survey	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
AB14_19	Anabat	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
CAM13_19	Camera trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
H10_19	Harp trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
H11_19	Harp trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
H12_19	Harp trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
QS11_19	Quaternary survey	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA12_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA13_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA15_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
BUS7_19	BUS survey	Pre wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland

Survey site number	Survey Type	Survey period	RE	Habitat
RA28_19	Rapid assessment	Pre wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland
AS1_19	Active search	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
AB11_19	Anabat	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
CAM14_19	Camera trap	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
CAM15_19	Camera trap	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
H17_19	Harp trap	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
QS1_19	Quaternary survey	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
QS2_19	Quaternary survey	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
QS3_19	Quaternary survey	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
RA1_19	Rapid assessment	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
RA2_19	Rapid assessment	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
RA3_19	Rapid assessment	Pre wet 2019	11.12.2	Eucalyptus crebra woodland to open woodland
H3_19	Harp trap	Pre wet 2019	11.3.25	Riparian
QS8_19	Quaternary survey	Pre wet 2019	11.3.25	Riparian
RA6_19	Rapid assessment	Pre wet 2019	11.3.25	Riparian
RA9_19	Rapid assessment	Pre wet 2019	Non-remnant	Non-remnant
BUS3_19	BUS survey	Pre wet 2019	Non-remnant	Non-remnant
RA8_19	Rapid assessment	Pre wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland
QS7_19	Quaternary survey	Pre wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland
RA7_19	Rapid assessment	Pre wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland
BUS10_19	BUS survey	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
QS6_19	Quaternary survey	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
AS2_19	Active search	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities

Survey site number	Survey Type	Survey period	RE	Habitat
BUS9_19	BUS survey	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
CAM20_19	Camera trap	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
QS5_19	Quaternary survey	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
QS16_19	Quaternary survey	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
RA29_19	Rapid assessment	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
BUS8_19	BUS survey	Pre wet 2019	11.12.4	Semi-evergreen Vine Thicket
AS7_19	Active search	Pre wet 2019	Non-remnant	Non-remnant
CAM21_19	Camera trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
H9_19	Harp trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
QS12_19	Quaternary survey	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
QS13_19	Quaternary survey	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA16_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA17_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA18_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
QS14_19	Quaternary survey	Pre wet 2019	8.12.9	Mixed eucalypt open forest communities
BUS5_19	BUS survey	Pre wet 2019	11.12.1	Eucalyptus crebra woodland to open woodland
H15_19	Harp trap	Pre wet 2019	Non-remnant	Non-remnant
RA22_19	Rapid assessment	Pre wet 2019	Non-remnant	Non-remnant
RA23_19	Rapid assessment	Pre wet 2019	Non-remnant	Non-remnant
RA10_19	Rapid assessment	Pre wet 2019	Non-remnant	Non-remnant
RA19_19	Rapid assessment	Pre wet 2019	Non-remnant	Non-remnant
QS15_19	Quaternary survey	Pre wet 2019	8.12.7c	Mixed eucalypt open forest communities
CAM19_19	Camera trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities

Survey site number	Survey Type	Survey period	RE	Habitat
RA32_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA33_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
AS3_19	Active search	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
AS10_19	Active search	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
BUS12_19	BUS survey	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
AB6_19	Anabat	Post wet 2019	8.12.7a	Mixed eucalypt open forest communities
AB9_19	Anabat	Post wet 2019	8.12.7a	Mixed eucalypt open forest communities
CAM9_19	Camera trap	Post wet 2019	8.12.7a	Mixed eucalypt open forest communities
CAM18_19	Camera trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
H4_19	Harp trap	Post wet 2019	8.12.7a	Mixed eucalypt open forest communities
H5_19	Harp trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
H14_19	Harp trap	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA34_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
RA35_19	Rapid assessment	Pre wet 2019	8.12.7a	Mixed eucalypt open forest communities
AB7_19	Anabat	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
AB8_19	Anabat	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
CAM10_19	Camera trap	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
CAM11_19	Camera trap	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
H6_19	Harp trap	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
H7_19	Harp trap	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
RA4_19	Rapid assessment	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities
RA30_19	Rapid assessment	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities

Survey site number	Survey Type	Survey period	RE	Habitat
RA31_19	Rapid assessment	Pre wet 2019	11.12.6a	Mixed eucalypt open forest communities



## APPENDIX C LIKELIHOOD OF OCCURRENCE – THREATENED SPECIES

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
<b>FLORA</b>						
<i>Cycas megacarpa</i>		E	E	Found in woodland and open forest, often in conjunction with a grassy understory. Found in habitat dominated by <i>Eucalyptus crebra</i> and <i>Corymbia citriodora</i> .	High, has been confirmed within the Site Boundary	High
<i>Cycas ophiolotoca</i>		E	E	Found on hills and slopes in sparse, grassy open forests, in association with <i>Corymbia dallachiana</i> , <i>Eucalyptus crebra</i> , and <i>Eucalyptus tereticornis</i> .	Moderate, has been confirmed close to the Site Boundary (Clarke Creek Wind Farm).	Moderate
<i>Denhamia megacarpa</i>	Large-fruited Denhamia	E		Known from three genetically isolated subpopulations: Mackenzie, Junee Tableland and Newlands. Favours shallow, Cainozoic lateritic duricrusts on or near steep upper slopes at the edge of tablelands in association with <i>Acacia shirleyi</i> Maiden and/or <i>A. catenulata</i> RE 11.7.2, or immediately adjacent upon the tablelands in woodland of <i>Eucalyptus crebra</i> and <i>Corymbia brachycarpa</i> (Halford and Jessup 2020)	Low. Suitable habitat absent from Site Boundary	Low
<i>Dichanthium queenslandicum</i>	King Blue-grass	V	E	Occurs on black cracking clay in tussock grasslands mainly in association with other species of blue grasses ( <i>Dichanthium spp.</i> and <i>Bothriochloa spp.</i> ) but also with other grasses restricted to this soil type	Moderate	Low. Habitat is absent from Project Area.

<sup>3</sup> Where the potential to be impacted was considered high, an assessment of the significance has been conducted (Section 8)

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
<i>Dichanthium setosum</i>	Bluegrass		V	Associated species include White Box ( <i>Eucalyptus albens</i> ), Silver-leaved Ironbark ( <i>Eucalyptus melanophloia</i> ), Yellow Box ( <i>Eucalyptus melliodora</i> ), Manna Gum ( <i>Eucalyptus viminalis</i> ), Amulla ( <i>Myoporum debile</i> ), Purple Wire-grass ( <i>Aristida ramosa</i> ), Kangaroo Grass ( <i>Themeda triandra</i> )	Low	Low.
<i>Eucalyptus raveretiana</i>	Black ironbox		V	Occurs on the banks of rivers, creeks and other watercourses, on clayey or loamy soil. There are 23 recorded sites or subpopulations in two main areas of occurrence: Nebo to Ayr, and Apis Creek to Rockhampton. The total population is unknown. This species occurs within Burdekin and Fitzroy (Queensland) Natural Resource Management Regions.	Moderate	Low. Habitat is absent from development footprint.
<i>Marsdenia brevifolia</i>		V	V	This species has an apparent disjunct distribution in northern and central Queensland. Populations north of Rockhampton grow on serpentine rock outcrops or crumbly black soils derived from serpentine, in eucalypt woodland often with broad-leaved ironbark ( <i>Eucalyptus fibrosa</i> ) and <i>Corymbia xanthope</i> .	Low	Low. Habitat is absent from development footprint.
<i>Omphalea celata</i>		V	V	<i>Omphalea celata</i> occurs in fragmented semi evergreen vine thicket or araucarian microphyll vine forest, along watercourses in steep sided gorges and gullies on weathered metamorphic or granitic soils (Queensland Herbarium, 2012). Associated species include <i>Eucalyptus raveretiana</i> , <i>E. tereticornis</i> , <i>Lysiphyllum hookeri</i> and <i>Ficus opposita</i> (Queensland Herbarium, 2012). Only known from three sites in central east Queensland - Hazlewood Gorge, near Eungella; Gloucester Island, near Bowen;	Low due to the absence of suitable habitat in the Site Boundary.	Low. Habitat is absent from development footprint.

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
				and Cooper Creek in the Homevale Station area, north-west of Nebo.		
<i>Phaius australis</i>	Lesser Swamp Orchid	E	E	Occurs in coastal wet heath/sedgeland wetlands, swampy grassland or swampy forest and often where Broad-leaved Paperbark or Swamp Mahogany are found.	Low due to the absence of swampy habitat in the Site Boundary	Low. Habitat is absent from development footprint.
<i>Samadera bidwillii</i>		V	V	Commonly occurs in lowland rainforest often with <i>Araucaria cunninghamii</i> or on rainforest margins, but it can also be found in other forest types, such as open forest and woodland, it is commonly found in areas adjacent to both temporary and permanent watercourses up to 510 m altitude. Commonly associated trees in the open forest and woodlands include spotted gum ( <i>Corymbia citriodora</i> ), grey gum ( <i>Eucalyptus propinqua</i> ), white mahogany ( <i>E. acmenoides</i> ), forest red gum ( <i>E. tereticornis</i> ), pink bloodwood ( <i>Corymbia intermedia</i> ), ironbark ( <i>E. siderophloia</i> ), gum topped box ( <i>E. moluccana</i> ), Gympie messmate ( <i>E. cloeziana</i> ) and broad-leaved ironbark ( <i>E. fibrosa</i> ) (Queensland Herbarium, 2012).	Moderate. Small amount of preferred habitat in the Site Boundary.	Moderate.
<i>Solanum adenophorum</i>		E		<i>Solanum adenophorum</i> occurs mostly in brigalow woodland and on very gently inclined slopes. It also occurs in gidgee ( <i>Acacia cambagei</i> ) scrub on deep cracking clay soils (DES 2019)	Low. Suitable habitat absent from Site Boundary	Low
<b>BIRDS</b>						
<i>Calyptrorhynchus lathamii erebus</i>	Glossy Black-cockatoo	V		Prefer woodland areas dominated by she-oak <i>Allocasuarina</i> , or open sclerophyll forests and woodlands with a stratum of <i>Allocasuarina</i> beneath	Moderate. Suitable habitat was present within the Site Boundary.	Moderate.

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
				<i>Eucalyptus</i> , <i>Corymbia</i> or <i>Angophora</i> . Glossy black-cockatoos have also been observed in mixed <i>Allocasaurina</i> , <i>Casuarina</i> , cypress <i>Callitris</i> and brigalow <i>Acacia harpophylla</i> woodland assemblages.		
<i>Epthianura crocea</i>	Capricorn Yellow Chat	E	CE	The Capricorn yellow chat is known to occur at three localities - Curtis Island, Torilla Plain and the Fitzroy Delta and is most abundant at Torilla Plain. Habitat consist of wetlands and associated grasslands on seasonally inundated marine plains. These wetlands have shallow braided channels and depressions with a mosaic of dense sedge-beds, grasslands, tall samphire and areas of mud and/or shallow water	Low due to absence of habitat within the Site Boundary.	Low. Habitat is absent from development footprint.
<i>Falco hypoleucos</i>	Grey Falcon	V	V	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey.	Moderate. Marginal habitat is present within the Site Boundary and this species has been confirmed close to the Site Boundary.	Moderate.
<i>Hirundapus caudacutus</i>	White-throated Needletail	V	V, MT	Migratory aerial species, found in Australian Eastern states and Territories.	High, has been confirmed within the Site Boundary.	High.
<i>Apus pacificus</i>	Fork-tailed Swift	SLC	MT	Migratory species found over much of Australia. Mostly occur over dry or open habitats, including riparian woodlands, open farmlands, foraging aerially between 1m and 300m above the ground.	High, has been confirmed within the Site Boundary.	High.
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	E	Freshwater wetlands, occasionally estuarine; prefers heavy vegetation- shrubbery, reedbeds, sedges.	Low due to the lack of preferred habitat within the Site Boundary.	Low. Habitat is absent from development footprint.

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
<i>Cuculus optatus</i>	Oriental Cuckoo	SLC	MT	Found in many wooded habitats (such as open and dry woodland and forest) with a range of understoreys from grasses to shrubs or heath. Sometimes found near clearings and in recently logged or burnt forests. Found in farmland with some trees, orchards, vineyards and urban parks and gardens.	Moderate, suitable open woodland and cleared habitat is found within the Site Boundary.	Moderate.
<i>Erythrorichis radiatus</i>	Red Goshawk	V	E	Occurs in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia. Is sparsely dispersed across these areas. Prefer a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands.	Moderate.	Moderate.
<i>Gallinago hardwickii</i>	Latham's Snipe	SLC	MT	Soft wet ground or shallow water with tussocks and other green or dead growth. Wet parts of paddocks, seepage below dams, irrigated areas, scrub or open woodland from sea level to alpine bogs over 2000 m above sea level, samphire on salt marshes and mangrove fringes.	Moderate.	Low due to absence of habitat in Project Area.
<i>Geophaps scripta scripta</i>	Squatter Pigeon (southern)	V	V	Occurs mostly in grassy woodlands and open forests dominated by eucalypts, usually with ready access to water.	High. Has been confirmed within the Site Boundary.	High.
<i>Neochmia ruficauda ruficauda</i>	Star Finch (eastern), Star Finch (southern)	E	E	Inhabits tall grassbeds and reedbeds associated with watercourses, swamps. It may be found in grassy woodlands, open forests, and mangroves. Habitat condition varies seasonally.	Moderate. Marginal habitat occurs within the Site Boundary associated with waterways.	Low due to absence of habitat in development footprint.
<i>Monarcha melanopsis</i>	Black-faced Monarch	SLC	MT	The Black-faced Monarch mainly occurs in rainforest ecosystems. It is also sometimes found in nearby open eucalypt forests (mainly wet sclerophyll forests),	Moderate	Moderate.

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
				especially in gullies with a dense, shrubby understorey as well as in dry sclerophyll forests and woodlands, often with a patchy understorey		
<i>Monarcha trivirgatus</i>	Spectacled Monarch	SLC	MT	The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	Low due to the lack of preferred habitat within the Site Boundary.	Low.
<i>Motacilla flava</i>	Yellow Wagtail	SLC	MT	Regular summer migrant to coastal Australia, especially Darwin to Broome, but also north eastern Queensland from November to April. Found in short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lands (Pizzey and Knight, 2007).	Low due to the lack of preferred habitat within the Site Boundary.	Low.
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	SLC	MT	The Satin Flycatcher is found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	High. Has been confirmed within the Site Boundary.	High.
<i>Ninox strenua</i>	Powerful Owl	V		The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old.	High. Has been confirmed within the Site Boundary.	High.
<i>Pandion haliaetus</i>	Osprey	SLC	MT	Eastern Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers.	Low due to the lack of preferred habitat within the Site Boundary.	Low.

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
<i>Poephila cincta</i>	Black-throated finch (southern)	E	E	Occurs mainly in grassy, open woodlands and forests, typically dominated by <i>Eucalyptus</i> , <i>Corymbia</i> and <i>Melaleuca</i> , and occasionally in tussock grasslands or other habitats, often along or near watercourses, or in the vicinity of water.	Moderate. Suitable habitat identified within the Site Boundary.	Moderate.
<i>Rhipidura rufifrons</i>	Rufous Fantail	SLC	MT	In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts.	Low due to the lack of preferred habitat within the Site Boundary.	Low.
<i>Rostratula australis</i>	Australian Painted snipe	V	V	The Australian Painted Snipe is usually found in shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled.	Moderate, marginal habitat occurs within the Site Boundary. However, this species was not recorded during site surveys.	Moderate.
<b>REPTILES</b>						
<i>Delma torquata</i>	Collared Delma	V	V	Inhabiting microhabitat of small rocks and leaf litter within eucalypt-dominated woodlands and open forests in Queensland. Common prey items include cockroaches, insects and spiders; however, some species have been captured within subterranean termite colonies. The species is endemic to Queensland with fragmented colonies known to occur within the Bunya Mountains, Blacktown Tablelands National Park, Expedition National Park, Western Creek near Millmerran and the Toowoomba Range.	Moderate, no sighting was observed within the Site Boundary but suitable habitat occurs. Critical habitat includes hollow logs on the ground, rocky outcrops and rock crevices.	Moderate. A spotter catcher will check habitat features before they are impacted, relocate habitat features from the development footprint where possible, and ensure injury to Collared Delmas is avoided during clearing.



Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
<i>Denisonia maculata</i>	Ornamental Snake	V	V	Known to inhabit Brigalow regions in Queensland. Core distribution in the drainage systems of the Fitzroy and Dawson Rivers. Preferred habitat is within, or close to, its prey – frogs. The species is known to prefer woodlands and open forests associated with moist areas.	Moderate. No sightings during survey, however suitable habitat and prey species occur within the Site Boundary.	Moderate. If confirmed within the Project Area, impacts will be avoided by encouraging it to move on. A spotter catcher will ensure injury to Ornamental Snakes is avoided during clearing.
<i>Egernia rugosa</i>	Yakka Skink	V	V	Known to inhabit open woodland and scrub within Mulga and Brigalow, preferring cavities under and between partially buried logs and rocks, and abandoned animal burrows.	Moderate. Suitable habitat was identified within the Site Boundary.	Moderate. A spotter catcher will check habitat features before they are impacted, relocate habitat features from the development footprint where possible, and ensure injury to Yakka Skink is avoided during clearing.
<i>Eelseya albagula</i>	Southern Snapping Turtle	E	CE	The white-throated snapping turtle is only found in the Burnett, Fitzroy, Raglan and Mary river drainages of south-east Queensland. It prefers permanent flowing water habitats where there are suitable shelters and refuges (e.g. fallen trees).	Low. Although connectivity to suitable habitat exists, presence of suitable habitat was	Low.

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
					not identified in Site Boundary.	
<i>Rheodytes leukops</i>	Fitzroy River Turtle	V	V	Found in deep pools associated with shallow fast flowing riffles within the Fitzroy River drainage area.	Low. Although connectivity to suitable habitat exists, presence of suitable habitat was not identified in Site Boundary.	Low.
<b>MAMMALS</b>						
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Caves and mines in dry sclerophyll forests and woodlands as well as higher altitude moist eucalypt forest and edges of rainforest.	Moderate. Suitable roosting habitat is present in the Site Boundary	Low.
<i>Dasyurus hallucatus</i>	Northern Quoll	E	E	Found in a range of open woodland and open forest types preferring rocky areas.	Moderate. Suitable habitat was identified in Site Boundary. No sightings recorded.	Moderate.
<i>Macroderma gigas</i>	Ghost Bat	V	V	Occurs in a wide range of habitats in Tropical Australia, including rainforest, monsoon and vine scrub, and open woodlands. This species requires undisturbed caves for disused mineshafts for roosting.	Moderate. Suitable habitat is present in the Site Boundary.	Moderate.
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	V	V	Throughout inland Queensland, the species habitat is dominated by various Eucalyptus and Bloodwood species, and various types of tree Mallee.	Moderate. Suitable habitat is present in retained gullies and on slopes.	Low.

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Potential to be impacted <sup>3</sup>
<i>Petauroides volans</i>	Greater Glider	V	V	Greater Glider occurs in open woodlands and open forests in eastern Australia.	High. Has been confirmed within the Site Boundary.	Low. Suitable habitat is outside project footprint.
<i>Phascolarctos cinereus</i>	Koala	V	V	The Koala occurs in Eucalypt woodlands and forests throughout eastern Australia and may prefer certain Eucalypt species within any local or regional area.	High. Has been confirmed within the Site Boundary.	High.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox		V	Occurs in a range of habitats including subtropical and temperate rainforests, dry and wet sclerophyll forests, Banksia woodland, heaths and Melaleuca swamps.	Moderate. Suitable habitat was identified on the Site Boundary.	Moderate.
<i>Xeromys myoides</i>	Water Mouse	V	V	In central south Queensland, has been found in the high inter-tidal zone in tall, closed fringing mangrove forest containing only <i>Ceriops tagal</i> and/or <i>Bruguiera sp.</i>	Low due to the absence of preferred habitat within the Site Boundary.	Low.
<b>INSECTS</b>						
<i>Jalmenus eubulus</i>	Pale Imperial Hairstreak	V		Only known to breed in old-growth forest or woodland. Suitable habitat is dominated by brigalow, <i>Acacia harpophylla</i> and Buloke, <i>Casuarina cristata</i> on clay soils on flat to gently undulating plains, usually with scattered emergent eucalypts such as Poplar Box, <i>Eucalyptus populnea</i> and low trees of Wilga, <i>Geijera parviflora</i>	Low due to the absence of preferred habitat within the Site Boundary.	Low.

\*Sources: DAWE (2016), DEHP (2016b), (DAWE, 2019b) and OEH (2012) unless otherwise stated.

Status: E: Endangered, V: Vulnerable, MT: Migratory Terrestrial, SLC: Special Least Concern

Likelihood of Occurrence: Low– no suitable habitat present, Moderate - suitable species habitat present, High - suitable species habitat present and has previously been recorded within 5km or species has been recorded during field survey.

(Note - Aquatic and marine species were not included in the table due to the limited impact of the development on aquatic environment)

## APPENDIX D FAUNA SPECIES LIST

Group	Scientific name	Common name	Status
Amphibia	<i>Limnodynastes fletcheri</i>	Fletcher's Frog	
Amphibia	<i>Litoria caerulea</i>	Green Tree Frog	
Amphibia	<i>Litoria fallax</i>	Eastern Sedge Frog	
Amphibia	<i>Litoria inermis</i>	Bumpy Rocket Frog	
Amphibia	<i>Litoria latopalmata</i>	Broad-palmed Rocket Frog	
Amphibia	<i>Litoria rubella</i>	Desert Tree Frog	
Amphibia	<i>Litoria wilcoxii</i>	Eastern Stony Creek Frog	
Amphibia	<i>Limnodynastes peronii</i>	Striped Marsh Frog	
Amphibia	<i>Platyplectrum ornatum</i>	Ornate Burrowing Frog	
Amphibia	<i>Pseudophryne coriacea</i>	Red-backed Broodfrog	
Amphibia	<i>Pseudophryne majori</i>	Great Brood Frog	
Amphibia	<i>Rhinella marina</i>	Cane Toad	Invasive
Amphibia	<i>Uperoleia rugosa</i>	Chubby Gungan	
Arachnida	<i>Latrodectus hasselti</i>	Red Back Spider	
Aves	<i>Acanthiza apicalis</i>	Inland Thornbill	
Aves	<i>Acanthiza nana</i>	Yellow Thornbill	
Aves	<i>Accipiter fasciatus</i>	Brown Goshawk	
Aves	<i>Acrocephalus australis</i>	Australian Reed-Warbler	
Aves	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	
Aves	<i>Alectura lathami</i>	Australian Brush-turkey	
Aves	<i>Anas superciliosa</i>	Pacific Black Duck	
Aves	<i>Anhinga novaehollandiae</i>	Australasian Darter	
Aves	<i>Anthus novaeseelandiae</i>	Australasian Pipit	
Aves	<i>Aprosmictus erythropterus</i>	Red-winged Parrot	

Group	Scientific name	Common name	Status
Aves	<i>Apus pacificus</i>	Fork-tailed Swift	EPBC Act Migratory / Marine NC Act SLC
Aves	<i>Aquila audax</i>	Wedge-tailed Eagle	
Aves	<i>Ardea pacifica</i>	White-necked Heron	
Aves	<i>Ardeotis australis</i>	Australian Bustard	
Aves	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	
Aves	<i>Artamus personatus</i>	Masked Woodswallow	
Aves	<i>Aviceda subcristata</i>	Pacific Baza	
Aves	<i>Aythya australis</i>	Hardhead	
Aves	<i>Burhinus grallarius</i>	Bush Stone-curlew	
Aves	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	
Aves	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	
Aves	<i>Calyptorhynchus banksii</i>	Red-tailed Black-Cockatoo	
Aves	<i>Centropus phasianinus</i>	Pheasant Coucal	
Aves	<i>Ceyx azureus</i>	Azure Kingfisher	
Aves	<i>Chenonetta jubata</i>	Australian Wood Duck	
Aves	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	
Aves	<i>Colluricincla megarhyncha</i>	Little Shrike-thrush	
Aves	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	
Aves	<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike	
Aves	<i>Coracina tenuirostris</i>	Cicadabird	
Aves	<i>Corcorax melanorhamphos</i>	White-winged Chough	
Aves	<i>Corvus coronoides</i>	Australian Raven	
Aves	<i>Corvus orru</i>	Torresian Crow	
Aves	<i>Coturnix ypsilophora</i>	Brown Quail	
Aves	<i>Cracticus nigrogularis</i>	Pied Butcherbird	

Group	Scientific name	Common name	Status
Aves	<i>Cracticus quoyi</i>	Black Butcherbird	
Aves	<i>Cracticus tibicen</i>	Australian Magpie	
Aves	<i>Cracticus torquatus</i>	Grey Butcherbird	
Aves	<i>Cygnus atratus</i>	Black Swan	
Aves	<i>Dacelo leachii</i>	Blue-winged Kookaburra	
Aves	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	
Aves	<i>Dicaeum hirundinaceum</i>	Mistletoebird	
Aves	<i>Dicrurus bracteatus</i>	Spangled Drongo	
Aves	<i>Dromaius novaehollandiae</i>	Emu	
Aves	<i>Egretta novaehollandiae</i>	White-faced Heron	
Aves	<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater	
Aves	<i>Eolophus roseicapillus</i>	Galah	
Aves	<i>Eopsaltria australis</i>	Eastern Yellow Robin	
Aves	<i>Eurostopodus argus</i>	Spotted Nightjar	
Aves	<i>Eurostopodus mystacalis</i>	White-throated Nightjar	
Aves	<i>Eurystomus orientalis</i>	Dollarbird	EPBC Act Marine
Aves	<i>Falco berigora</i>	Brown Falcon	
Aves	<i>Falco cenchroides</i>	Nankeen Kestrel	
Aves	<i>Gallinula tenebrosa</i>	Dusky Moorhen	
Aves	<i>Geopelia humeralis</i>	Bar-shouldered Dove	
Aves	<i>Geopelia striata</i>	Peaceful Dove	
Aves	<i>Geophaps scripta</i>	Squatter Pigeon	EPBC Act & NC Act Vulnerable
Aves	<i>Gerygone albugularis</i>	White-throated Gerygone	
Aves	<i>Gerygone mouki</i>	Brown Gerygone	
Aves	<i>Grallina cyanoleuca</i>	Magpie-lark	

Group	Scientific name	Common name	Status
Aves	<i>Grus rubicunda</i>	Brolga	
Aves	<i>Haliastur sphenurus</i>	Whistling Kite	
Aves	<i>Hirundapus caudacutus</i>	White-throated Needletail	EPBC Act Migratory / Marine EPBC Act & NC Act Vulnerable
Aves	<i>Lalage leucomela</i>	Varied Triller	
Aves	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	
Aves	<i>Lichenostomus flavus</i>	Yellow Honeyeater	
Aves	<i>Lichenostomus leucotis</i>	White-eared Honeyeater	
Aves	<i>Lichmera indistincta</i>	Brown Honeyeater	
Aves	<i>Lopholaimus antarcticus</i>	Topknot Pigeon	
Aves	<i>Malurus elegans</i>	Red-winged Fairy-wren	
Aves	<i>Malurus melanocephalus</i>	Red-backed Fairy-wren	
Aves	<i>Manorina melanocephala</i>	Noisy Miner	
Aves	<i>Meliphaga lewinii</i>	Lewin's Honeyeater	
Aves	<i>Melithreptus albogularis</i>	White-throated Honeyeater	
Aves	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	
Aves	<i>Melithreptus lunatus</i>	White-naped Honeyeater	
Aves	<i>Merops ornatus</i>	Rainbow Bee-eater	EPBC Act Migratory
Aves	<i>Microcarbo melanoleucos</i>	Little Pied Cormorant	
Aves	<i>Milvus migrans</i>	Black Kite	
Aves	<i>Mirafrja javanica</i>	Horsfield's Bushlark	
Aves	<i>Myiagra cyanoleuca</i>	Satin Flycatcher	
Aves	<i>Myiagra rubecula</i>	Leaden Flycatcher	
Aves	<i>Neochmia temporalis</i>	Red-browed Finch	
Aves	<i>Nettapus coromandelianus</i>	Cotton Pygmy-goose	
Aves	<i>Ninox novaeseelandiae</i>	Southern Boobook	



Group	Scientific name	Common name	Status
Aves	<i>Nycticorax caledonicus</i>	Nankeen Night-Heron	
Aves	<i>Ocyphaps lophotes</i>	Crested Pigeon	
Aves	<i>Oriolus sagittatus</i>	Olive-backed Oriole	
Aves	<i>Pachycephala rufiventris</i>	Rufous Whistler	
Aves	<i>Pardalotus striatus</i>	Striated Pardalote	
Aves	<i>Pelecanus conspicillatus</i>	Australian Pelican	
Aves	<i>Phalacrocorax varius</i>	Pied Cormorant	
Aves	<i>Philemon citreogularis</i>	Little Friarbird	
Aves	<i>Philemon corniculatus</i>	Noisy Friarbird	
Aves	<i>Platycercus adscitus</i>	Pale-headed Rosella	
Aves	<i>Plectorhyncha lanceolata</i>	Striped Honeyeater	
Aves	<i>Plegadis falcinellus</i>	Glossy Ibis	
Aves	<i>Podargus strigoides</i>	Tawny Frogmouth	
Aves	<i>Poliocephalus poliocephalus</i>	Hoary-headed Grebe	
Aves	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler	
Aves	<i>Rhipidura albiscapa</i>	Grey Fantail	
Aves	<i>Rhipidura leucophrys</i>	Willie Wagtail	
Aves	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo	
Aves	<i>Sericornis frontalis</i>	White-browed Scrubwren	
Aves	<i>Smicrornis brevirostris</i>	Weebill	
Aves	<i>Sphecotheres vieilloti</i>	Australasian Figbird	
Aves	<i>Strepera graculina</i>	Pied Currawong	
Aves	<i>Struthidea cinerea</i>	Apostlebird	
Aves	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	

Group	Scientific name	Common name	Status
Aves	<i>Taeniopygia bichenovii</i>	Double-barred Finch	
Aves	<i>Taeniopygia guttata</i>	Zebra Finch	
Aves	<i>Threskiornis molucca</i>	Australian White Ibis	
Aves	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	
Aves	<i>Todiramphus macleayii</i>	Forest Kingfisher	
Aves	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	
Aves	<i>Vanellus miles</i>	Masked Lapwing	
Insecta	<i>Acraea andromacha</i>	Glasswing	
Insecta	<i>Belenois java</i>	Caper White	
Insecta	<i>Candalides erinus</i>	Small Dusky-blue	
Insecta	<i>Catopsilia gorgophone</i>	Yellow Migrant	
Insecta	<i>Euploea core</i>	Common Crow	
Insecta	<i>Eurema smilax</i>	Small Grass-yellow	
Insecta	<i>Papilio anactus</i>	Dingy Swallowtail	
Insecta	<i>Tetragonula carbonaria</i>	Sugarbag Bee	
Insecta	<i>Tirumala hamata</i>	Blue Tiger	
Mammalia	<i>Canis familiaris</i>	Wild Dog	
Mammalia	<i>Scotorepens sp</i>	Broad Nose Bat	
Mammalia	<i>Aepyprymnus rufescens</i>	Rufous Bettong	
Mammalia	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	
Mammalia	<i>Felis catus</i>	Cat	
Mammalia	<i>Macropus agilis</i>	Agile Wallaby	
Mammalia	<i>Macropus giganteus</i>	Eastern Grey Kangaroo	
Mammalia	<i>Macropus parryi</i>	Whiptail Wallaby	
Mammalia	<i>Melomys burtoni</i>	Grassland Melomys	

Group	Scientific name	Common name	Status
Mammalia	<i>Mus musculus</i>	House Mouse	Invasive
Mammalia	<i>Saccolaimus flaviventris</i>	Rabbit	Invasive
Mammalia	<i>Petauroides volans</i>	Greater Glider	EPBC Act & NC Act Vulnerable
Mammalia	<i>Petaurus breviceps</i>	Sugar Glider	
Mammalia	<i>Petaurus norfolcensis</i>	Squirrel Glider	
Mammalia	<i>Petrogale inornata</i>	Unadorned Rock-wallaby	
Mammalia	<i>Phascolarctos cinereus</i>	Koala	EPBC Act & NC Act Vulnerable
Mammalia	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	
Mammalia	<i>Pteropus scapulatus</i>	Little Red Flying-fox	
Mammalia	<i>Pteropus sp.</i>	Flying-fox sp.	
Mammalia	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tailed Bat	
Mammalia	<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat	
Mammalia	<i>Sminthopsis murina</i>	Common Dunnart	
Mammalia	<i>Sus scrofa</i>	Feral Pig	Invasive
Mammalia	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	
Reptilia	<i>Amalosia rhombifer</i>	Zigzag Velvet Gecko	
Reptilia	<i>Boiga irregularis</i>	Brown Tree Snake	
Reptilia	<i>Carlia munda</i>	Shaded-litter Rainbow-skink	
Reptilia	<i>Carlia pectoralis</i>	Open-litter Rainbow-skink	
Reptilia	<i>Chlamydosaurus kingii</i>	Frilled Lizard	
Reptilia	<i>Cryptoblepharus pulcher</i>	Elegant Snake-eyed Skink	
Reptilia	<i>Ctenotus robustus</i>	Eastern Striped Skink	
Reptilia	<i>Dendrelaphis punctulatus</i>	Common Tree Snake	
Reptilia	<i>Diplodactylus vittatus</i>	Eastern Stone Gecko	
Reptilia	<i>Diporiphora australis</i>	Tommy Round Head Dragon	

Group	Scientific name	Common name	Status
Reptilia	<i>Eulamprus quoyii</i>	Eastern Water Skink	
Reptilia	<i>Gehyra dubia</i>	Dubious Dtella	
Reptilia	<i>Gehyra versicolor</i>	Eastern Tree Dtella	
Reptilia	<i>Heteronotia binoei</i>	Bynoe's Gecko	
Reptilia	<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	
Reptilia	<i>Lampropholis delicata</i>	Grass Skink	
Reptilia	<i>Lygisaurus foliorum</i>	Tree-base Rainbow-skink	
Reptilia	<i>Menetia greyii</i>	Common Dwarf Skink	
Reptilia	<i>Morelia spilota</i>	Carpet Python	
Reptilia	<i>Morethia taeniopleura</i>	Fire-tailed Skink	
Reptilia	<i>Oedura monilis</i>	Ocellated Velvet Gecko	
Reptilia	<i>Pseudonaja textilis</i>	Eastern Brown Snake	
Reptilia	<i>Varanus varius</i>	Lace Monitor	

## APPENDIX E FLORA SPECIES LIST

Species	Common Name	Strata	NC Act Status	EPBC Act Status
<i>Acacia crassa</i> subsp. <i>crassa</i>		S1	LC	
<i>Acacia disparrima</i>		S1	LC	
<i>Acacia falciformis</i> - 170	Broad-Leaved Hickory	S1	LC	
<i>Acacia leiocalyx</i>		S1	LC	
<i>Acacia salicina</i> - 0043-45	Doolan	S1	LC	
<i>Acacia</i> sp.		S1		
<i>Allocasuarina littoralis</i>		S1	LC	
<i>Allocasuarina torulosa</i>		T1/T2//S1	LC	
<i>Alphitonia excelsa</i>	Soap Tree	G/S1	LC	
<i>Alyxia ruscifolia</i>		S1	LC	
<i>Archidendropsis basaltica</i>	Red Lancewood	S1	LC	
<i>Aristida latifolia</i>	Feathertop Wiregrass	G	LC	
<i>Aristida</i> sp		G	-	
<i>Arundinella nepalensis</i>	Reedgrass	G	LC	
<i>Atalaya hemiglauca</i>		S1	LC	
<i>Banksia integrifolia</i> subsp. <i>compar</i>		S1	LC	
<i>Brachychiton australis</i>	Broad-Leaved Bottle Tree	T1	LC	
<i>Breynia oblongifolia</i>		S1	LC	
<i>Bridelia</i> sp. ( <i>leichhardtii</i> )		S1	LC	
<i>Brunoniella australe</i>	Blue Trumpet	G	LC	
<i>Capparis lasiantha</i>	Nipan	G	LC	
<i>Carissa ovata</i>	Currant Bush	S	LC	
<i>Cassia brewsterii</i>		T1	LC	
<i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i>		T2	LC	
<i>Corymbia citriodora</i>	Lemon-Scented Gum	T1/T2/S1	LC	
<i>Corymbia intermedia</i>	Pink Bloodwood	T1/T2/S1	LC	
<i>Corymbia trachyphloia</i>		T1/T2	LC	
<i>Croton insularis</i>	Queensland Cascarilla	S1	LC	
<i>Cryptostegia grandiflora</i>	Rubber Vine	S1	Weed	

Species	Common Name	Strata	NC Act Status	EPBC Act Status
<i>Cupaniopsis anacardioides</i>	Tuckeroo	S1	LC	
<i>Cycas megacarpa</i>	Cycad	S1	E	E
<i>Cynathillium cinereum</i>		G	LC	
<i>Denhamia</i> sp -297-300		S1	LC	
<i>Dianella caerulea</i>		S1/G	LC	
<i>Dianella</i> sp.		G	LC	
<i>Dinebra decipiens</i>		G	LC	
<i>Diospyros</i> 238-240		S1	LC	
<i>Eleocharis</i> sp.		G	LC	
<i>Entolasia stricta</i>	Wiry Panic	G	LC	
<i>Eucalyptus acmenoides</i>		T1	LC	
<i>Eucalyptus crebra</i>	Narrow-Leaved Ironbark	T1/T2/S1/G	LC	
<i>Eucalyptus drepanophylla</i> ( <i>crebra</i> )	Narrow-Leaved Ironbark	T2	LC	
<i>Eucalyptus exserta</i>	Queensland Peppermint	T2	LC	
<i>Eucalyptus melanophloia</i>		T1	LC	
<i>Eucalyptus moluccana</i>	Gum-Topped Box	T1/T2	LC	
<i>Eucalyptus platyphylla</i>	Poplar Gum	T1	LC	
<i>Eucalyptus portuensis</i> ( <i>acmenoides</i> )	White Mahogany	T1/T2	LC	
<i>Eucalyptus tereticornis</i>		T1/S1	LC	
<i>Euroschinus falcatus</i>		T1/S1	LC	
<i>Exocarpus cupressiformis</i>	Native Cherry	S1	LC	
<i>Ficus rubiginosa</i>	Port Jackson Fig	S	LC	
<i>Glochidion lobocarpum</i>		S1	LC	
<i>Glycine clandestina</i>		G	LC	
<i>Gomphocarpus physocarpus</i>	Balloon Cottonbush	S1	Weed	
<i>Goodenia hederacifolia</i> ( <i>hederacea</i> )		G	LC	
<i>Grevillea striata</i>	Beefwood	T1	LC	
<i>Heteropogon contortus</i>	Black Speargrass	G	LC	
<i>Imperata cylindrica</i>	Blady Grass	G	LC	
<i>Jasmines wiith trifoliolate leaf</i>		G	LC	

Species	Common Name	Strata	NC Act Status	EPBC Act Status
<i>Juncos sp.</i>		G	LC	
<i>Lantana camara</i>	Lantana	S1/S	Weed	
<i>Lepidosperma laterale</i>		G	LC	
<i>Lomandra confertifolia</i>		G	LC	
<i>Lomandra hystrix</i>	Mat Rush	G	LC	
<i>Lophostemon confertus</i>	Brush Box	T2	LC	
<i>Lophostemon suaveolens</i>	Swamp Box	S1	LC	
<i>Lysiphyllum maytenus -116-127</i>		S1	-	
<i>Melaleuca sp.</i>		T1	-	
<i>Melaleuca bracteata</i>		S1	LC	
<i>Melaleuca fluviatilis</i>		T2	LC	
<i>Melaleuca viminalis</i>		S1	LC	
<i>Melaleuca viridiflora</i>		T2/S1	LC	
<i>Melia azedarach</i>	White Cedar	T1	LC	
<i>Notelaea microcarpa</i>		S1	LC	
<i>Oplismenus aemulus</i>		G	LC	
<i>Opuntia tomentosa</i>	Velvety Tree Pear	S1	Weed	
<i>Panicum sp.</i>		G		
<i>Parsonsia straminea</i>	Monkey Rope	G	LC	
<i>Petalostigma pubsecens</i>	Quinine Tree	S1	LC	
<i>Pittosporum spinescens</i>		G	LC	
<i>Pleiogynium timorense</i>	Burdekin Plum	T1	LC	
<i>Pogonolobus reticulatus</i>		S1	LC	
<i>Psydrax attenuata -112-114</i>		S1	LC	
<i>Psydrax with long eel linear leaf</i>		S1	LC	
<i>Sida rhombifolia</i>	Paddy's Lucerne	G	Weed	
<i>Sporobolus creber</i>		G	LC	
<i>Stylosanthes scabra</i>		G	LC	
<i>Themeda australis</i>	Kangaroo Grass	G	LC	
<i>Typha sp.</i>	Cumbungi	G	Weed	
<i>Vine – 101,102</i>		G	-	



<b>Species</b>	<b>Common Name</b>	<b>Strata</b>	<b>NC Act Status</b>	<b>EPBC Act Status</b>
<i>Xanthorrhoea</i>		G	-	
<i>Xanthorrhoea johnsonii</i>		G/S1	LC	
<i>Xanthorrhoea latifolia</i>		S1	LC	

# **APPENDIX F    BAT CALL ANALYSIS REPORT**

# Bat Call Analysis Report

## Lotus Creek Wind Farm

Prepared for Lotus Creek Wind Farm Pty Ltd

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## 1.0 Introduction

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### 1.1 Background

An assessment on the likelihood of the presence of microbat species using echolocation detectors (Anabats swift) in April (11 days), October 2019 (16 days) and October 2020 (7 days) was conducted during an ecological survey of the proposed Lotus Creek Wind Farm located at Lotus Creek, Central Queensland.

### 1.2 Scope of Works

The specific scope of works for this report includes the following:

- Outline the methodology used to survey microbat species within the subject site;
- Present the findings of all of the bat call surveys conducted at the project site.
- Analyse and provide an assessment of the likelihood of occurrence of threatened microbat species listed under State and Commonwealth legislation; and,
- Identify of local statutory considerations relevant to ecological aspects (relevant to bats) of the site.



## 2.0 Methodology

---

### 2.1 Desktop Assessment

A desktop assessment was undertaken in March 2019 to review relevant environmental documents, databases, maps and legislation (Commonwealth, State and Local) to identify ecological values and threatened flora and fauna species that may potentially occur within and surrounding the site. This documentation was used as a preliminary source of information for consideration of field survey scoping. Following the first seasonal survey, Green Tape Solutions undertook additional database searches in October 2019 and 2020 to further refine our understanding of the potential species occurrences in the area, and included the following sources of information:

- The Department of Agriculture, Water and the Environment (DAWE) Protected Matters Search Tool to identify Matters of National Environmental Significance (MNES) within a 20 km search area using the coordinates (corners of a bounding polygon) for the proposed windfarm location;
- DAWE Species Profiles and Threats Database (SPRAT);
- The Department of Environment and Science (DES) Wildlife Online database to identify flora and fauna species occurring within approximately 20 km of the subject site. The search was defined using the coordinates (corners of the bounding polygon) for the proposed windfarm location;
- Atlas of Living Australia as defined by the coordinates (corners of the bounding polygon) for the proposed windfarm location;
- Published ecological information on threatened flora and fauna species for adjoining areas of land.

The results of the desktop assessment were used to inform the bat survey methodology described below.

### 2.2 Capture Technique and Survey Effort

Targeted bat surveys were conducted at 19 sites within all five vegetation communities that are identified in the Ecological Assessment report for the project:

- Vegetation Community 1: Eucalyptus crebra Woodland to Open Woodland
- Vegetation Community 2: Riparian Vegetation
- Vegetation Community 3: Mixed Eucalypt Open Forest communities
- Vegetation Community 4: Semi-Evergreen Vine Thicket (SEVT)
- Vegetation Community 5: Wetland/Alluvial Plains Eucalyptus crebra open Woodland vegetation community

The following four survey methods were employed during the bat surveys:

#### 2.2.1 Ultrasonic Detectors

Microbat calls were sampled using Anabat Swift detectors (Titley Electronics). Passive monitoring was undertaken during two seasons (two surveys were done in summer and one in winter) in 2019 and 2020 at location outlined in **Figures 1** and **2**. as follow:

- During the wet season (31<sup>st</sup> April - 10<sup>th</sup> May 2019), passive monitoring was undertaken for 10 consecutive nights using eight detectors – 80 detector nights during the warmer season.
- During the dry season surveys (29<sup>th</sup> October to 14<sup>th</sup> November 2019), passive monitoring was undertaken for 13 consecutive nights using eight detectors; 104 detector nights during cooler season. All detectors had extended microphones.
- During the dry season surveys (21<sup>th</sup> October to 27 October 2020), passive monitoring was undertaken for six consecutive nights using four detectors; 24 detector nights during cooler season.

Monitoring commenced at dusk (approximately 1830 hours) and continued until dawn (approximately 0545 hours). Ultrasonic call monitoring surveys were conducted using stereo-channel full-spectrum detectors fitted with one omnidirectional ultrasonic microphone. The detectors were attached to tree trunks and set approximately 3 and 5m above the ground using telescopic microphones angled 45 degrees upwards.

No caves were observed within the survey area; however, a number of hollows were identified, providing potential roost sites for microbats. As such, the detectors were placed for general recording throughout the survey area. In particular, the detectors were placed within all three vegetation communities, in location where bats were likely to occur (e.g. proximity of hollow-bearing trees, along waterways, dam, etc.) and at proximity to the road and turbines where possible to maximise the chance of capturing all species that may roost or forage within the site.

### **2.2.2 Habitat searches**

Habitat search were undertaken across the project area. Team of ecologists (1 team of 2 ecologists during April and 2 teams of 2 ecologists in October 2019 and 2020) drove and walked across the project area and flew drones (Phantom 3) covering an all vegetation communities. Habitat searches involved hand searches of suitable microhabitats, such as under loose bark, within hollow-bearing trees, and in rock fissures and crevices.

### **2.2.3 Spotlighting**

Spotlight searches for nocturnally active mammals were also undertaken. Active monitoring surveys were conducted on all spotlighting nights during both seasons using an EchoMeter Touch from a slow-moving vehicle travelling along the access track from the vicinity of proposed turbines or along the walking tracks (Figures 1 and 2). Transects were undertaken by two ecologists.

Surveys commenced one hour after dusk and involved searching for any wildlife but targeting flying-fox's species on foot. Areas with hollow bearing trees were also targeted to detect bats emerging from diurnal roosts to forage. Spotlighting was also undertaken along vehicle tracks.

Spotlighting was undertaken every survey night over the three survey periods with a total of 50 survey hours. This results in an area of approximately 41.25km being covered through the combined effort of the spotlighting transects.

### **2.2.4 Harp Trap**

Four harp traps were also set up at a different location every night during both seasonal surveys. A total of 100 trap nights were undertaken within the project area. At each site, monitoring commenced at dusk

(approximately 18:30hours) and traps were checked in the early morning, 2 hours before dawn (approximately 03:00 hours).

The use of a combination of trapping and echolocation call recording was the most efficient approach to for bat inventory surveys. The bat survey effort meets the Australasian Bat Society Guideline which recommends that effort should involve detector deployment for at least three complete nights in each major habitat type in the survey area. The survey effort is also consistent with the EPBC Act survey guidelines for Australia's threatened bats (DoE, 2010b) which recommends the 16 detector nights across four nights within each vegetation communities. The guidelines also indicate that 20 trap nights is recommended to capture the presence of *N. corbeni*.

### 2.3 Climate

Mean daily maximum temperatures (from the temperature recording station located in St Lawrence (BoM station 33210, approximately 40 km north east) indicates that summer temperatures average around 27-30°C. Maximum temperatures in the low to mid 40's have been recorded in October – March 2019, and minimum temperatures as low as zero have also been recorded during winter. There is a high incidence of winter and early spring fogs.

Rainfall data from the Bureau of Meteorology (BoM) weather station at Junee Station (034061), approximately 30 km south west from the study area, indicates that rainfall is seasonally distributed with a distinct wet season typically present from November through March and a drier season extending from April through October 2019 as well as in 2020. The median annual rainfall is 600-1000 mm, mostly falling between January and March (BoM, 2020).

The survey timing and condition were considered optimal for both seasons and as per vertebrate fauna surveys guidelines. The April survey was undertaken after summer rainfall and before the onset of cold winter nights. This timing coincides with an active period including dispersal and migration of many bat species. The condition of the site was moist and suitable for undertaking bat surveys.

During the second and third survey (October / November 2019 and 2020), temperatures began to warm up after winter and there was an increase in vertebrate activity with the commencement of breeding activity in many species. The survey conditions were undertaken in dry conditions.

The weather conditions during the field investigation were suitable for undertaking bat survey and collect seasonal variation across the site.

### 2.4 Call Identification

Bat detector recordings were analysed using Anabat Insight. Identifications were made by categorising call shape and frequency, with a species match given in consideration to region, known bat distributions, and habitats present. The focus of the bat surveys was to assess the presence of bat species found within the allotment, and to assess the potential for rare and threatened species to occur.

Call identification for this dataset was based on call keys and descriptions published for Queensland (Reinhold, 2001) and Northern Territory (PWCNT, 2002) with reference to descriptions for New South Wales (Pennay *et al.*, 2004).

Species' identification was further refined using the probability of occurrence of each species based on their geographic distribution (Churchill, 2008, Van Dyck *et al.*, 2008). Species nomenclature used in this report follows Churchill (2008).

The reliability of identification is as follows:

- **Definite** - one or more calls where there is no doubt about the identification of the species;
- **Probable** - most likely to be the species named, low probability of confusion with species that use similar calls; and,
- **Possible** - call is comparable with the named species, with a moderate to high probability of confusion with species of similar calls.

## 2.5 Survey Limitations

The ability to detect calls and accurately identify them to species level can vary greatly with the surrounding environment and the location of the echolocation device. The survey undertaken as part of this assessment only represents a 'snapshot' in time and therefore, may not provide a true indication of species presence at the site. Hence, this survey should not be regarded as conclusive evidence that certain microbat species do not occur at the site, although the species identified in both surveys were the same providing confidence that it is likely that all the species have been identified.

Not all areas within the project development area were easily/efficiently accessible for vegetation survey, due mostly to the presence of a very dense shrub layer, steepness of the terrain or lack of any existing access tracks in the vicinity of proposed wind farm infrastructure. In these areas, inspection from nearby accessible vantage points utilising high-powered binoculars or drone were used to confirm vegetation types. Condition for these areas was extrapolated from other known areas of similar vegetation that had been surveyed in detail.

## 2.6 National Standard

The format and content of this report complies with the nationally accepted standards for the interpretation and reporting of Anabats and Songmeters data (Reardon, 2003), which is currently available from the Australasian Bat Society at [www.ausbats.org.au](http://www.ausbats.org.au).



**FIGURE 1: Bat survey Locations**

**North**

**Project: Lotus Creek Wind Farm**

**Legend**

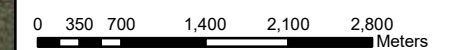
-  Harp trap site
-  Anabat
-  Spotlighting
-  Site boundary
-  Project area
-  Development footprint

**Ground truthed vegetation**

-  Community 1
-  Community 2
-  Community 3
-  Community 4
-  Community 5



Notes:  
-Flora and Fauna Survey by Green Tape Solutions and NGH Environmental 2019  
-Site Infrastructure and Impact Areas from Client 2020  
-Base map Copyright (c) Esri and its data suppliers.  
-Regional Ecosystems and QTopo Base map Copyright (c) State of Queensland (DNRM)



Ref: Lotus Creek Wind Farm 2020  
Author: JV



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**FIGURE 2: Bat survey Locations**


**South**

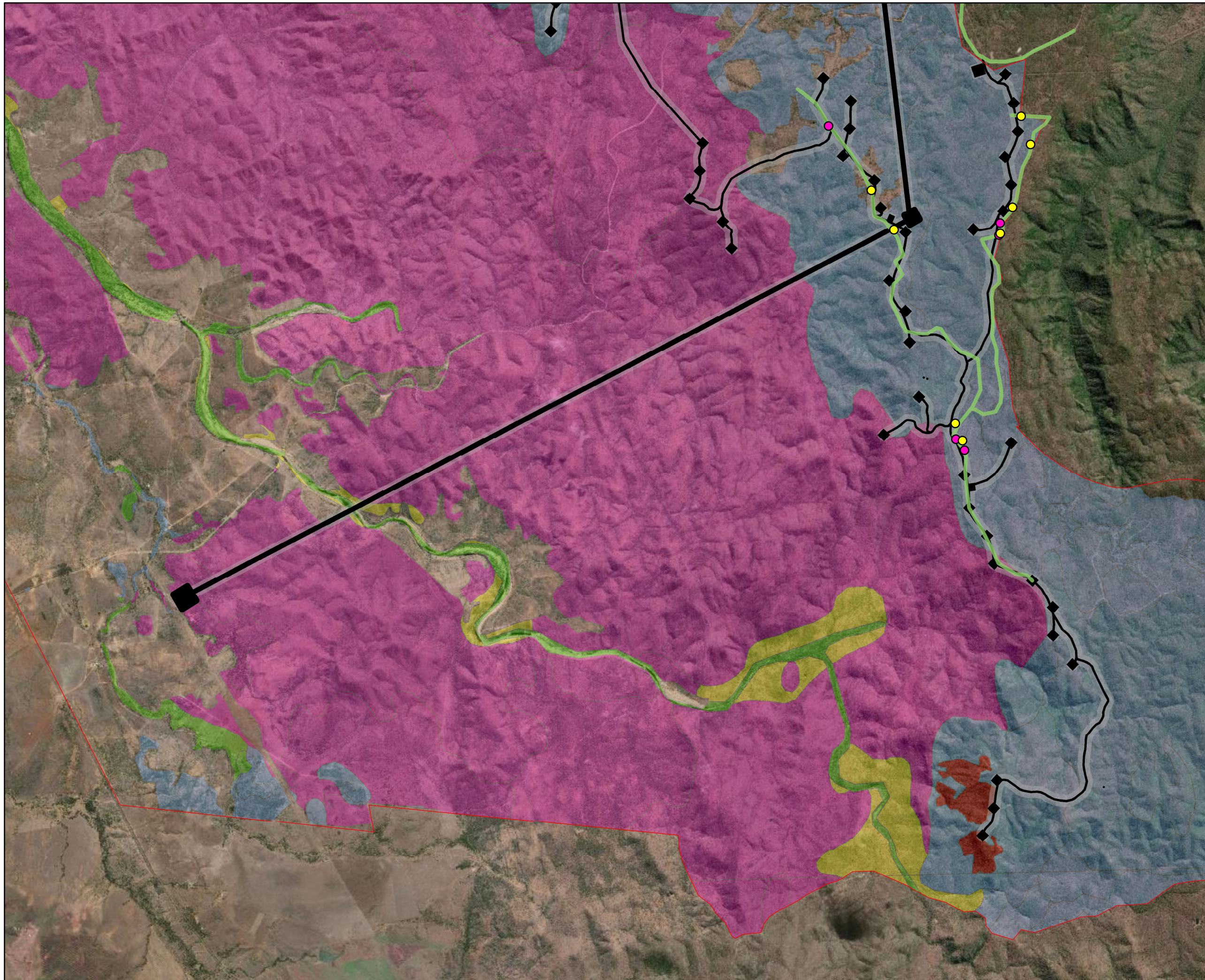
**Project: Lotus Creek Wind Farm**

**Legend**

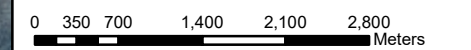
-  Harp trap site
-  Anabat
-  Spotlighting
-  Site boundary
-  Project area
-  Development footprint

**Ground truthed vegetation**

-  Community 1
-  Community 2
-  Community 3
-  Community 4
-  Community 5



Notes:  
-Flora and Fauna Survey by Green Tape Solutions and NGH Environmental 2019  
-Site Infrastructure and Impact Areas from Client 2020  
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Ref: Lotus Creek Wind Farm 2020  
Author: JV



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## 3.0 Results

---

### 3.1 Total of Species Recorded

The original call files display Australian Eastern Standard Time. The majority of calls were considered to be of medium to good quality calls. The locations of the devices are illustrated in **Figures 1** and **2**.

In total, 15,651 call sequence files were received, of which 50% were marked as containing recognisable bat calls. Most of the detectors generated a large quantity of identifiable bat calls. All detectors recorded data. A summary of the species present on site is provided in **Table 1**.



Table 1: Summary of bat calls (April 2019)

Species	NC Act	EPBC Act	An 1	An 2	An 3	An 4	An 5	2019 An 6	2019 An 7	2019 An 8	2020 An 1	2020 An 2	2020 An 3	2020 An 4
<i>Austronomus australis</i>	LC	NOC	NR	Definite	Definite	NR	Definite	c	Definite	Definite	Definite	Definite	Definite	Definite
<i>Chalinolobus gouldii</i>	LC	NOC	NR	NR	Definite - Captured	Definite	NR	NR	Definite	NR	NR	NR	Definite	Definite
<i>Chalinolobus morio</i>	LC	NOC	NR	Definite - Captured	NR	Definite	NR	NR	NR	Definite	Definite - Captured	NR	NR	NR
<i>Chalinolobus nigrogriseus</i>	LC	NOC	NR	Definite	Definite	NR	Definite	Definite	NR	Definite	Definite	Definite	Definite	Definite
<i>Chalinolobus picatus</i>	LC	NOC	NR	NR	NR	Definite	NR	Definite	Definite	NR	NR	NR	NR	NR
<i>Miniopterus australis</i>	LC	NOC	Definite	NR	Definite	NR	Definite	Definite	Definite	NR	NR	Definite	Definite	Definite
<i>Miniopterus orianae oceanensis</i>	LC	NOC	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite
<i>Myotis macropus</i>	LC	NOC	Probable	NR	Probable	Probable	NR	NR	NR	NR	NR	NR	Probable	Probable
<i>Nyctophilus geoffroyi</i> , - <i>N. gouldi</i> - <i>N. bifax</i>	LC LC LC	NOC NOC NOC		Probable Probable	NR	NR	NR	NR	Probable	NR	Probable	NR	NR	NR
- <i>N. corbeni</i>	Vulnerable	Vulnerable	Possible	Possible	NR	NR	NR	NR	Possible	NR	Possible	NR	NR	NR
<i>Ozimops lumsdenae</i>	LC	NOC	Possible	Possible	Possible	Possible	NR	NR	Possible	NR	Possible	NR	Possible	Possible
<i>Ozimops ridei</i>	LC	NOC	Definite	Definite	NR	Definite	Definite	NR	Definite	Definite	Definite	Definite	NR	NR
<i>Rhinolophus megaphyllus</i>	LC	NOC	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite
<i>Saccolaimus flaviventris</i>	LC	NOC	Probable	Probable	NR	Probable	Probable	Probable	Probable	NR	Probable	Probable	NR	NR
<i>Scotorepens balstoni</i>	LC	NOC	Definite - Captured	Definite	Definite	Definite	NR	NR	Definite	Definite	Definite	NR	Definite	Definite
<i>Scotorepens greyii</i>	LC	NOC	Probable	Probable	NR	Probable	NR	Probable	Probable	Probable	Probable	NR	NR	NR
<i>Taphozous troughtoni</i>	LC	NOC	Possible	Possible	Possible	Possible	NR	NR	NR	NR	Possible	NR	Possible	Possible
<i>Vespadelus troughtoni</i>	LC	NOC	Definite	NR	Definite	NR	NR	NR	Definite	NR	NR	NR	Definite	Definite
<i>Vespadelus vulturnus</i>	LC	NOC	Possible	Possible	Possible	Possible	NR	NR	NR	NR	Possible	NR	Possible	Possible

LC: Least Concern, NOC: Not of Concern, NR: Not recorded, V: Vulnerable, An: Anabat Swift

Table 2: Summary of bat calls (October 2019)

Species	NC Act	EPBC Act	An 1	An 2	An 3	An 4	An 5	An 6	An 7	An 8
<i>Austronomus australis</i>	LC	NOC	NR	Definite	Definite	NR	Definite	NR	Definite	Definite
<i>Chalinolobus gouldii</i>	LC	NOC	NR	NR	NR	Definite - Captured	NR	Definite	NR	NR
<i>Chalinolobus morio</i>	LC	NOC	NR	NR	NR	NR	NR	Definite	NR	Definite - Captured
<i>Chalinolobus nigrogriseus</i>	LC	NOC	NR	Definite	Definite	NR	Definite	Definite	NR	Definite
<i>Chalinolobus picatus</i>	LC	NOC	NR	NR	NR	Definite	NR	Definite	Definite	NR
<i>Miniopterus australis</i>	LC	NOC	Definite	NR	Definite	NR	Definite	Definite	Definite	NR
<i>Miniopterus orianae oceanensis</i>	LC	NOC	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite
<i>Myotis macropus</i>	LC	NOC	Probable	NR	Probable	Probable	NR	NR	NR	NR
<i>Nyctophilus geoffroyi</i> ,	LC	NOC	Probable	Definite - Captured	NR	NR	NR	NR	Probable	NR
- <i>N. gouldi</i>	LC	NOC	Possible	Possible	NR	NR	NR	NR	Possible	NR
- <i>N. bifax</i>	LC	NOC								
- <i>N. corbeni</i>	Vulnerable	Vulnerable	Possible	Possible	NR	NR	NR	NR	Possible	NR
<i>Ozimops lumsdenae</i>	LC	NOC	Possible	Possible	Possible	Possible	NR	NR	Possible	NR
<i>Ozimops ridei</i>	LC	NOC	Definite	Definite - Captured	NR	Definite	Definite	NR	Definite	Definite
<i>Rhinolophus megaphyllus</i>	LC	NOC	Definite	Definite	Definite	Definite	Definite	Definite	Definite	Definite
<i>Saccolaimus flaviventris</i>	LC	NOC	Definite - Captured	Probable	NR	Probable	Probable	Probable	Probable	NR
<i>Scotorepens balstoni</i>	LC	NOC	Definite	Definite - Captured	Definite	Definite - Captured	NR	NR	Definite	Definite
<i>Scotorepens greyii</i>	LC	NOC	Probable	Probable	NR	Probable	NR	Probable	Probable	Probable
<i>Scotorepens Sanborni</i>										
<i>Taphozous troughtoni</i>	LC	NOC	Possible	Possible	Possible	Possible	NR	NR	NR	NR
<i>Vespadelus troughtoni</i>	LC	NOC	Definite	NR	Definite	NR	NR	NR	Definite	NR

LC: Least Concern, NOC: Not of Concern, NR: Not recorded, V: Vulnerable, An: Anabat Swift,

Table 3: Summary of bat calls (October 2020)

Species	NC Act	EPBC Act	An 1	An 2	An 3	An 4
<i>Austronomus australis</i>	LC	NOC	Definite	Definite	Definite	Definite
<i>Chalinolobus gouldii</i>	LC	NOC	NR	NR	Definite	Definite
<i>Chalinolobus morio</i>	LC	NOC	Definite	NR	NR	NR
<i>Chalinolobus nigrogriseus</i>	LC	NOC	Definite	Definite	Definite	Definite
<i>Chalinolobus picatus</i>	LC	NOC	NR	NR	NR	NR
<i>Miniopterus australis</i>	LC	NOC	NR	Definite	Definite	Definite
<i>Miniopterus orianae oceanensis</i>	LC	NOC	Definite	Definite	Definite	Definite
<i>Myotis macropus</i>	LC	NOC	NR	NR	Probable	Probable
<i>Nyctophilus geoffroyi</i> ,	LC	NOC				
- <i>N. gouldi</i>	LC	NOC	Probable	NR	NR	NR
- <i>N. bifax</i>	LC	NOC				
- <i>N. corbeni</i>	Vulnerable	Vulnerable	Possible	NR	NR	NR
<i>Ozimops lumsdenae</i>	LC	NOC	Possible	NR	Possible	Possible
<i>Ozimops ridei</i>	LC	NOC	Definite	Definite	NR	NR
<i>Rhinolophus megaphyllus</i>	LC	NOC	Definite	Definite	Definite	Definite
<i>Saccolaimus flaviventris</i>	LC	NOC	Probable	Probable	NR	NR
<i>Scotorepens balstoni</i>	LC	NOC	Definite	NR	Definite	Definite
<i>Scotorepens greyii</i>	LC	NOC	Probable	NR	NR	NR
<i>Taphozous troughtoni</i>	LC	NOC	Possible	NR	Possible	Possible
<i>Vespadelus troughtoni</i>	LC	NOC	NR	NR	Definite	Definite
<i>Vespadelus vulturinus</i>	LC	NOC	Possible	Possible	Possible	Possible

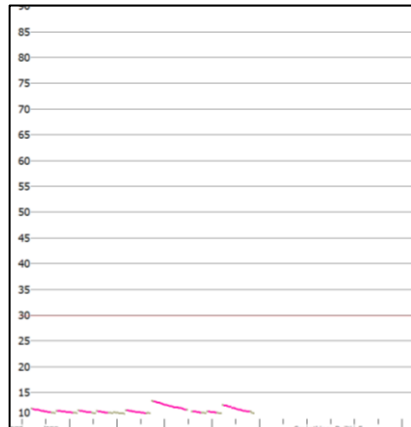
LC: Least Concern, NOC: Not of Concern, NR: Not recorded, V: Vulnerable, An: Anabat Swift

### 3.2 Samples of Calls / Sequences Files

Samples of call extracted from the dataset for each species identified is provided in the following figures.

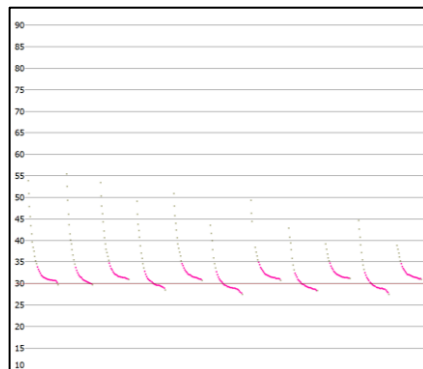
**Figure 3: Definite *Austronomus australis***

This bat is easily recognised by its constant frequency calls range in bandwidth from 10.5 to 15 kHz.



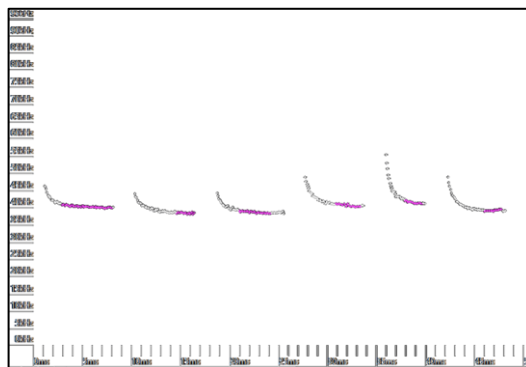
**Figure 4: Definite *Chalinolobus gouldii***

Curved shape with characteristic frequency 28 to 31kHz. Pulse alternate in frequency.



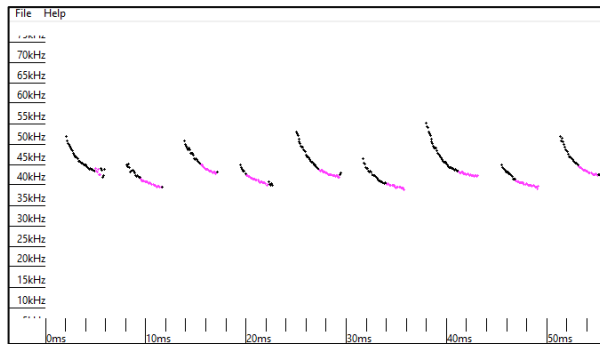
**Figure 5: Definite *Chalinolobus nigrogriseus***

Curved shape with characteristic frequency 37 to 40kHz (Reinhold *et al*, 2001). Usually has no tail. Characteristic section and tail take up at least 2/3 if the time of the pulse when in search phase.



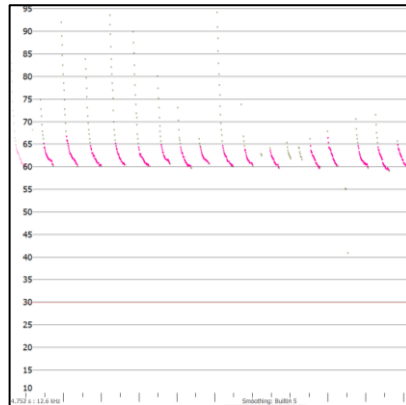
**Figure 6: Definite *Chalinolobus picatus***

Characteristic frequency between 38.5 and 43 kHz (n = 9). Curved. Pulses alternate in frequency. Good quality calls should not be confused with any other species. Characteristic frequency is usually higher than *Scotorepens greyii*, and lower than *Vespadelus vulturnus*. Non-alternating calls below 40 kHz may be confused with *Scotorepens greyii* (Reinhold *et al*, 2001).



**Figure 7: Definite *Miniopterus australis***

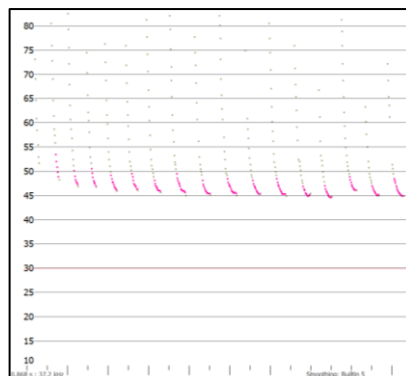
This species displays a characteristic frequency between 54.5 – 64.5 kHz with a curved, usually down-sweeping tail (Pennay *et al* 2004). It overlaps in frequency with *Vespadelus pumilus* between 57 – 58 kHz but the latter exhibits curved up-sweeping tail.



**Figure 8: Possible *Miniopterus orianae oceanensis***

The species call is characterised by its relatively long curved pulse with a small down-sweeping tail and its frequency 43-47kHz (Reinhold, 2001).

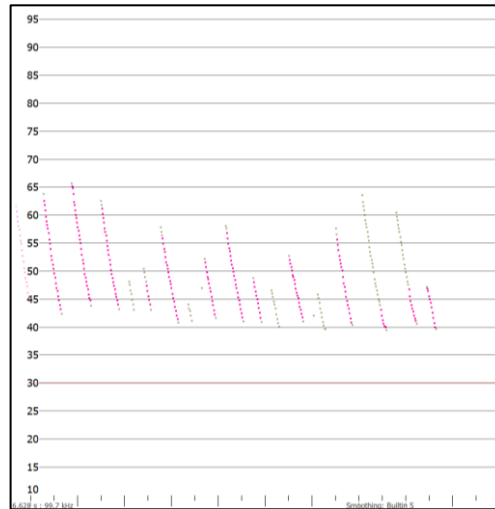
Pulse shape and time between calls usually variable within a sequence.



**Figure 9: Probable *Myotis macropus***

Near-vertical pulse dropping to about 30 to 35-50kHz. *M. macropus* mostly have a pulse interval of less than 75ms and usually have one kink close to the middle so that the second part has a lesser slope than the first (Reinhold, 2001).

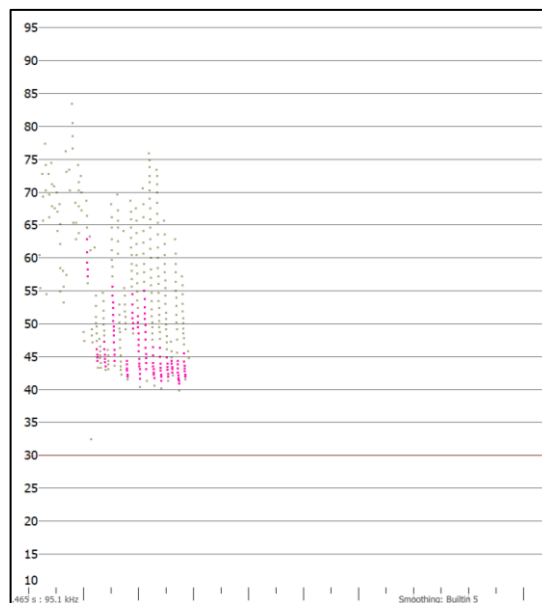
This call can be confused with *Nyctophilus sp* calls. The latest have usually a pulse interval greater than 95ms and are slightly more complicated structure with two kinks instead of one.



**Figure 10: Definite *Nyctophilus sp.***

This species displays a near-vertical pulse, characteristic frequency between 80 and 35KHz (Pennay *et al*, 2004). The call of these species cannot be distinguished from each other.

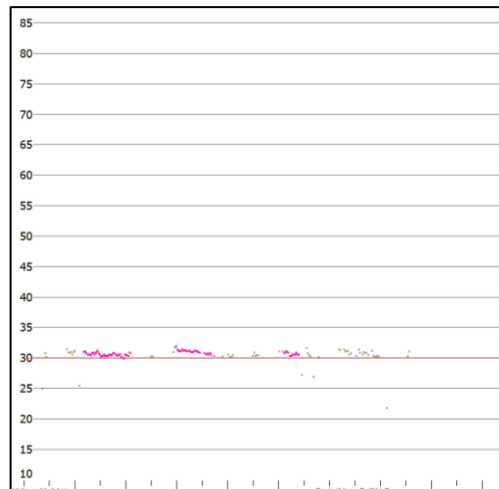
There are four species of *Nyctophilus spp* occurring within the site area. One of them, *N. corbenii* can occur within the site and is listed under NC Act and EPBC Act. Harp trap surveys did not capture this species within the project area. The locations of the calls recorded match the capture location of the other 3 least concern microbats' species.





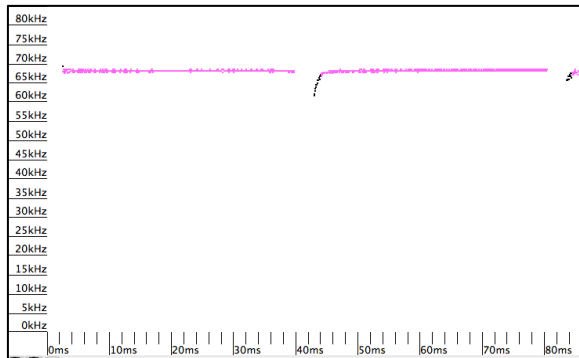
**Figure 11: Definite *Ozimops ridei***

This species exhibits a characteristic frequency between 28.5 – 31 kHz (Pennay *et al*, 2004). This call can be confused with other species. The call is flat and occasional pulses in a sequence may have a higher frequency but not in a regular up and down patterns.



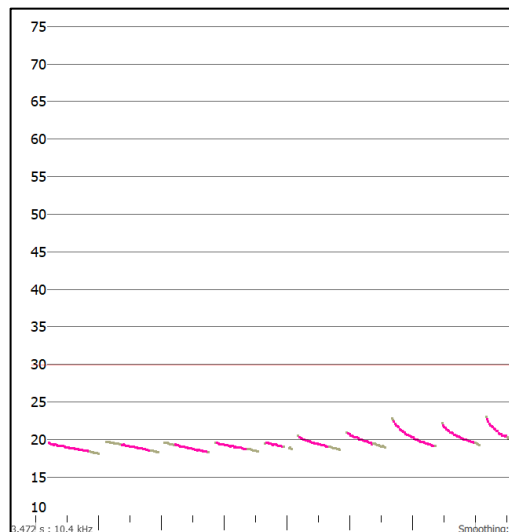
**Figure 12: Definite *Rhinolophus megaphyllus***

The species call cannot be misidentified with any other species. Pulses have an up-sweeping initial section a perfectly flat, relatively long characteristic section and a down sweeping tail (Reinhold, 2001). Characteristic frequency ranges from 66 to 72 kHz.



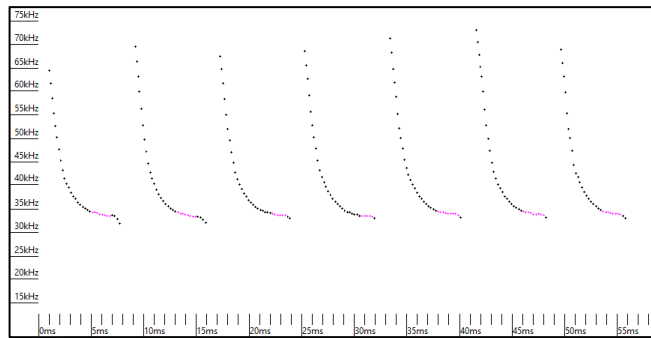
**Figure 13: Probable *Saccolaimus flaviventris***

This species displays a curved pulse, characteristic frequency between 17.5 to 22.5 kHz (Pennay *et al*, 2004). Dominant harmonics are between 18-20 kHz.



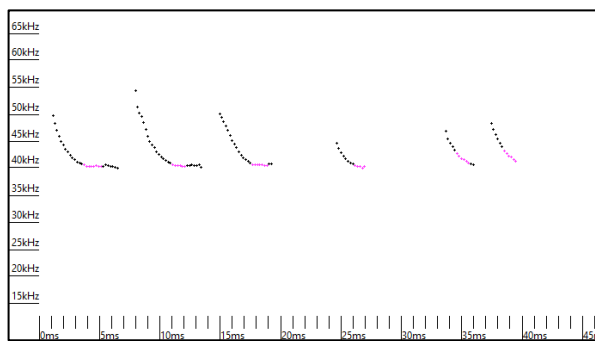
**Figure 14: Definite *Scotorepens balstoni***

This species was captured on site. Characteristic frequency 31 to 35kHz. Distinguished from *C. gouldii* by the lack of alternation in the frequency. This species can also be distinguished by the frequency of the knee which is lower than 37kHz.



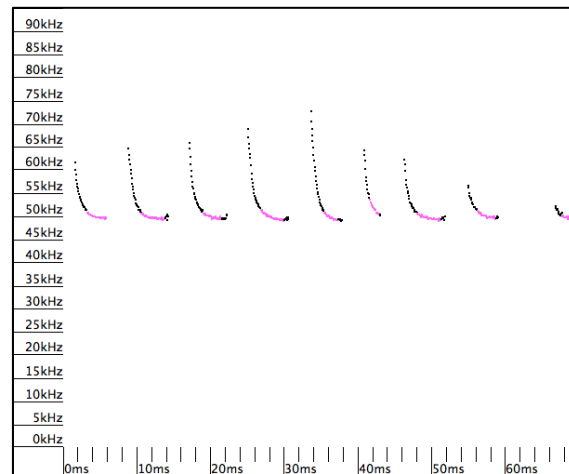
**Figure 15: Probably *Scotorepens greyii***

This species' calls overlap with *C. picatus* around 39-41 kHz and have similar pulse shapes (mostly steep FM sweep with cup-shaped body and upward-sloping tail). Good calls from *C. picatus* usually exhibit distinctive frequency alternation of 2-4 kHz between successive pulses.



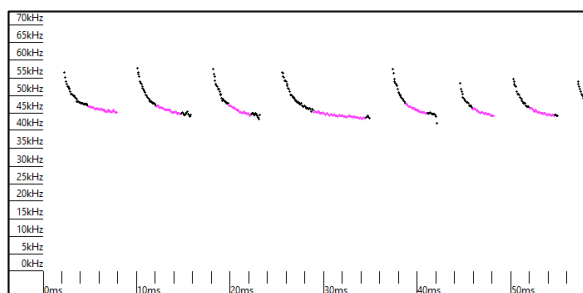
**Figure 16: Definite *Vespadelus troughtoni***

This species displays a curved pulse, characteristic frequency between 48.5 to 55 kHz (Pennay *et al*, 2004). If the end frequency is lower than 51 kHz, then the call can be identified to *V. Troughtoni* and be differentiated from *V. pumilus*.



**Figure 17: Probable *Vespadelus vulturnus***

This species call has a characteristic relatively long and between 42.5 to 48.5 kHz, with no tail. This call outlined in this figure is similar to *V. darlingtonia*; however, the site is outside this species' known distribution.



## 4.0 Discussion

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### 4.1 Analysis of the presence of *Nyctophilus corbeni*

The purpose of the bat survey was to identify the presence of threatened microbat species (Vulnerable under the EPBC Act and NC Act) within the project area.

While no threatened species were 'definitely' recorded or 'probably' recorded within the project area, species such as *Nyctophilus corbeni* (Vulnerable under the EPBC Act and NC Act) have been recorded as "possible" in this report. The identification of their calls cannot be distinguishable reliably from the other sympatric *Nyctophilus* species.

*Nyctophilus corbeni* roosts in tree hollows, under exfoliating bark and possibly in dense foliage. Usually found in semiarid areas, including the mallee districts of South Australia, Victoria and western New South Wales and in grasslands, open woodland and dry sclerophyll forest in New South Wales and Queensland. Habitat occurs within the project area and its presence could be expected within the project area.

A total of 100 trap nights were set across the project area. *Nyctophilus geoffroyi* were captured in the harp traps during the field work. The calls recorded by the anabats match this non-threatened species because they were recorded contemporaneously with and at the same location of their capture. While the absence of *Nyctophilus corbeni* cannot be totally confirmed, we are confident that the calls recorded by the anabat detectors would belong to this non-threatened species.

### 4.2 Mt Etna Caves National Park

The following assessment has been undertaken to identify potential impacts of the project to bat species recorded within the Mount Etna Caves National Park, a significant roosting site located approximately 100km east-south-east from the southernmost turbine.

A desktop assessment was undertaken to identify bat species recorded within the national park and their habitat and foraging behaviour. On the basis of this information, an assessment of the potential impacts to populations within the national park has been made. Species within the national park were identified by searches of the Wildlife Online database, maintained by the Department of Science, Information Technology, Innovation and the Arts (DSITIA) and the Atlas of Living Australia (ALA). The Wildlife Online database was searched using the Mount Etna National Park protected area as the area search parameter. Records within the ALA database were searched using the central coordinates of -23.159248, 150.474503 with a buffer of a 5 km radius applied.

All bat species identified by the desktop searches are given in **Table 4**. To date, there is little known about the timing of migration and movement of bat species between roosts, flight paths between roosts and foraging areas and the impact of wind farms on Australian bats in general (Law, Eby, Lumsden and Lunney, 2011). For many of these species, there are few or no studies into foraging distance and ranges. For those species for which the distance between roost sites and foraging areas is known (i.e. *Taphozous troughtoni*, *Macroderma giga*, *Pteropus alecto*, *Rhinolophus megaphyllus* and *Vespadelus pumilus*), the project area is located well outside of these foraging ranges, which vary from  $\leq 2$  km to 50 km.

For species which travel considerable distances between overwintering roost sites and maternity colony sites (e.g. Eastern Bent-wing Bat), a Bird and Bat Management Plan (BBMP) will be prepared to monitor and provide management strategies to reduce the likelihood of occurrence of impacts to these species.

An assessment of the potential impacts to this species is included in **Table 3** below.

**Table 4: Assessment of potential impacts to bat species recorded within Mount Etna Caves National Park**

Species	Common Name	NC Act Status	EPBC Act Status	Habitat and foraging activity	Likelihood of occurrence within the project area	Assessment of potential impact on populations within Mt Etna National Park
<i>Taphozous georgianus</i>	Common Sheathtail bat	-	-	This species is generally found in rocky landscapes with outcrops that form caves. It roosts in vertical cracks, caves, and similar artificial habitats such as mine shafts. It is often found roosting in small groups, however, colonies of up to 100 animals have been recorded (Jolly <i>et al.</i> 2008). They have a high fidelity to their roost site, even after capture (K.N. Armstrong unpublished obs.). (Armstrong and Reardon, 2017). Utilises a variety of habitat types for foraging, including monsoon forest, paperbark forest, tall open forest, open woodland, spinifex and hummock grasslands.	Unlikely. This site contains rocky outcrop landscapes; however no caves were identified at proximity to the turbines or infrastructure location. This species has not been recorded within or near the project area.	The project is unlikely to impact upon populations that utilise roosting sites within the Mount Etna Caves National Park, given the project won't disturb the caves themselves, and the distance from the caves to the site indicates that the bats using the caves are unlikely to forage over 100km from their roosting habitat, to within the project site, with typical movements found to be generally less than 2km from a roost cave (Jolly 1990).  This species is not threatened under the NC Act or EPBC Act.
<i>Taphozous troughtoni</i>	Troughton's Sheathtail Bat	-	-	This species generally roosts in natural shallow caves or within the twilight zone of larger cave systems, frequently near narrow crevices, boulder piles and abandoned mines. Foraging habitat includes wet and dry	This site contains rocky outcrop landscapes; however, no caves were	The project is unlikely to impact upon populations that utilise roosting sites within the Mount Etna Caves National Park, due to

Species	Common Name	NC Act Status	EPBC Act Status	Habitat and foraging activity	Likelihood of occurrence within the project area	Assessment of potential impact on populations within Mt Etna National Park
				<p>sclerophyll forests, open woodland, mulga shrublands, spinifex-covered hills and grasslands where rocky areas, caves or mines are present (Churchill, 2008).</p> <p><i>Taphozous</i> species are typically swift, high-flying species, which forage above canopy height (Thomson et al. 2001). Radio-tracking studies indicate this species hunts within a small area around roost sites (up to 2 kilometres) (Churchill, 2008).</p>	<p>identified at proximity to the turbines or infrastructure location.</p> <p>This species was possibly recorded on site and would like forage within the project area.</p>	<p>the site being located outside of the foraging range (<math>\leq 2</math> km) of this population.</p> <p>This species is not threatened under the NC Act or EPBC Act.</p>
<i>Macroderma gigas</i>	Ghost Bat	E	V	<p>Occurs in a wide range of habitats in tropical northern Australia, including rainforest, monsoon and vine scrub, and open woodlands. This species roosts in shallow sandstone caves along cliff lines, under boulder piles, in deep limestone caves and in abandoned mines. It is strictly carnivorous and often catches most of its prey on the ground. It utilises a broad range of habitats for foraging, including arid spinifex hillside, grasslands, monsoon forest, open savannah woodland, deciduous vine forest and tropical rainforest. Radio-tracking studies indicate that individuals travel up to 2 km from the roost when foraging and use the same foraging areas of approximately 60 ha each night (Churchill, 2008).</p>	<p>This site contains only small patches of vine thickets sparsely spread across the project area. No caves were identified at proximity to the turbines or infrastructure locations. This species has not been recorded within the project area.</p>	<p>The project is unlikely to impact upon populations that utilise roosting sites within the Mount Etna Caves National Park, due to the site being located outside of the foraging range (<math>\leq 2</math> km) of this population.</p>



Species	Common Name	NC Act Status	EPBC Act Status	Habitat and foraging activity	Likelihood of occurrence within the project area	Assessment of potential impact on populations within Mt Etna National Park
<i>Miniopterus australis</i>	Little Bent-wing Bat	-	-	This species roosts in colonies in caves and tunnels, and may also be found roosting in tree holes. Maternity colonies are established in the summer months within limestone cave systems. It forages for insects in well-timbered areas including rainforest, vine thicket, wet and dry sclerophyll forests, <i>Melaleuca</i> swamps and coastal forests (Churchill, 2008) where it pursues prey beneath the canopy and between the shrub and canopy strata. This species ranges of Australia from Cape York in Queensland to Wollongong in NSW. It has been recorded flying up to 59.5 kilometers from the nursery site, but no more than that (Dwyer, 1968)	No caves were identified at proximity to the turbines or infrastructure locations. Some tree-hollows were identified within the site and may be suitable as roosting habitat. This species has been recorded within the project area.	The project is unlikely to impact upon populations that utilise roosting sites within the Mount Etna Caves National Park due to the site being located outside of the foraging range ( $\leq 60$ km) of this population.  This species is not threatened under the NC Act or EPBC Act.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing bat	-	-	Populations of this species are centred on maternity caves that are used annually. Large maternity roosts are established during the summer months in limestone and sandstone caves, abandoned gold mines, concrete bunkers and lava tubes. Females fly large distances in spring to maternity roost sites (Churchill, 2008). In February, the females leave the maternity roosts with the juveniles departing in March. Both travel considerable	No caves were identified at proximity to the turbines or infrastructure locations. This species has not been recorded within the project area.	This species has not been recorded on site. The project is unlikely to impact upon populations that utilise roosting sites within the Mount Etna Caves National Park.  The species has been recorded as being able to disperse over

Species	Common Name	NC Act Status	EPBC Act Status	Habitat and foraging activity	Likelihood of occurrence within the project area	Assessment of potential impact on populations within Mt Etna National Park
				distances to their overwintering roosts, with the juveniles often travelling up to several hundred kilometres. This species forages in open areas, above the tree canopy in forested areas, along waterways and tracks (Van Dyck and Strahan, 2008).		300km (NSW OEH, 2018), but the dispersal of the population at Mt Etna Caves NP is unlikely to bring them into conflict with the project, given the lack of records of the species anywhere near the site that might otherwise suggest a dispersal pathway near/through the site.  Daily foraging movements are generally only a few kilometres, although individuals have been known to travel up to 65km in a single night (Churchill, 2008), much less than the 100km flight distance required to bring the bats into the project site area.
<i>Pteropus alecto</i>	Black Flying-fox	-	-	Camps are usually located near reliable food sources and are generally found in mangroves, <i>Melaleuca</i> and monsoon forests, closed and open eucalypt forest and bamboo. Groups of individuals may travel up to 50 km from the camp, however the foraging area is usually	Suitable habitat occurs across the site. This species was sighted as part of the spotlighting activities.	The project is unlikely to impact upon populations within the Mount Etna Caves National Park, due to the site being located outside of the foraging range ( $\leq 20 - 50$ km)

Species	Common Name	NC Act Status	EPBC Act Status	Habitat and foraging activity	Likelihood of occurrence within the project area	Assessment of potential impact on populations within Mt Etna National Park
				restricted to a 20 km radius (Churchill, 2008). This is confirmed Hall <i>et al.</i> (2000) who mentions that black flying-fox has a general home range of 15-30 km radius.	However, the abundance of this species on site is low.	of this population. This species is not threatened under the NC Act or EPBC Act.
<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	-	-	Roosts in caves, disused mine tunnels, roadside culverts, old bunkers, boulder piles and occasionally, houses. Forages within and at the edge of stands of vegetation, in rainforest, eucalypt open forest and woodland. Radio-tracking studies indicate that some individuals travel up to 2 km from the roost when foraging (Van Dyck and Stahan, 2008).	Suitable foraging habitat occur across the site and this species was recorded on numerous occasions within survey activities. However, no caves were sighted at proximity of the turbines.	The project is unlikely to impact upon populations within the Mount Etna Caves National Park, due to the site being located outside of the foraging range ( $\leq 2$ km) of this population. This species is not threatened under the NC Act or EPBC Act.
<i>Vespadelus pumilus</i>	Eastern Forest Bat	-	-	This species prefers moister forest habitats, especially rainforest areas at lower altitudes. This species has a disjunct distribution along the eastern seaboard. It roosts in tree hollows. Foraging ranges are small, averaging approximately 6 hectares and comprise a number of discrete centres of activity (Van Dyck and Strahan, 2008).	Suitable foraging habitat is limited within the site. This species was recorded on site.	The project is unlikely to impact upon populations within the Mount Etna Caves National Park, due to the lack of suitable foraging habitat within the project area and the site is located outside of the foraging range for this population,

Species	Common Name	NC Act Status	EPBC Act Status	Habitat and foraging activity	Likelihood of occurrence within the project area	Assessment of potential impact on populations within Mt Etna National Park
						with the average foraging range of the species estimated at about 5ha (Law & Anderson, 2000). This species is not threatened under the NC Act or EPBC Act.

### 4.3 Project Impact Assessment

The project area contains suitable habitat for two of the four threatened bat species identified within the search area (including Mt Etna Caves National Park). An assessment of the likelihood of occurrence of these species was prepared following the field investigations, based on habitat type, availability and quality throughout the site, and the known distribution and ecological requirements of each species (Table 4).

Table 5: Likelihood of Impact

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Likelihood of Impact -
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	-	Caves and mines in dry sclerophyll forests and woodlands as well as higher altitude moist eucalypt forest and edges of rainforest.	Unlikely due to the absence of preferred habitat on the Site. This species was not recorded on site during the field investigation.	No. Species has not been recorded at the site, and preparation of a Bird and Bat Management Plan to monitor and provide mitigation measures will further reduce likelihood of a significant impact.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	-	Occurs in a range of habitats including subtropical and temperate rainforests, dry and wet sclerophyll forests, Banksia woodland, heaths and Melaleuca swamps.	Possible, Suitable foraging habitat occurs on the site. However, this species was not recorded on site during the field investigation.	No. Species has not been recorded at the site, and preparation of a Bird and Bat Management Plan to monitor and provide mitigation measures will further reduce likelihood of a significant impact.
<i>Macroderma gigas</i>	Ghost Bat	V	V	Occurs in a wide range of habitats in Tropical Australia, including rainforest, monsoon and vine scrub, and open woodlands. This species requires undisturbed caves for disused mineshafts for roosting.	Unlikely. Limited habitat occurs on site. This species was not recorded on site during the field investigation.	No. Species has not been recorded at the site, and preparation of a Bird and Bat Management Plan to monitor and provide mitigation measures will further reduce likelihood of a significant impact.

Species	Common Name	NC Act Status	EPBC Act Status	Habitat	Likelihood of Occurrence	Likelihood of Impact -
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat, Corben's Long-eared Bat	V	V	Preferred habitat is eucalypt woodland, although it has also been recorded from rainforest with hoop pines in the Bunya Mountains, and in semi evergreen vine thickets on the banks of the Dawson River. It is most abundant in vegetation with a distinct canopy and a dense cluttered shrub layer.	Possible. Suitable habitat identified on site. This species was not recorded on site during the field investigation.	No. Species has not been recorded at the site, and preparation of a Bird and Bat Management Plan to monitor and provide mitigation measures will further reduce likelihood of a significant impact.

**Status:** E: Endangered, V: Vulnerable, NT: Near Threatened

**Likelihood of Occurrence:** **Unlikely** – no suitable habitat present, **Possible** – suitable species habitat present, **Likely** – suitable species habitat present and has previously been recorded within 5km, **Confirmed** – species recorded during field survey

Consideration of the Mount Etna Caves National Park was given when assessing the impact of the project for the area. Mount Etna Caves National Park, located approximately 100km east-south-east from the southernmost turbine, represents a significant roosting site for a variety of bats, in particular the Ghost Bat and the bent-wing bats.

The primary concern for these species arising from wind farm developments is the possibility of mortality of bats resulting from collision with turbine rotors. Some species are more prone to collide with turbine rotors than others, such as some bat species that are known to fly at the height of the turbine rotors. Hence, species that fly high are considered to be at greater risk of mortality from collision with rotors than species that tend to stay below the sweep area of the rotor blades.

Investigations undertaken in April 2019, October 2019 and October 2020 indicate a relatively medium diversity of bat species occurring within the site (16 species). No threatened bat species were recorded during the field surveys, although one threatened bat species, *Nyctophilus corbeni*, was possibly recorded on site. As stated above, calls from this species are not reliably distinguishable from other species of bats that were positively confirmed as being present at the site from the trapping study and *N. corbeni* was not. While the absence of *N. corbeni* cannot be totally confirmed (refer to Section 4.1), we are confident that the calls recorded by the devices would belong to the *N. geoffroyi*, a non-threatened species as the calls were recorded at the same location of capture. Furthermore, *N. corbeni* is a low flyer in forest, over water pools and is also found in disturbed forests. As such, the proposed wind farm should not have a significant impact on this species through rotor blade strikes.

Rotor blade strikes on bat species will also be minimised to the greatest extent possible to ensure impacts are acceptable, and this can be controlled through the Bird and Bat Management Plan.



Given that no bat roosts or conservation significant fauna species were identified in the project area, the level of impact is likely to be low. To further reduce the likelihood of impact, it is also recommended that periodic monitoring of fauna strikes is undertaken and records of these events maintained and disseminated to relevant authorities to further the knowledge of such events. Details will be provided within the Bird and Bat Management Plan.

Further assessment of the impact on threatened bat is provided in the Ecological Assessment report prepared for the project.

## 5.0 Conclusion

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A total of 16 microbat species were detected occurring as either 'Definitely', 'Probably' or 'Possibly' recorded on site. All of these are non-threatened species. All bats identified on the site were expected to be present within the region.

Bat activity levels at the site are similar compared to other surveys within similar areas in the surrounding region. The presence of *Nyctophilus corbeni* (Vulnerable under the EPBC Act and NC Act) was not identified on site. While its calls could not be distinguishable reliably from other sympatric *Nyctophilus* species using anabat detectors and processing with full-spectrum analysis, *Nyctophilus geoffroyi* was captured in the harp traps during the survey, while *Nyctophilus corbeni* was not. The calls recorded by the anabat swifths match this non-threatened species it was recorded contemporaneously with and at the same location of their capture. Therefore, while the *Nyctophilus corbeni* could occur at proximity of the project area, it is unlikely that it is present within the surveyed area. Furthermore, this species flies low in the air, and therefore, it is unlikely that the project would have any significant impact on this species if there were to be present on site.

Consideration was given to the potential impacts of the project on other listed threatened species that have been recorded at the Mount Etna Caves National Park, 100km east-south-east from the southernmost turbines, and concluded that the project is also unlikely to result in an impact to these species.

A Bird and Bat Management Plan will be prepared to provide recommendations on the monitoring, the management and mitigation measures to further reduce the possibility of the project resulting in a significant impact to bats.

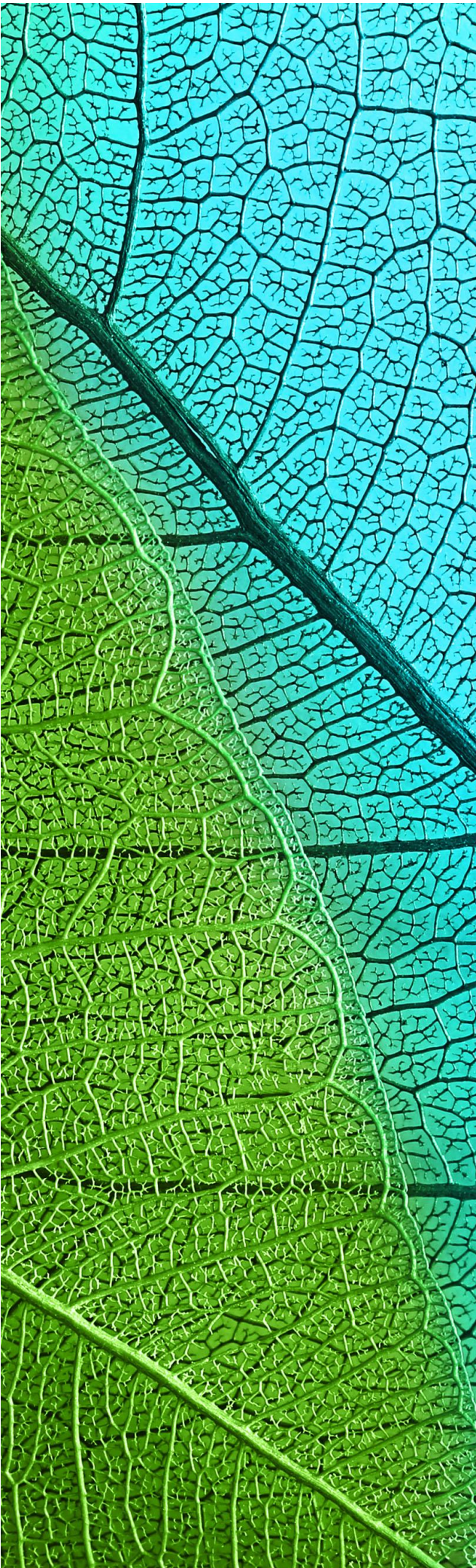
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# **APPENDIX G BIRD UTILISATION SURVEY REPORT**





# Lotus Creek Wind Farm

## Bird Utilisation Survey

Prepared for Lotus Creek Wind Farm Pty Ltd  
C/- NGH

December 2019  
Report 19037 (1.0)



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## 1. INTRODUCTION

Nature Advisory have been commissioned to undertake a bird utilisation survey to support the proposed Lotus Creek Wind Farm (the Project). The Project is located in Isaac Shire Council Local Government Area, approximately 210 km north-west of the Rockhampton and 30 km west of the township of St Lawrence, Central Queensland. The Project is proposed over three properties with an estimated area of 30,000 hectares (ha) and known collectively as the 'Project Area'.

This investigation was commissioned to provide the relevant assessment required under State Code 23 of the State Development Assessment Provisions (SDAP) to support lodgement of a Development Application for the wind farm to the State Assessment Referral Agency (SARA) (Department of Infrastructure, Local Government and Planning, 2019). This report provides information on diversity of bird species and their utilisation of height strata to gauge their risk of collision with proposed turbines.

Specifically, the scope of the investigation included:

- Two seasonal surveys (Spring and Autumn) covering representative parts of the properties where turbines are proposed to be located, involving:
  - A statistically significant number of replicate surveys at each site, recording the numbers and heights at which each bird species was observed flying, covering the maximum area where turbines may be located and maximising the coverage of different habitats which birds may utilise.
  - Incidental observations throughout the wind farm site, to elucidate the overall bird diversity of the site and to check whether threatened species are likely to be present.
  - Compilation of bird and (incidental) mammal species lists for the site.

This report is divided into the following sections:

**Section 2** describes the sources of information, including the methods used for the field survey.

**Section 3** provides an overview of the characteristics of the study area.

**Section 4** presents the limitation of the assessment

**Section 5** presents the investigation results, describing the flora and fauna of the study area.

**Section 6** discusses the conclusions and recommendations to inform the design process and assist the development of a minimum impact proposal.

This investigation was undertaken by a team from Nature Advisory Pty Ltd and NGH Consultancy, comprising Martin Kim (Ecologist), Natalie Sheppard (Ecologist), Eamon O'Meara (Senior Zoologist), Bernard O'Callaghan (Project Manager) and Brett Lane (Principal Ecologist).

## 2. SOURCES OF INFORMATION

### 2.1. Existing information

Existing information regarding the bird utilisation survey is described below. The Project Area refers to private properties located approximately 20 km west of St Lawrence and 210 km north-west of Biloela, central Queensland. Specifically, the area where turbines are proposed to be located comprises part of the southern Connors Range, to altitudes of 400 to 600 metres AHD, aligned primarily north-south, to the west of the Bruce Highway.

Threatened species information was obtained from a wider area, termed the 'search region' defined for this assessment as an area of 20-kilometre radius from the approximate centre point of the study area; coordinates: latitude 22° 23' 32" S and longitude 149° 21' 15" E.

#### 2.1.1. Fauna

A representative list of the bird species recorded in the search region was obtained from the Atlas of Australian Birds (Birddata), a database administered by BirdLife Australia (2019), and from *Wildlife Online*, the Queensland State Government (2019) wildlife database. Fauna taxonomy used throughout this report follows the BirdLife nomenclature.

The presence or likelihood of occurrence in the study area of nationally threatened fauna species was obtained through the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (DoE 2019) based on a search region of 20 km from the boundary of the study area.

### 2.2. Field methodology

The surveys were consistent with the requirements for a "Level One" bird risk assessment in accordance with 'Wind Farms and Birds - Interim Standards for Risk Assessment' issued by the Australian Wind Energy Association (AusWEA 2005). This approach has been endorsed in the latest Best Practice Guidelines (Clean Energy Australia 2018). The methodology conforms with Queensland State Code 23 (Appendix 3), relating to wind farm development (Department of Infrastructure, Local Government and Planning, 2017).

Two field assessments were conducted namely:

- 7<sup>th</sup> to 10<sup>th</sup> May (Autumn survey), and
- 3<sup>rd</sup> to 8<sup>th</sup> November 2019 (Spring survey).

Surveys were completed by Senior Zoologist Eamon O'Meara, NGH zoologists Martin Kim and Natalie Sheppard. During these assessments, the study area was accessed by vehicle, and birds recorded using binoculars.

Survey sites in the study area were selected according to whether they were located on a ridge top or spur and offered a minimum 270-degree viewing, out to 80 metres. In some cases, the terrain made this impossible so a more restricted viewing arc was accepted. Habitats covered some reasonably intact grassy woodland and some mostly cleared sites on ridges and spurs. Habitat data was recorded for each site. Each of the survey points was at least 500 metres apart from each other.

### 2.2.1. Bird Utilisation Survey

The following techniques were used to document bird species at the survey sites:

- At each of the survey points, a complete count of all birds seen and heard in a 20-minute period, from a central point out 80 metres and recording the height at which each bird or group of birds (flock) was first seen.
- The fixed-point bird count method involved an observer stationed at a survey point for 20 minutes. The adequacy of using 20 minutes as an interval to record the presence of birds during bird utilisation surveys was investigated in an earlier study at another wind farm site (Nature Advisory Pty. Ltd., unpublished data). This showed that 82 to 100 percent (average 88 percent) of species actually seen in one hour of surveying were seen in the initial 20 minutes of observation. Based on this result, the period of 20 minutes used in the formal bird utilisation surveys was considered adequate to generate representative data on the bird species in the area during the survey.
- During this period, all bird species and numbers of individual birds observed within 80 metres were recorded. The species, the number of birds and the height of the bird when first observed were documented. For species of concern (threatened species, waterbirds and raptors), the minimum and maximum heights were recorded.
- Flight height is presented as below, at or above rotor swept area height (RSA height):
  - A = Below RSA (< 40 metres above ground)
  - B = At RSA (40 – 250 metres above ground)
  - C = Above RSA (> 250 metres above ground)

Each of the points was surveyed eight times (8 replicates), twice each at each of four different times of day: early morning (6 to 9am), late morning (9am to 12 noon), early afternoon (12 noon to 3pm) and late afternoon (3 to 6pm). This ensured even, unbiased coverage of bird activity at each site throughout the day, over the duration of the survey.

The daily schedule of survey sites visited is set out below:

**Table 1: Daily BUS schedule, Lotus Creek Wind Farm, 2018**

Date \ time	09:00 - 11:00	11:00 - 13:00	13:00 - 15:00	15:00 - 17:00
7-May	3,4,3,4	3,4,3,4	3,4,3,4	3,4,3,4
8-May	5,6,5,6	5,6,5,6	5,6,5,6	5,6,5,6
9-May	7,8,7,8	7,8,7,8	7,8,7,8	7,8,7,8
10-May	1,2,1,2	1,2,1,2	1,2,1,2	1,2,1,2
time	07:00 - 09:00	09:00 - 11:00	11:00 - 13:00	13:00 - 15:00
03-Nov	3,4,3,4	3,4,3,4	3,4,3,4	3,4,3,4
04-Nov	9,10,9,10	9,10,9,10	9,10,9,10	9,10,9,10
05-Nov	5,6,5,6	5,6,5,6	5,6,5,6	5,6,5,6
06-Nov	11,12, 11, 12	11,12, 11, 12	11,12, 11, 12	11,12, 11, 12
07-Nov	7,8,7,8	7,8,7,8	7,8,7,8	7,8,7,8
08-Nov	1,2,1,2	1,2,1,2	1,2,1,2	1,2,1,2

Nocturnal bird surveys as part of BUS were considered unlikely to supply useful information in that it is difficult to record heights of any species seen, particularly if they are flying at considerable height above ground. Incidental sightings and calls of nocturnal species were recorded, and members of the fauna survey team surveyed for nocturnal species using separate methodology.

The level of BUS in the two seasonal surveys is considered sufficient to assess the risk to birds over the proposed turbine field.

### **2.2.2. *Incidental observations***

In addition to the observations during formalised, fixed-point counts, incidental observations of birds of concern (threatened species, raptors, waterbirds) were made whilst travelling throughout the proposed wind farm site. Emphasis was placed on observing birds that were moving through the site at rotor-swept area (RSA) height.

### **2.2.3. *Collision risk modelling***

The Queensland Wind Farm State Code Planning Guideline (July 2016) requires collision risk modelling (CRM) for birds to be part of the fauna impact assessment for wind farms. Currently, the code makes no distinction between common or listed species. Elsewhere in Australia, CRM has been used to model the number of individuals of listed threatened species affected over the life of a wind farm project, or annually, expressed as the likely number of individuals per turbine per year.

An important input to CRM is an estimate of the number of flights at risk across a wind farm site, a proportion of which can be assumed to be at turbine height (based on recorded flight heights) and estimated density. These data are generated through formal Bird Utilisation Surveys (BUS), the method used in the current field investigation.

At the Lotus Creek Wind Farm, three listed species were recorded: Squatter Pigeon and White-throated Needletail, which are listed on the EPBC Act as Vulnerable, and the Satin Flycatcher which is listed as Migratory.

Together with the Fork-tailed Swift, the White-throated Needletail is unique in being an almost exclusively aerial forager, flying at a range of heights up to a kilometre or more in search of airborne insects. Flocks often dwell in the wind shear zone ahead of storms where airborne insects are concentrated.

Their occurrence is sporadic and numbers vary greatly, with flocks ranging from several birds to several hundred birds. Mapping flight paths of this species does not provide reliable information on the location of flyways as they are just as likely to fly over any part of the landscape when in the area. The spatial and temporal variability in their occurrence make it very difficult to develop meaningful CRM inputs, in particular, generating a valid estimate of the number of birds passing through a wind farm in a year (i.e. the seasons they are in Australia) is challenging. For this reason, CRM was not applied to this species even though it was recorded on the site once (many birds) during the formal counts and several times incidentally.

### 3. SITE DESCRIPTION

The Project Area supported a number of habitat types. The dominant vegetation type was tropical open Narrow-leaved Ironbark *Eucalyptus crebra* woodland. Some areas of Spotted Gum *Corymbia maculata* and Lemon-scented Gum *Corymbia citriodora* were present throughout the study area. The understorey and ground layer were dominated by a mosaic of native and introduced grasses including Buffel Grass *Cenchrus ciliaris* and regenerating Wattle *Acacia* spp. Occasional dry rainforests or semi-evergreen vine thickets (SEVTs) and stands of Paperbark *Melaleuca* sp. occurred in more sheltered areas such as gullies and sandy soil area, and on some southern aspects of the hill areas.

Several creeks and waterways crossed the study area, most of which had water flowing during the Autumn surveys, however many of these had dried by the Spring survey. Farm dams were also present throughout the study area.

The dominant land use is for cattle grazing. Surrounding land is a mixture of mostly cleared land for raising cattle, and state forest supporting intact native vegetation to the south of the study area.

The study area lies within the Brigalow Belt bioregion and falls within the Fitzroy River and Styx River catchments, in Isaac Shire, central Queensland.

#### **3.1.1. Locations of survey points**

Over the survey period, 24 fixed survey points were established, 16 in Autumn and 24 in Spring.

The survey points were distributed as evenly as possible (subject to access constraints) across the wind farm to maximise coverage. Impact points were positioned as far as possible on elevated ground, allowing a clear view in all directions.

Table 2 below provides a description of the Regional Ecosystem (RE) types associated with each survey area point.

**Table 2: Habitat associated with each survey point, Lotus Creek Wind Farm, 2019**

Autumn Survey Point	RE and description	Lat	Long
E1 E2	11.12.1/11.12.2 E1 edge of escarpment on spot height. E2 on access track cleared of veg for 50 m all directions	-22.2569 -22.2546	149.2234 149.2279
M1 M2	11.12.1/11.12.2 <i>Eucalyptus crebra</i> grassy woodland / <i>Eucalyptus melanophloia</i> and <i>Corymbia erythrophloia</i> +/- <i>E. populnea</i> grassy woodland on igneous rocks, sparse.	-22.2701 -22.2636	149.2311 149.2288
E3 E4	11.12.1/11.12.6a E3 Open <i>E. crebra</i> ridgeline, low Acacia/Lantana/Hibiscus, with <i>Erythrina vespertilio</i> and <i>Brachychiton</i> /SEVT species to the west. S, W & N aspects. E4 open montane grassland with emergent <i>Acacia</i> sp. on periphery, adjacent to shrubland/thick woodland	-22.3383 -22.3443	149.2492 149.2465
M3 M4	11.12.1/11.12.2 <i>Eucalyptus crebra</i> , <i>E. tereticornis</i> +/- <i>Angophora leiocarpa</i> and <i>E. melanophloia</i> woodland. Other tree species that may be present include <i>Corymbia clarksoniana</i> , <i>C. tessellaris</i> , <i>C. erythrophloia</i> , <i>C. citriodora</i> and <i>E. exserta</i> .	-22.3404 -22.3440	149.2649 149.2666
E5 E6	11.12.6a: E5 N, S & W aspects, grassy woodland. E6 Low <i>E. crebra</i> grassy woodland with <i>Xanthorrhoea</i> sp.	-22.4540 -22.4595	149.3308 149.3333
M5 M6	11.12.1/11.12.2 <i>Eucalyptus crebra</i> grassy woodland / <i>Eucalyptus melanophloia</i> and <i>Corymbia erythrophloia</i> +/- <i>E. populnea</i> grassy woodland on igneous rocks, sparse.	-22.4499 -22.4506	149.3194 149.3234
E7 E8	8.12.7a/8.12.9/8.12.23/8.3.14 E7 & E8 Open forest, mixed <i>E. sp.</i> + <i>Melaleuca</i> , sandy substrate, <i>Xanths</i> , low grass and herbaceous sp. + <i>ficus</i> and cycad. Fire in November 2018, low near ground vegetation.	-22.3916 -22.3953	149.3283 149.3259
M7 M8	8.12.5a/8.12.16 <i>Lophostemon confertus</i> and/or <i>Eucalyptus portuensis</i> (or <i>E. exserta</i> ) open forest to closed scrub (5-38m tall). Other occasional co-dominant or associated species include <i>Corymbia trachyphloia</i> , <i>Acacia spirorbis</i> subsp. <i>solandri</i> , <i>E. drepanophylla</i> and <i>Acacia falcata</i> . / Deciduous to semi-evergreen microphyll vine thicket +/- <i>Brachychiton spp.</i> +/- <i>Araucaria cunninghamii</i> emergents, of foothills and uplands	-22.4019 -22.4076	149.3254 149.3245
Spring Survey Point	RE and description	Lat	Long
E1 E2	8.12.7a/8.12.9/8.12.23/8.3.14 E1 large open forest grove with high canopy, low undulations, near creekline. E2 open forest mixed canopy species.	-22.3334 -22.3390	149.3154 149.3116
N1 N2	8.12.7a/8.12.9/8.12.23/8.3.14 <i>Corymbia citriodora</i> +/- <i>Eucalyptus portuensis</i> +/- <i>E. drepanophylla</i> (or <i>E. crebra</i> ) open forest on hill slopes and undulating plateaus / <i>Eucalyptus tereticornis</i> +/- <i>Corymbia intermedia</i> +/- <i>Lophostemon suaveolens</i> woodland on undulating uplands / <i>Eucalyptus moluccana</i> woodland on elevated tablelands / <i>Ischaemum australe</i> and/or <i>Imperata cylindrica</i> and/or <i>Sorghum nitidum</i> forma aristatum tussock grassland on drainage channels in gently undulating upland areas.	-22.3280 -22.3225	149.3163 149.3135
E3 E4	11.12.1/11.12.6a E3 Open <i>E. crebra</i> ridgeline, low Acacia/Lantana/Hibiscus, with <i>Erythrina vespertilio</i> and <i>Brachychiton</i> /SEVT species to the west. S, W & N aspects. E4 open montane grassland with emergent <i>Acacia</i> sp. on periphery, adjacent to shrubland/thick woodland	-22.3383 -22.3443	149.2492 149.2465



N3 N4	11.12.1/11.12.2 <i>Eucalyptus crebra</i> , <i>E. tereticornis</i> +/- <i>Angophora leiocarpa</i> and <i>E. melanophloia</i> woodland. Other tree species that may be present include <i>Corymbia clarksoniana</i> , <i>C. tessellaris</i> , <i>C. erythrophloia</i> , <i>C. citriodora</i> and <i>E. exserta</i> .	-22.3404 -22.3440	149.2649 149.2666
E5 E6	11.12.6a: E5 N, S & W aspects, grassy woodland. E6 Low <i>E. crebra</i> grassy woodland with <i>Xanthorrhoea</i> sp.	-22.4475 -22.4595	149.3222 149.3333
N5 N6	11.12.1/11.12.2 <i>Eucalyptus crebra</i> grassy woodland / <i>Eucalyptus melanophloia</i> and <i>Corymbia erythrophloia</i> +/- <i>E. populnea</i> grassy woodland on igneous rocks, sparse.	-22.4499 -22.4506	149.3194 149.3234
E7 E8	8.12.7a/8.12.9/8.12.23/8.3.14 E7 & E8 Open forest, mixed <i>E. sp.</i> + <i>Melaleuca</i> , sandy substrate, <i>Xanths</i> , low grass and herbaceous sp. + <i>ficus</i> and cycad. Fire in November 2018, low near ground vegetation.	-22.3916 -22.3953	149.3283 149.3259
N7 N8	8.12.5a/8.12.16 <i>Lophostemon confertus</i> and/or <i>Eucalyptus portuensis</i> (or <i>E. exserta</i> ) open forest to closed scrub (5-38m tall). Other occasional co-dominant or associated species include <i>Corymbia trachyphloia</i> , <i>Acacia spirorbis</i> subsp. <i>solandri</i> , <i>E. drepanophylla</i> and <i>Acacia falcata</i> . / Deciduous to semi-evergreen microphyll vine thicket +/- <i>Brachychiton spp.</i> +/- <i>Araucaria cunninghamii</i> emergents, of foothills and uplands	-22.4019 -22.4076	149.3254 149.3245
E9 E10	8.12.7c E9 & E10 Open forest along farm trail, heavily grazed and cleared for agriculture.	-22.3925 -22.3974	149.3037 149.3084
N9 N10	8.12.7c <i>Eucalyptus drepanophylla</i> low woodland to open forest (6-20m tall). <i>Corymbia citriodora</i> may sometimes be codominant in the canopy. Other occasional associated species in the canopy may include <i>E. melanophloia</i> , <i>C. trachyphloia</i> , <i>E. exserta</i> , <i>C. erythrophloia</i> , <i>E. portuensis</i> and <i>E. platyphylla</i> .	-22.3896 -22.3860	149.3037 149.3338
E11 E12	8.12.7a/8.12.9/8.12.23/8.3.14 E11 used powerline easement, E12 cleared forest grove.	-22.2853 -22.2884	149.2972 149.2928
N11 N12	8.12.7a/8.12.9/8.12.23/8.3.14 <i>Corymbia citriodora</i> +/- <i>Eucalyptus portuensis</i> +/- <i>E. drepanophylla</i> (or <i>E. crebra</i> ) open forest on hill slopes and undulating plateaus / <i>Eucalyptus tereticornis</i> +/- <i>Corymbia intermedia</i> +/- <i>Lophostemon suaveolens</i> woodland on undulating uplands / <i>Eucalyptus moluccana</i> woodland on elevated tablelands / <i>Ischaemum australe</i> and/or <i>Imperata cylindrica</i> and/or <i>Sorghum nitidum</i> forma <i>aristatum</i> tussock grassland on drainage channels in gently undulating upland areas.	-22.2779 -22.2746	149.3000 149.3033

Full descriptions of RE for each site found in Appendix 4.

Image of the site is shown photographically in Figure 3 and Figure 4. These show the site where the highest density of birds was recorded (site E8), the site with the lowest density of birds (site E4) and other sites showing representative habitats sampled (sites E5 and E12).

**Figure 3: Lotus Creek Wind Farm BUS points (upper) site E8, (lower) site E4.**





**Figure 4: Lotus Creek Wind Farm BUS points (upper) site E5, (lower) site E12.**



## 4. LIMITATIONS

Weather conditions were mostly fine, warm and sunny throughout, with daily temperature range of around 18 – 32 °C during both May and November. Northerly to Easterly winds prevailed throughout the surveys, varying from almost calm to a fresh breeze. Rain and drizzle was experienced in the morning of the first day in November with low level cloud cover obscuring the wider view, which had limiting factor on viewing for approximately 1 hour, but no surveys were conducted in this time, and no further rain events were experienced. No significant limitations were experienced during the data collection phase of this work.

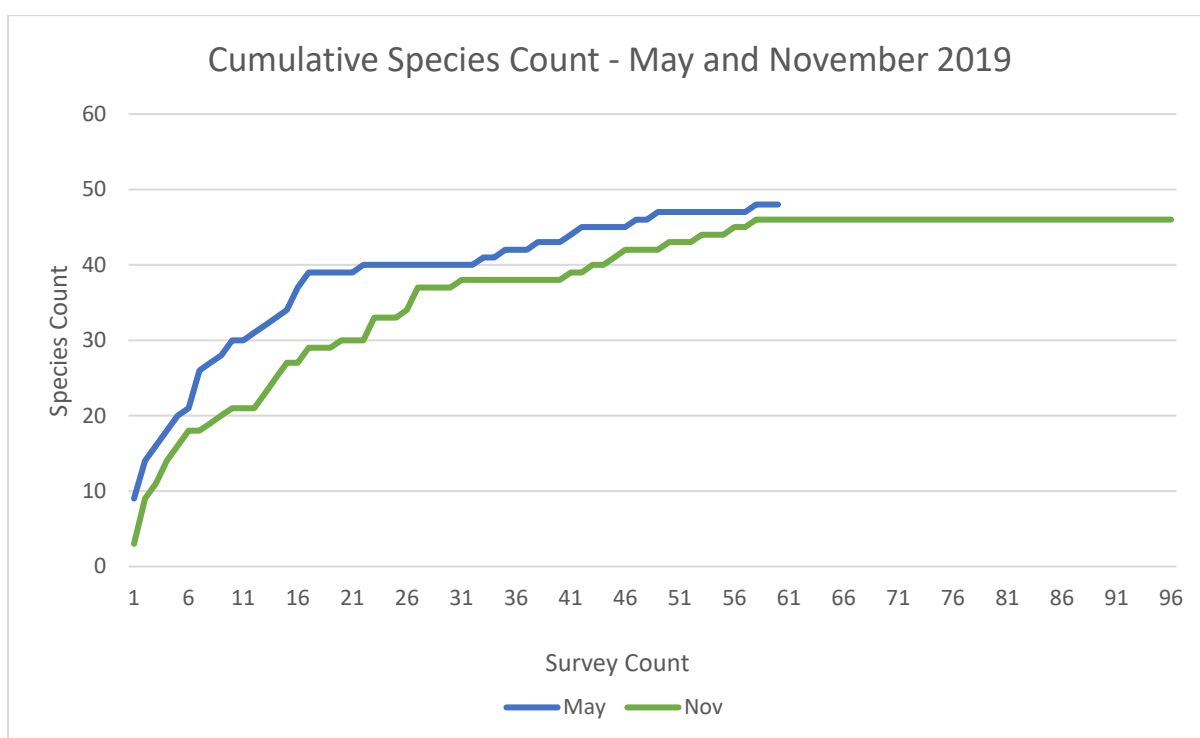
The BUS points were adjusted between from the first survey to the second survey. This included BUS points which were at location of additional turbine locations to be considered for the LCWF.

## 5. ASSESSMENT RESULTS

### 5.1. Survey suitability

The cumulative number of species observed from the consecutive fixed-point bird counts conducted at the observation points during the survey period was plotted (Figure 5). This indicated that during the autumn survey, the number of species recorded levelled out after 56 counts. In the spring count, the number of species recorded levelled out after 58 counts. This supports the adequacy of using eight replicates to generate representative data on the bird species in the area during the relevant time of year.

**Figure 5: The cumulative number of species of birds recorded during consecutive counts at the impact points on the Lotus Creek Wind Farm, 2019.**



### 5.2. Species Composition

A total of 66 bird species were recorded during the two survey efforts at the impact survey points (Table 4). Species recorded were predominantly farmland and bushland species with some records of raptors. The raw data is presented in Appendices 2 and 3.

Species composition (diversity) can often differ between months due to seasonal changes in presence and abundance, activity, changes in foraging behaviour and seasonal distribution of birds among various habitats.

The diversity of birds during the autumn and spring surveys was similar with a small degree of seasonal variation. During BUS, a total of 24 species were seen in both Autumn and Spring surveys with 20 species added in the spring survey that were not recorded in the autumn survey. In total, 66 bird species were seen during the combined bird utilisation surveys. An

additional 29 species were seen elsewhere as incidental observations on the proposed wind farm properties and access roads.

The frequently observed species are listed below (Table 3).

**Table 3: The five most common species at the impact survey points**

Impact Sites		
Autumn	Spring	Both Seasons
Pied Currawong	Noisy Miner	Pied Currawong
Grey Fantail	Australian Magpie	Noisy Miner
Australian Magpie	Torresian Crow	Australian Magpie
Striated Pardalote	Laughing Kookaburra	Grey Fantail
Rainbow Lorikeet	Rainbow Lorikeet	Rainbow Lorikeet

Overall, the most abundant species across the combined seasonal counts in order of cumulative frequencies were:

- Pied Currawong
- Noisy Miner
- Australian Magpie
- Grey Fantail
- Rainbow Lorikeet

The five most abundant species comprised 48.05% of all birds recorded at the impact survey points. The total number of birds observed over both surveys varied between 182 observations at survey point E8, to 13 observations at survey point E11. Most species recorded during the BUS surveys were common and widespread species of agricultural and open woodland habitats of eastern Australia.

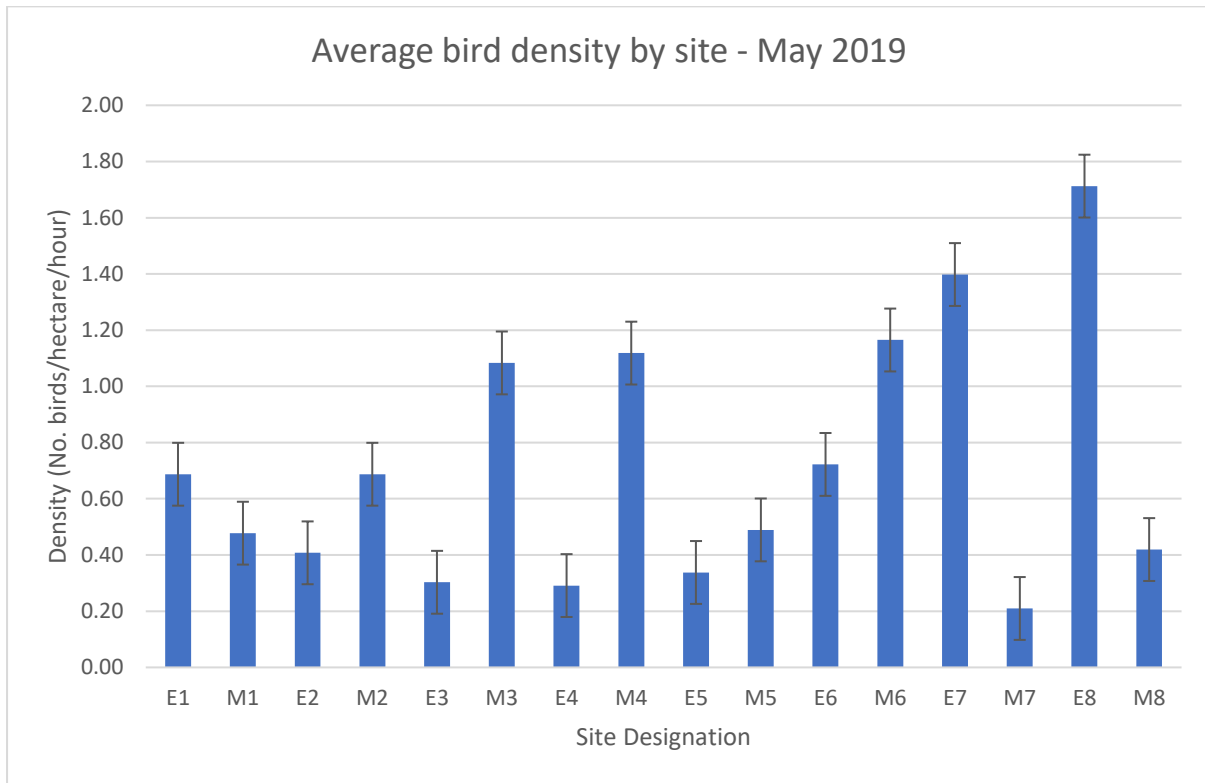
Densities of birds were relatively low across the entire survey area, recording a maximum of 1.7 birds/ha/hr at site E8 in the Autumn surveys, and a maximum of 0.6 birds/ha/hr at site N1 in the Spring. This is probably explained by the proximity of E8 to the escarpment to the east of the survey area, and the presence of a number of habitat niches (forest/woodland; cleared grassy country, ephemeral riparian and edge) at these sites as compared to the relatively treeless site E4 which was dominated by regenerating wattles *Acacia* sp. and grasses. The bird densities recorded at Lotus Creek are lower than at some other wind farms in eastern Australia (BL&A, unpublished data).

Seasonal differences are evident when density is analysed for each survey effort. Density is much higher in the Autumn, which is most likely due to greater abundance in resources such as food and water after the wet Summer season in Tropical Queensland ( Figure 6 and Figure 7). Other seasonal differences included the appearance of larger numbers of White-throated Needletail and the presence of migratory species such as the Satin Flycatcher and Eastern Koel in November. Seasonal migratory species that may have moved into the area from southern areas, namely Grey Fantail, Rufous Whistler and Silvereye, were present in the May survey period, which suggests these species may overwinter in the broader landscape.

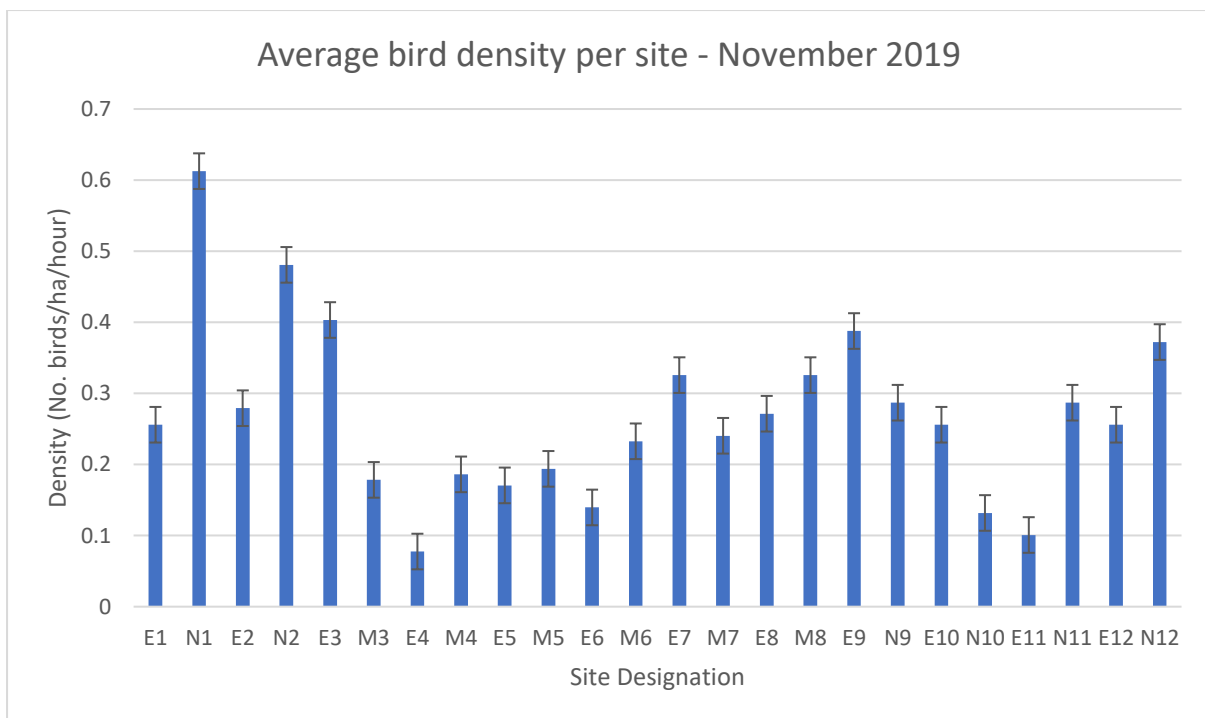
Fifty-four birds were recorded flying at RSA height in the May BUS (5.4% of 986 records), as compared to 66 in November (7.7% of 856). Over the combined survey period the percentage of birds flying at RSA was 6.6%.



**Figure 6: Density of bird species at impact points on the Lotus Creek Wind Farm, May 2019 (mean ± S.E.)**



**Figure 7: Density of bird species at impact points on the Lotus Creek Wind Farm, November 2019 (mean ± S.E.)**



The full bird list recorded by BL&A within the wind farm footprint is set out below (Table 4). The list follows the International Ornithological Congress nomenclature (Gill and Donsker, 2018).

**Table 4: List of birds recorded at the Lotus Creek Wind Farm, May & November 2019**

Common Name	Scientific Name	EPBC Act	NC Act	Recorded (BUS)	Recorded (Incidental)
Apostlebird	<i>Struthidea cinerea</i>				X
Australasian Darter	<i>Anhinga novaehollandiae</i>				X
Australasian Pipit	<i>Anthus novaeseelandiae</i>			X	
Australian Brushturkey	<i>Alectura lathami</i>				X
Australian Bustard	<i>Ardeotis australis</i>				X
Australian Magpie	<i>Gymnorhina tibicen</i>			X	
Australian Pelican	<i>Pelecanus conspicillatus</i>				X
Australian Raven	<i>Corvus coronoides</i>			X	
Australian Wood Duck	<i>Chenonetta jubata</i>				X
Barn Swallow	<i>Hirundo rustica</i>			X	
Black Kite	<i>Milvus migrans</i>				X
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>			X	
Blue-billed Duck	<i>Oxyura australis</i>				X
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>			X	
Blue-winged Kookaburra	<i>Dacelo leachii</i>			X	
Brolga	<i>Antigone rubicunda</i>				X
Brown Falcon	<i>Falco berigora</i>			X	
Brown Goshawk	<i>Accipiter fasciatus</i>			X	
Bush Stone-curlew	<i>Burhinus grallarius</i>				X
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>			X	
Cicadabird	<i>Edolisoma tenuirostre</i>			X	
Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>			X	
Comb-crested Jacana	<i>Irediparra gallinacea</i>				X
Common Bronzewing	<i>Phaps chalcoptera</i>			X	
Common Myna	<i>Acridotheres tristis</i>			X	
Crested Pigeon	<i>Ocyphaps lophotes</i>			X	
Dollarbird	<i>Eurystomus orientalis</i>			X	
Double-barred Finch	<i>Taeniopygia bichenovii</i>				X
Dusky Moorhen	<i>Gallinula tenebrosa</i>				X
Eastern Koel	<i>Eudynamis orientalis</i>			X	
Figbird	<i>Sphecotheres vieilloti</i>			X	
Forest Kingfisher	<i>Todiramphus macleayii</i>			X	
Galah	<i>Eolophus roseicapilla</i>			X	
Green Pygmy Goose	<i>Nettapus pulchellus</i>				X
Grey Butcherbird	<i>Cracticus torquatus</i>			X	

Common Name	Scientific Name	EPBC Act	NC Act	Recorded (BUS)	Recorded (Incidental)
Grey Fantail	<i>Rhipidura albiscapa</i>			X	
Grey Shrike-thrush	<i>Colluricincla harmonica</i>			X	
Hardhead	<i>Aythya australis</i>				X
Laughing Kookaburra	<i>Dacelo novaeguineae</i>			X	
Leaden Flycatcher	<i>Myiagra rubecula</i>			X	
Lewin's Honeyeater	<i>Meliphaga lewinii</i>			X	
Little Friarbird	<i>Philemon citreogularis</i>			X	
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>				X
Little Shrike-thrush	<i>Colluricincla megarrhyncha</i>			X	
Magpie-lark	<i>Grallina cyanoleuca</i>			X	
Masked Lapwing	<i>Vanellus miles</i>				X
Mistletoebird	<i>Dicaeum hirundinaceum</i>			X	
Nankeen Kestrel	<i>Falco cenchroides</i>			X	
Noisy Friarbird	<i>Philemon corniculatus</i>			X	
Noisy Miner	<i>Manorina melanocephala</i>			X	
Olive-backed Oriole	<i>Oriolus sagittatus</i>			X	
Pacific Baza	<i>Aviceda subcristata</i>			X	
Pacific Black Duck	<i>Anas superciliosa</i>				X
Painted Button-quail	<i>Turnix varius</i>			X	
Pale-headed Rosella	<i>Platycercus adscitus</i>			X	
Pallid Cuckoo	<i>Cacomantis pallidus</i>			X	
Peaceful Dove	<i>Geopelia placida</i>			X	
Pheasant Coucal	<i>Centropus phasianinus</i>			X	
Pied Butcherbird	<i>Cracticus nigrogularis</i>			X	
Pied Cormorant	<i>Phalacrocorax varius</i>				X
Pied Currawong	<i>Strepera graculina</i>			X	
Plum-headed Finch	<i>Neochmia modesta</i>				X
Powerful Owl	<i>Ninox strenua</i>				X
Rainbow Bee-eater	<i>Merops ornatus</i>			X	
Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>			X	
Red-backed Button-quail	<i>Turnix maculosus</i>			X	
Red-backed Fairy-wren	<i>Malurus melanocephalus</i>			X	
Red-tailed Black Cockatoo	<i>Calyptorhynchus banksii</i>			X	
Red-winged Parrot	<i>Aprosmictus erythropterus</i>			X	
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	Migratory	S-LC	X	
Southern Boobook	<i>Ninox boobook</i>				X
Spangled Drongo	<i>Dicrurus bracteatus</i>			X	
Spotted Pardalote	<i>Pardalotus punctatus</i>			X	
Squatter Pigeon	<i>Geophaps scripta scripta</i>	V	V		X
Straw-necked Ibis	<i>Threskiornis spinicollis</i>				X

Common Name	Scientific Name	EPBC Act	NC Act	Recorded (BUS)	Recorded (Incidental)
Striated Pardalote	<i>Pardalotus striatus</i>			X	
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>			X	
Tawny Frogmouth	<i>Podargus strigoides</i>				X
Torresian Crow	<i>Corvus orru</i>			X	
Tree Martin	<i>Petrochelidon nigricans</i>			X	
Wedge-tailed Eagle	<i>Aquila audax</i>			X	
Western Gerygone	<i>Gerygone fusca</i>			X	
Whistling Kite	<i>Haliastur sphenurus</i>				X
White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>			X	
White-eared Honeyeater	<i>Nesoptilotis leucotis</i>			X	
White-faced Heron	<i>Egretta novaehollandiae</i>				X
White-throated Honeyeater	<i>Melithreptus albobularis</i>			X	
White-throated Needletail	<i>Hirundapus caudacutus</i>	V	S-LC	X	
White-throated Treecreeper	<i>Cormobates leucophaea</i>			X	
White-winged Chough	<i>Corcorax melanorhamphos</i>			X	
Willy Wagtail	<i>Rhipidura leucophrys</i>			X	
Yellow Thornbill	<i>Acanthiza nana</i>			X	

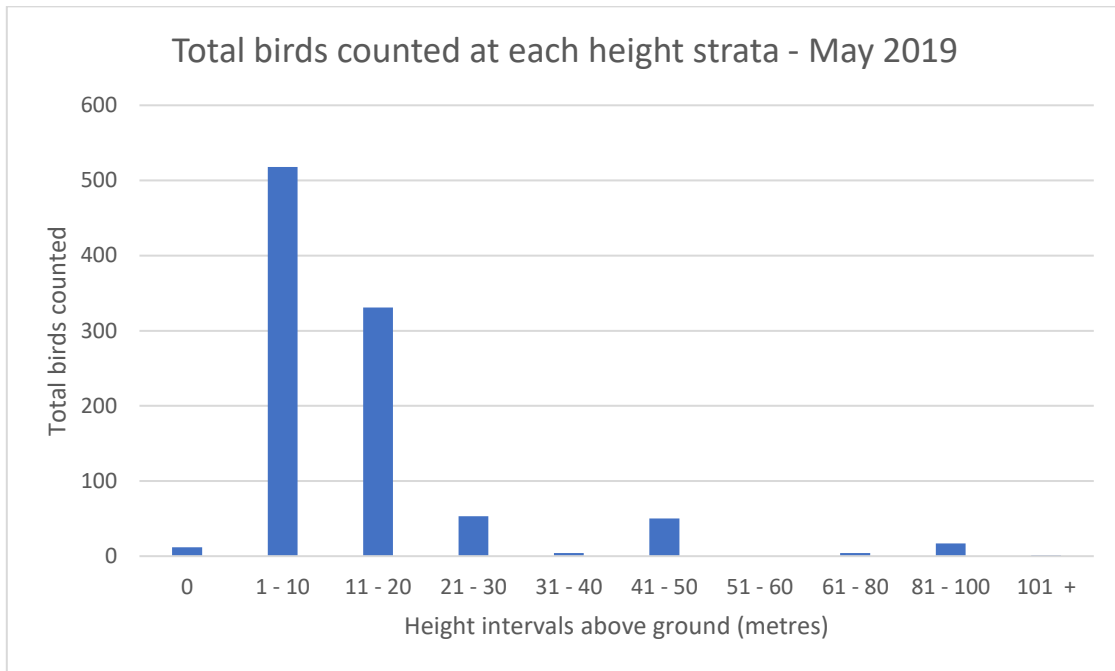
### 5.3. Bird Utilisation Survey

The two seasonal field surveys recorded a total of 93 bird species across the wind farm properties including the 66 bird species recorded at the BUS locations. This total included the “Vulnerable” listed White-throated Needletail (Table 4) which was seen during the BUS and incidentally, during the both the May and November 2019 surveys.

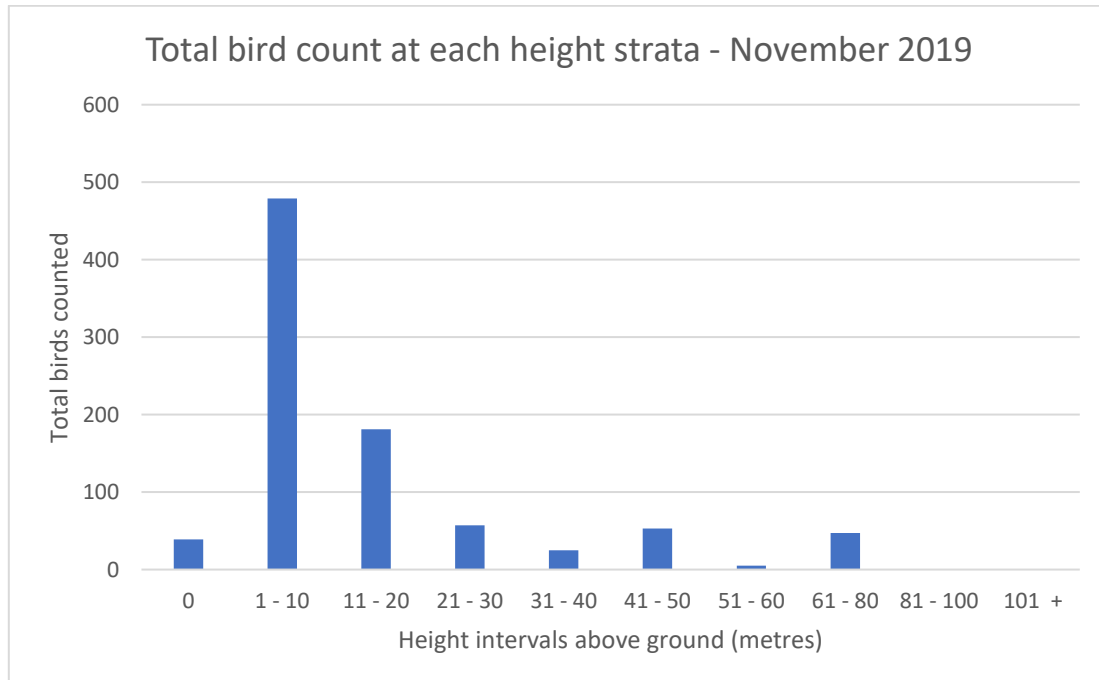
Analysis of the field data shows that most birds are active in the lower strata between 0 and 20 metres height (i.e. ground, and in trees) (Figure 8 & Figure 9). A small proportion of birds flew at above 40 metres, particularly White-throated Needletail, Wedge-tailed Eagle, Rainbow Lorikeet, Rainbow Bee-eater, and Torresian Crow.

There was minor variation in flight heights across the two seasons and potentially some evidence of migration, i.e. birds that were present in May might be indicative of movements of these species within or beyond the tropics (e.g. Grey Fantail, Rufous Whistler and Silveryeye; likely have arrived from further south, but also have resident populations in central Queensland) whereas in November the White-throated Needletail had already arrived from the northern hemisphere on its southward migration.

**Figure 8: Number and height distribution of bird species at impact points on the Lotus Creek Wind Farm, May 2019**



**Figure 9: Number and height distribution of bird species at impact points on the Lotus Creek Wind Farm, November 2019**



#### 5.4. Flight Heights

Bird heights were classified as below (< 40 metres), at (40–250 metres), and above (> 250 metres) RSA height. Detailed results of the number of birds recorded at the different flight heights are presented in Table 5. The raw data are presented in Appendices 2 and 3.

**Table 5: Summary of birds recorded at the three flight heights**

Flight Height	Impact survey points	
	Number of birds	Percentage of all birds
A (below RSA)	1,696	93.3%
B (at RSA)	121	6.6%
C (above RSA)	1	0.06%
<b>Total birds recorded</b>	<b>1818</b>	<b>100</b>

The five most abundant species flying at RSA are detailed below.

- White-throated Needletail
- Rainbow Lorikeet/ Wedge-tailed Eagle (equal observations)
- Rainbow Bee-eater
- Torresian Crow

These accounted for 5.2% of the total birds observed at impact survey points.

#### 5.5. Threatened Species

The majority of birds found to utilise the proposed wind farm site were common, widespread birds. Of the species recorded during the bird utilisation surveys the following species was listed under the EPBC Act (Commonwealth).

- White-throated Needletail (Vulnerable and Migratory).
- Satin Flycatcher (Migratory)

No other listed threatened bird species were recorded during the surveys, either at state level under the state *Nature Conservation Act 1992* (NC Act) or under the Commonwealth EPBC Act.

Birddata (BirdLife Australia 2019) includes a species listed as threatened at state level, the Squatter Pigeon (two records). This species was detected within the wind farm footprint in both autumn or spring surveys, incidentally and not near any proposed turbine locations, suggesting that where present on the wind farm site, it occupies areas away from sites of proposed turbine placement. In any event, in view of the terrestrial habits of the species it would be very unlikely to be flying at RSA height so is unlikely to be affected by the wind farm as proposed.



## 5.6. White-throated Needletail

The White-throated Needletail is listed under the EPBC Act as both Migratory and Vulnerable. It breeds in Siberia and Japan and migrates to Australia in its non-breeding season. It usually arrives in Queensland moving southward in October and northward in March or April (Higgins 1999; Menkhorst et al. 2017). The species is listed as “Special Least Concern” under Queensland’s Nature Conservation Act.

A total of 42 White-throated Needletails were recorded during the formal BUS, 38 at site E3, three at site M4 on 3<sup>rd</sup> November (See Figure 2), and a single bird was recorded at site E3 on 7<sup>th</sup> May. A further 3 incidental sightings totalling 41 individuals were recorded across the footprint of the windfarm during the November surveys.

Section 2.3.3 provides a discussion of the difficulties of generating information on the location, numbers and timing of Needletails generally and, therefore, the problems in developing accurate and precise predictions of the likely impacts of wind farms on this species through, for example, collision risk modelling.

That said, observations elsewhere in Australia indicate that this species occasionally collides with wind farms, having been recorded once or twice at about half the 18 wind farms monitored for bird impacts (for at least a year and up to three years) by Nature Advisory in the last decade (Nature Advisory, unpubl. data).

It is not expected that numbers of Needletails passing through Lotus Creek Wind Farm would be great enough nor the rate of collision high enough (based on observations elsewhere in Australia) to place the overall population at risk in light of the large area of Great Dividing Range that this species would move through during its stay in Australia. Collision with wind turbines is not considered to affect a large number of birds (Hull 2013).

The impacts of the Lotus Creek Wind Farm on the White-throated Needletail are therefore not likely to lead to a significant impact on the state or wider population of the species. If causalities do occur to the White-throated Needletail mitigation measures will be detailed in a Bird and Bat Management Plan to be prepared as part of the operational phase of the project.

## 5.7. Raptors

Four raptor species were recorded during the BUS point surveys, comprising 26 observations in total (Table 6). The Spring raptor species composition (point survey and incidental observations) differed from the Autumn by the observation of Pacific Baza, Collared Sparrowhawk (incidental), Brown Goshawk and Nankeen Kestrel (incidental). The frequency of observations at RSA height also differed between seasons. In Autumn there were 21 individual sightings of raptors during surveys, with 14 individuals (13 Wedge-tailed Eagles and 1 Brown Falcon) at RSA height, as compared to only six raptor sightings during the Spring BUS surveys (Brown Falcon, Brown Goshawk, Wedge-tailed Eagle and Pacific Baza), of which five were at RSA height.

Generally, raptors were recorded in low numbers. The raw data are presented in Appendices 2 and 3.

Wedge-tailed Eagle was the most abundant raptor species at Lotus Creek Wind Farm over both seasons. It was observed a total of 37 times throughout the study area across both

seasons, with 12 incidental observations in the Spring and 9 incidental observations in Autumn in addition to the 15 recorded sightings during BUS efforts.

Wedge-tailed Eagles will often fly at RSA heights and 93.3% of Wedge-tailed Eagle flights observed at Lotus Creek Wind Farm were at RSA height. Wedge-tailed Eagles are vulnerable to collision with operating turbines because of their soaring habits while foraging.

Wedge-tailed Eagles are regularly recorded colliding with wind turbines elsewhere in Australia. Most of the affected individuals are sub-adult birds between one and two years old. Once sub-adult Wedge-tailed Eagles leave their natal territory (usually expelled by their parents before the next breeding season commences), they wander long distances, up to one to two thousand kilometres based on banding records and recent satellite-tracking results (Cherriman 2019). This indicates that the population operates at a continental scale and numbers at least tens of thousands (Olsen 2006), and given observed breeding densities (Marchant & Huggins 1993), likely over 100,000. The Lotus Creek Wind Farm may affect several eagles per year, on average. Observations elsewhere (Nature Advisory, unpubl. data) indicate that numbers affected vary from year to year depending on how much breeding occurs, with mortality higher if there are heavy rains inland that support successful breeding.

In summary, it is considered that the Lotus Creek Wind farm will not lead to a significant impact on the eagle's population.

The number of raptors was low in relation to the total number of birds recorded during the survey, and raptors formed approximately 15.7% of birds seen at RSA height (Table 6). Based on the utilisation rate by other raptors (Nankeen Kestrel and Brown Falcon) at the impact points, the likely collision rate for these would be low (Brown Falcon) to moderate (Brown Goshawk). It is not expected however that large regional and wider populations of these common raptor species would be affected significantly by the Lotus Creek Wind Farm proposal.

**Table 6: Raptor species recorded at survey points during surveys at Lotus Creek Wind Farm**

Raptors	A	B	C	Grand Total	Total at RSA	Total Raptor Flights (%)	Flights at RSA (%)	Flights recorded at RSA compared with all bird flights at RSA (%)	Flights recorded at RSA compared with all bird flights observed (%)
Wedge-tailed Eagle	0	14	1	14	14	53.8	93.33	11.57	0.77
Brown Goshawk	0	3	0	3	3	11.5	100.00	2.48	0.16
Brown Falcon	6	2	0	8	1	3.8	33.33	1.65	0.11
Pacific Baza	1	0	0	1	0	0.0	0	0	0
Total	6	19	1	26	19	69.1	56.7 (avg)	15.70	1.05

**A**=below rotor swept area (RSA) height (<40 m); **B**= at RSA height (40-250 m); **C**= above RSA height (>250 m).

## 5.8. Waterbirds

No waterbirds were observed during the formal BUS. Several incidental observations at farm dams and waterways comprised the waterbird observations over the duration of the BUS.

Four species of waterbird were observed incidentally during the Autumn survey period:

- Australian Pelican
- Brolga
- Pied Cormorant
- White-faced Heron

Eleven species of waterbird were observed incidentally during the Spring survey period:

- Australasian Darter
- Australian Wood Duck
- Blue-billed Duck
- Comb-crested Jacana
- Dusky Moorhen
- Green Pygmy Goose
- Hardhead
- Little Pied Cormorant
- Masked Lapwing
- Pacific Black Duck
- Straw-necked Ibis

All species were observed near standing water, farm dams, or creeks. The Brolga was observed in the house paddock at Killarney homestead.

The Brolga would be typical of an occasional movement by large waterbirds in Australia, where large distances are covered in response to seasonal drying or flooding of wetlands across the landscape.

Given the paucity of waterbird records at Lotus Creek Wind Farm, and the lack of extensive habitat in the immediate vicinity, it is not expected there would be significant risk to any waterbird populations arising from construction and operation of the wind farm.

## 6. CONCLUSIONS AND RECOMMENDATIONS

### 6.1. Conclusions

- A total of 93 bird species were recorded within the project area, 66 of these were recorded during the formalised Bird Utilisation Surveys.
- The White-throated Needletail (listed as Vulnerable and Migratory species under EPBC Act) and the Satin Flycatcher (Migratory EPBC Act) were the only listed species observed during the point surveys. No other listed threatened species under the *Nature Conservation Act 1992* or EPBC Act were recorded during the bird utilisation survey.
- Squatter Pigeon was observed incidentally across the study area, but due to their ground-dwelling nature, this species is not likely to be at risk from the operational wind farm.
- The main species likely to be affected by turbine operation are the Wedge-tailed Eagle, other raptors, and possibly the White-throated Needletail. Mitigation measures for these species are expected to be covered in the Bird and Bat Management Plan (BBMP) due to be devised for the Lotus Creek Wind Farm project.
- There were no significant populations of threatened species recorded at the proposed wind farm site. Hence there is no need to undertake collision risk modelling or population viability assessments for the project as it is unlikely to pose a significant risk to these species.
- Impacts on Wedge-tailed Eagle and other common raptors will occur, with experience at other wind farms indicating that small numbers of these species will collide with turbines each year. Their large, widespread populations and wide-ranging movements make it highly unlikely that the population effects will be of conservation concern.
- Notwithstanding the difficulties of predicting the impact of the wind farm on the White-throated Needletail, small numbers of the species are generally affected by wind farms elsewhere and it is possible that there may be an occasional mortality at the Lotus Creek Wind Farm. The impact of this on the species' population is not considered to be significant.

### 6.2. Recommendations

It is recommended that, if feasible, the established survey sites be used as reference points in a BACI (Before-After-Control-Impact) monitoring program, which will be developed as part of a Bird and Bat Management Plan (BBMP) for the project. The use of control and impact points was not differentiated during this BUS, however these may be defined for the purposes of BACI when the final turbine layout is confirmed – control points being those outside the zone of influence of the turbines.

## 7. REFERENCES

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**Appendix 1: List of bird species recorded in an approximate 20 km radius of the central point of the study area (source: BirdLife Australia 2019)**

Common Name	Scientific Name
Apostlebird	<i>Struthidea cinerea</i>
Australasian Darter	<i>Anhinga novaehollandiae</i>
Australasian Figbird	<i>Sphecotheres vieilloti</i>
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>
Australasian Pipit	<i>Anthus novaeseelandiae</i>
Australian Brush-turkey	<i>Alectura lathami</i>
Australian Bustard	<i>Ardeotis australis</i>
Australian King-Parrot	<i>Alisterus scapularis</i>
Australian Magpie	<i>Gymnorhina tibicen</i>
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>
Australian Pelican	<i>Pelecanus conspicillatus</i>
Australian Raven	<i>Corvus coronoides</i>
Australian White Ibis	<i>Threskiornis moluccus</i>
Australian Wood Duck	<i>Chenonetta jubata</i>
Azure Kingfisher	<i>Ceyx azureus</i>
Bar-shouldered Dove	<i>Geopelia humeralis</i>
Black Kite	<i>Milvus migrans</i>
Black Swan	<i>Cygnus atratus</i>
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>
Black-fronted Dotterel	<i>Euseyonis melanops</i>
Black-shouldered Kite	<i>Elanus axillaris</i>
Black-winged Stilt	<i>Himantopus leucocephalus</i>
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>
Blue-winged Kookaburra	<i>Dacelo leachii</i>
Brolga	<i>Antigone rubicunda</i>
Brown Cuckoo-Dove	<i>Macropygia phasianella</i>
Brown Falcon	<i>Falco berigora</i>
Brown Goshawk	<i>Accipiter fasciatus</i>
Brown Honeyeater	<i>Lichmera indistincta</i>
Brown Quail	<i>Synoicus ypsilophora</i>
Brown Treecreeper	<i>Climacteris picumnus</i>
Brown-capped Emerald-Dove	<i>Chalcophaps longirostris</i>
Cattle Egret	<i>Bubulcus ibis</i>
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>
Chestnut-breasted Mannikin	<i>Lonchura castaneothorax</i>
Cicadabird	<i>Edolisoma tenuirostris</i>
Cotton Pygmy-goose	<i>Nettapus coromandelianus</i>
Crested Pigeon	<i>Ocyphaps lophotes</i>
Dollarbird	<i>Eurystomus orientalis</i>
Double-barred Finch	<i>Taeniopygia bichenovii</i>

Common Name	Scientific Name
Dusky Moorhen	<i>Gallinula tenebrosa</i>
Eastern Koel	<i>Eudynamis orientalis</i>
Emu	<i>Dromaius novaehollandiae</i>
Eurasian Coot	<i>Fulica atra</i>
Fairy Martin	<i>Petrochelidon ariel</i>
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>
Forest Kingfisher	<i>Todiramphus macleayii</i>
Galah	<i>Eolophus roseicapilla</i>
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>
Golden Whistler	<i>Pachycephala pectoralis</i>
Golden-headed Cisticola	<i>Cisticola exilis</i>
Great Egret	<i>Ardea alba</i>
Grey Fantail	<i>Rhipidura fuliginosa</i>
Grey Shrike-thrush	<i>Colluricincla harmonica</i>
Grey Teal	<i>Anas gracilis</i>
Helmeted Friarbird	<i>Philemon buceroides</i>
Horsfield's Bushlark	<i>Mirafrja javanica</i>
Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Leaden Flycatcher	<i>Myiagra rubecula</i>
Lemon-bellied Flycatcher	<i>Microeca flavigaster</i>
Lewin's Honeyeater	<i>Meliphaga lewinii</i>
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>
Little Bronze-Cuckoo	<i>Chalcites minutillus</i>
Little Eagle	<i>Hieraaetus morphnoides</i>
Little Egret	<i>Egretta garzetta</i>
Little Friarbird	<i>Philemon citreogularis</i>
Little Lorikeet	<i>Glossopsitta pusilla</i>
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>
Magpie-lark	<i>Grallina cyanoleuca</i>
Masked Lapwing	<i>Vanellus miles</i>
Mistletoebird	<i>Dicaeum hirundinaceum</i>
Nankeen Kestrel	<i>Falco cenchroides</i>
Noisy Friarbird	<i>Philemon corniculatus</i>
Noisy Miner	<i>Manorina melanocephala</i>
Pacific Baza	<i>Aviceda subcristata</i>
Pacific Black Duck	<i>Anas superciliosa</i>
Pale-headed Rosella	<i>Platycercus adscitus</i>
Pallid Cuckoo	<i>Heteroscenes pallidus</i>
Peaceful Dove	<i>Geopelia placida</i>
Pheasant Coucal	<i>Centropus phasianinus</i>
Pied Butcherbird	<i>Cracticus nigrogularis</i>



Common Name	Scientific Name
Pied Currawong	<i>Strepera graculina</i>
Plumed Whistling-Duck	<i>Dendrocygna eytoni</i>
Rainbow Bee-eater	<i>Merops ornatus</i>
Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>
Red-backed Fairy-wren	<i>Malurus melanocephalus</i>
Red-backed Kingfisher	<i>Todiramphus pyrrhopygius</i>
Red-tailed Black-Cockatoo	<i>Calyptorhynchus banksii</i>
Red-winged Parrot	<i>Aprosmictus erythropterus</i>
Rose Robin	<i>Petroica rosea</i>
Rufous Fantail	<i>Rhipidura rufifrons</i>
Rufous Songlark	<i>Cincloramphus mathewsi</i>
Rufous Whistler	<i>Pachycephala rufiventris</i>
Sacred Kingfisher	<i>Todiramphus sanctus</i>
Scaly-breasted Lorikeet	<i>Trichoglossus chlorolepidotus</i>
Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>
Silvereye	<i>Zosterops lateralis</i>
Singing Honeyeater	<i>Gavicalis virescens</i>
Southern Boobook	<i>Ninox boobook</i>
Spangled Drongo	<i>Dicrurus bracteatus</i>
Speckled Warbler	<i>Pyrrholaemus sagittatus</i>
Spotted Bowerbird	<i>Ptilonorhynchus maculatus</i>
Squatter Pigeon	<i>Geophaps scripta scripta</i>
Straw-necked Ibis	<i>Threskiornis spinicollis</i>
Striated Pardalote	<i>Pardalotus striatus</i>
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>
Tawny Frogmouth	<i>Podargus strigoides</i>
Torresian Crow	<i>Corvus orru</i>
Tree Martin	<i>Petrochelidon nigricans</i>
Varied Sittella	<i>Daphoenositta chrysoptera</i>
Varied Triller	<i>Lalage leucomela</i>
Variegated Fairy-wren	<i>Malurus lamberti</i>
Wedge-tailed Eagle	<i>Aquila audax</i>
Welcome Swallow	<i>Hirundo neoxena</i>
Whistling Kite	<i>Haliastur sphenurus</i>
White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>
White-browed Scrubwren	<i>Sericornis frontalis</i>
White-faced Heron	<i>Egretta novaehollandiae</i>
White-naped Honeyeater	<i>Melithreptus lunatus</i>
White-necked Heron	<i>Ardea pacifica</i>
White-throated Gerygone	<i>Gerygone olivacea</i>
White-throated Honeyeater	<i>Melithreptus albobularis</i>

Common Name	Scientific Name
White-throated Treecreeper	<i>Cormobates leucophaea</i>
White-winged Chough	<i>Corcorax melanorhamphos</i>
White-winged Triller	<i>Lalage tricolor</i>
Willie Wagtail	<i>Rhipidura leucophrys</i>
Yellow Honeyeater	<i>Stomiopera flava</i>
Yellow Thornbill	<i>Acanthiza nana</i>
Yellow-throated Miner	<i>Manorina flavigula</i>





**Appendix 4: Regional Ecosystem and habitat descriptions of each survey point, Lotus Creek Wind Farm, 2019**

Autumn Survey Point	RE and description	Lat	Long
E1 E2	11.12.1/11.12.2 <i>Eucalyptus crebra</i> grassy woodland / <i>Eucalyptus melanophloia</i> and <i>Corymbia erythrophloia</i> +/- <i>E. populnea</i> grassy woodland on igneous rocks, sparse. E1 edge of escarpment on spot height. E2 on access track cleared of veg for 50 m all directions	-22.2569 -22.2546	149.2234 149.2279
M1 M2	11.12.1/11.12.2 <i>Eucalyptus crebra</i> grassy woodland / <i>Eucalyptus melanophloia</i> and <i>Corymbia erythrophloia</i> +/- <i>E. populnea</i> grassy woodland on igneous rocks, sparse.	-22.2701 -22.2636	149.2311 149.2288
E3 E4	11.12.1/11.12.6a <i>Eucalyptus crebra</i> +/- <i>Corymbia erythrophloia</i> shrubby woodland. <i>E. melanophloia</i> is often present and may be locally dominant. Also includes localised areas dominated by <i>E. persistens</i> . Occurs on ranges on igneous rocks. <i>Corymbia citriodora</i> , <i>Eucalyptus crebra</i> , <i>E. microcarpa</i> / <i>E. moluccana</i> , <i>Angophora leiocarpa</i> and <i>E. melanophloia</i> open forest to woodland. E3 Open <i>E. crebra</i> ridgeline, low <i>Acacia</i> / <i>Lantana</i> / <i>Hibiscus</i> , with <i>Erythrina vespertilio</i> and <i>Brachychiton</i> /SEVT species to the west. S, W & N aspects. E4 open montane grassland with emergent <i>Acacia sp.</i> on periphery, adjacent to shrubland/thick woodland	-22.3383 -22.3443	149.2492 149.2465
M3 M4	11.12.1/11.12.2 <i>Eucalyptus crebra</i> , <i>E. tereticornis</i> +/- <i>Angophora leiocarpa</i> and <i>E. melanophloia</i> woodland. Other tree species that may be present include <i>Corymbia clarksoniana</i> , <i>C. tessellaris</i> , <i>C. erythrophloia</i> , <i>C. citriodora</i> and <i>E. exserta</i> . There is usually a low tree layer with species including <i>Alphitonia excelsa</i> and <i>Petalostigma pubescens</i> . / <i>Eucalyptus melanophloia</i> and <i>Corymbia erythrophloia</i> +/- <i>E. populnea</i> grassy woodland	-22.3404 -22.3440	149.2649 149.2666
E5 E6	11.12.6a: <i>Eucalyptus crebra</i> +/- <i>Corymbia citriodora</i> and/or <i>E. acmenoides</i> +/- <i>Lophostemon suaveolens</i> woodland to open forest. E5 N, S & W aspects, grassy woodland. E6 Low <i>E. crebra</i> grassy woodland with <i>Xanthorrhoea sp.</i>	-22.4540 -22.4595	149.3308 149.3333
M5 M6	11.12.1/11.12.2 <i>Eucalyptus crebra</i> grassy woodland / <i>Eucalyptus melanophloia</i> and <i>Corymbia erythrophloia</i> +/- <i>E. populnea</i> grassy woodland on igneous rocks, sparse.	-22.4499 -22.4506	149.3194 149.3234
E7 E8	8.12.7a/8.12.9/8.12.23/8.3.14 <i>Corymbia citriodora</i> +/- <i>Eucalyptus portuensis</i> +/- <i>E. drepanophylla</i> (or <i>E. crebra</i> ) open forest on hill slopes and undulating plateaus / <i>Eucalyptus tereticornis</i> +/- <i>Corymbia intermedia</i> +/- <i>Lophostemon suaveolens</i> woodland on undulating uplands / <i>Eucalyptus moluccana</i> woodland on elevated tablelands / <i>Ischaemum australe</i> and/or <i>Imperata cylindrica</i> and/or <i>Sorghum nitidum forma aristatum</i> tussock grassland on drainage channels in gently undulating upland areas. E7 & E8 Open forest, mixed <i>E. sp.</i> + <i>Melaleuca</i> , sandy substrate, <i>Xanths</i> , low grass and herbaceous sp. + ficus and cycad. Fire in November 2018, low near ground vegetation.	-22.3916 -22.3953	149.3283 149.3259
M7 M8	8.12.5a/8.12.16 <i>Lophostemon confertus</i> and/or <i>Eucalyptus portuensis</i> (or <i>E. exserta</i> ) open forest to closed scrub (5-38m tall). Other occasional co-dominant or associated species include <i>Corymbia trachyphloia</i> , <i>Acacia spirorbis subsp. solandri</i> , <i>E. drepanophylla</i> and <i>Acacia falcata</i> . / Deciduous to semi-evergreen microphyll vine thicket +/- <i>Brachychiton spp.</i> +/- <i>Araucaria cunninghamii</i> emergents, of foothills and uplands	-22.4019 -22.4076	149.3254 149.3245
Spring Survey Point	RE and description	Lat	Long
E1 E2	8.12.7a/8.12.9/8.12.23/8.3.14 <i>Corymbia citriodora</i> +/- <i>Eucalyptus portuensis</i> +/- <i>E. drepanophylla</i> (or <i>E. crebra</i> ) open forest on hill slopes and undulating plateaus / <i>Eucalyptus tereticornis</i> +/- <i>Corymbia intermedia</i> +/- <i>Lophostemon suaveolens</i> woodland on undulating uplands / <i>Eucalyptus moluccana</i> woodland on elevated tablelands / <i>Ischaemum australe</i> and/or <i>Imperata cylindrica</i> and/or <i>Sorghum nitidum forma aristatum</i> tussock grassland on drainage channels in gently undulating upland areas. E1 large open forest grove with high canopy, low undulations, near creekline. E2 open forest mixed canopy species.	-22.3334 -22.3390	149.3154 149.3116
N1 N2	8.12.7a/8.12.9/8.12.23/8.3.14 <i>Corymbia citriodora</i> +/- <i>Eucalyptus portuensis</i> +/- <i>E. drepanophylla</i> (or <i>E. crebra</i> ) open forest on hill slopes and undulating plateaus / <i>Eucalyptus tereticornis</i> +/- <i>Corymbia intermedia</i> +/- <i>Lophostemon suaveolens</i> woodland on undulating uplands / <i>Eucalyptus moluccana</i> woodland on elevated tablelands / <i>Ischaemum australe</i> and/or <i>Imperata cylindrica</i> and/or <i>Sorghum nitidum forma aristatum</i> tussock grassland on drainage channels in gently undulating upland areas.	-22.3280 -22.3225	149.3163 149.3135
E3 E4	11.12.1/11.12.6a <i>Eucalyptus crebra</i> +/- <i>Corymbia erythrophloia</i> shrubby woodland. <i>E. melanophloia</i> is often present and may be locally dominant. Also includes localised areas dominated by <i>E. persistens</i> . Occurs on ranges on igneous rocks. <i>Corymbia citriodora</i> , <i>Eucalyptus crebra</i> , <i>E. microcarpa</i> / <i>E. moluccana</i> , <i>Angophora leiocarpa</i> and <i>E. melanophloia</i> open forest to woodland. E3 Open <i>E. crebra</i> ridgeline, low <i>Acacia</i> / <i>Lantana</i> / <i>Hibiscus</i> , with <i>Erythrina vespertilio</i> and <i>Brachychiton</i> /SEVT species to the west. S, W & N aspects. E4 open montane grassland with emergent <i>Acacia sp.</i> on periphery, adjacent to shrubland/thick woodland	-22.3383 -22.3443	149.2492 149.2465
N3 N4	11.12.1/11.12.2 <i>Eucalyptus crebra</i> , <i>E. tereticornis</i> +/- <i>Angophora leiocarpa</i> and <i>E. melanophloia</i> woodland. Other tree species that may be present include <i>Corymbia clarksoniana</i> , <i>C. tessellaris</i> , <i>C. erythrophloia</i> , <i>C. citriodora</i> and <i>E. exserta</i> . There is usually a low tree layer with species including <i>Alphitonia excelsa</i> and <i>Petalostigma pubescens</i> . / <i>Eucalyptus melanophloia</i> and <i>Corymbia erythrophloia</i> +/- <i>E. populnea</i> grassy woodland	-22.3404 -22.3440	149.2649 149.2666

E5 E6	11.12.6a: <i>Eucalyptus crebra</i> +/- <i>Corymbia citriodora</i> and/or <i>E. acmenoides</i> +/- <i>Lophostemon suaveolens</i> woodland to open forest. E5 N, S & W aspects, grassy woodland. E6 Low <i>E. crebra</i> grassy woodland with <i>Xanthorrhoea</i> sp.	-22.4475 -22.4595	149.3222 149.3333
N5 N6	11.12.1/11.12.2 <i>Eucalyptus crebra</i> grassy woodland / <i>Eucalyptus melanophloia</i> and <i>Corymbia erythrophloia</i> +/- <i>E. populnea</i> grassy woodland on igneous rocks, sparse.	-22.4499 -22.4506	149.3194 149.3234
E7 E8	8.12.7a/8.12.9/8.12.23/8.3.14 <i>Corymbia citriodora</i> +/- <i>Eucalyptus portuensis</i> +/- <i>E. drepanophylla</i> (or <i>E. crebra</i> ) open forest on hill slopes and undulating plateaus / <i>Eucalyptus tereticornis</i> +/- <i>Corymbia intermedia</i> +/- <i>Lophostemon suaveolens</i> woodland on undulating uplands / <i>Eucalyptus moluccana</i> woodland on elevated tablelands / <i>Ischaemum australe</i> and/or <i>Imperata cylindrica</i> and/or <i>Sorghum nitidum forma aristatum</i> tussock grassland on drainage channels in gently undulating upland areas. E7 & E8 Open forest, mixed <i>E. sp.</i> + <i>Melaleuca</i> , sandy substrate, <i>Xanths</i> , low grass and herbaceous sp. + ficus and cycad. Fire in November 2018, low near ground vegetation.	-22.3916 -22.3953	149.3283 149.3259
N7 N8	8.12.5a/8.12.16 <i>Lophostemon confertus</i> and/or <i>Eucalyptus portuensis</i> (or <i>E. exserta</i> ) open forest to closed scrub (5-38m tall). Other occasional co-dominant or associated species include <i>Corymbia trachyphloia</i> , <i>Acacia spirorbis subsp. solandri</i> , <i>E. drepanophylla</i> and <i>Acacia falcata</i> . / Deciduous to semi-evergreen microphyll vine thicket +/- <i>Brachychiton spp.</i> +/- <i>Araucaria cunninghamii</i> emergents, of foothills and uplands	-22.4019 -22.4076	149.3254 149.3245
E9 E10	8.12.7c <i>Eucalyptus drepanophylla</i> low woodland to open forest (6-20m tall). <i>Corymbia citriodora</i> may sometimes be codominant in the canopy. Other occasional associated species in the canopy may include <i>E. melanophloia</i> , <i>C. trachyphloia</i> , <i>E. exserta</i> , <i>C. erythrophloia</i> , <i>E. portuensis</i> and <i>E. platyphylla</i> . Open forest along farm trail, heavily grazed and cleared for agriculture.	-22.3925 -22.3974	149.3037 149.3084
N9 N10	8.12.7c <i>Eucalyptus drepanophylla</i> low woodland to open forest (6-20m tall). <i>Corymbia citriodora</i> may sometimes be codominant in the canopy. Other occasional associated species in the canopy may include <i>E. melanophloia</i> , <i>C. trachyphloia</i> , <i>E. exserta</i> , <i>C. erythrophloia</i> , <i>E. portuensis</i> and <i>E. platyphylla</i> .	-22.3896 -22.3860	149.3037 149.3338
E11 E12	8.12.7a/8.12.9/8.12.23/8.3.14 <i>Corymbia citriodora</i> +/- <i>Eucalyptus portuensis</i> +/- <i>E. drepanophylla</i> (or <i>E. crebra</i> ) open forest on hill slopes and undulating plateaus / <i>Eucalyptus tereticornis</i> +/- <i>Corymbia intermedia</i> +/- <i>Lophostemon suaveolens</i> woodland on undulating uplands / <i>Eucalyptus moluccana</i> woodland on elevated tablelands / <i>Ischaemum australe</i> and/or <i>Imperata cylindrica</i> and/or <i>Sorghum nitidum forma aristatum</i> tussock grassland on drainage channels in gently undulating upland areas.. E11 used powerline easement, E12 was a cleared forest grove	-22.2853 -22.2884	149.2972 149.2928
N11 N12	8.12.7a/8.12.9/8.12.23/8.3.14 <i>Corymbia citriodora</i> +/- <i>Eucalyptus portuensis</i> +/- <i>E. drepanophylla</i> (or <i>E. crebra</i> ) open forest on hill slopes and undulating plateaus / <i>Eucalyptus tereticornis</i> +/- <i>Corymbia intermedia</i> +/- <i>Lophostemon suaveolens</i> woodland on undulating uplands / <i>Eucalyptus moluccana</i> woodland on elevated tablelands / <i>Ischaemum australe</i> and/or <i>Imperata cylindrica</i> and/or <i>Sorghum nitidum forma aristatum</i> tussock grassland on drainage channels in gently undulating upland areas.	-22.2779 -22.2746	149.3000 149.3033