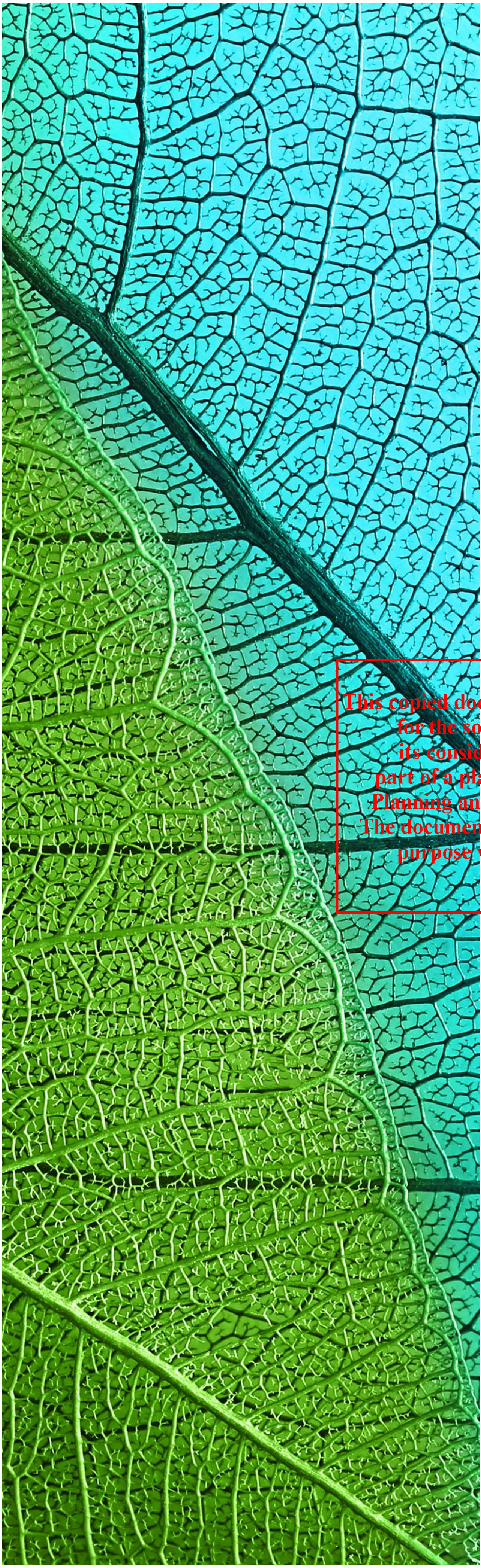

Swansons Lane Wind Farm

Impacts on Matters of National Environmental Significance

Prepared for
RE Future Pty Ltd

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Executive summary

The Swansons Lane Wind Farm (SLWF; the study area), is located on Sisters – Garvoc Rd at Garvoc, Victoria, approximately 8 km southwest of Terang, Victoria. The wind farm will consist of up to five wind turbine generators with a minimum rotor swept height (RSH) of 64 m above ground level (AGL) and a maximum RSH of 252 m AGL, together with ancillary civil and electrical infrastructure required to construct and the operate the wind farm. The proposed point of connection with the national electricity grid is located directly adjacent to the site, in the road reserve of the Princes Hwy, meaning no new powerlines will be required.

The SLWF study area encompasses operational dairy farms and is predominantly characterised by large open expanses of mixed grazing exotic grasslands.

Description of the impacts

The proposed SLWF requires assessment and approval under the EPBC Act because it has been made a Controlled Action for its potential significant impact on the following two matters of national significance (MNES):

- White-throated Needletail *Hirundapus caudacutus* (WTNT) – Vulnerable, Marine and Migratory;
- Southern Bent-wing bat *Miniopterus orianae bassanii* (SBWB) – Critically Endangered.

In addition, other EPBC listed threatened species and communities to be considered included Grey-headed Flying Fox, 14 EPBC listed bird species, and five EPBC listed migratory species. Impacts are below and in detail in the body of the report.

White-throated Needletail

The White-throated Needletail is an aerial species that moves fast over long distances, with a tendency to congregate over native forested areas in eastern Australia. The lack of native treed vegetation make site highly unlikely that any needletails in the area would spend much time over the site so it does not represent important habitat. Furthermore, the small number of turbines and limited spatial extent of the project make regular collisions unlikely. Therefore, the number of WTNT collisions is highly unlikely to reach the nationally significant proportion (0.1%) of the population, or 41 individuals (Table 8). This and the limited size of the project makes its contribution to cumulative impacts from similar projects in the region negligible.

Southern Bent-winged Bat (SBWB)

Low rates of recording the calls of this species during surveys, the lack of indigenous treed, remnant habitat and lack of wetlands (two know preferred foraging habitats of the SBWB), the limited area of planted treed vegetation near turbines and the comparatively high turbine blade tip height (64m) make an ongoing, significant impact on this routinely lower-flying bat species highly unlikely.

Grey-headed Flying Fox

There are few historical records of the GHFF in the study area and the development layout has actively placed turbines away from treed foraging resources. Given there will only be five turbines installed on site, the potential direct impacts to the Grey-headed Flying-fox population are predicted to be low.

Other Migratory and EPBC listed bird species

Based on the information from a likelihood of occurrence analysis, no additional bird species are considered likely to occur in the study area due to a lack of suitable habitat or a lack of recent nearby records. There were no records of these species on the SLWF site during site assessments (EHP 2024). Consequently, it is not considered that they will be significantly impacted by the proposed SLWF.

Avoidance and mitigation

The proponent is developing proactive avoidance, minimisation and mitigation in consultation with DEECA and DCCEEW. This will require a multi-faceted approach that is embedded in the avoidance and mitigation hierarchy but also accounts for the known ecology and behaviour of both species, site features relating to available habitat and foraging opportunities, and the influence of weather and season on bat activity.

This approach includes a minimum RSH of 64 m AGL, avoidance of potential SBWB habitat, and micro-siting key turbines to allow for a 269 m buffer. Further mitigation commitments include a low-windspeed cut in speed of 4.5 m/s for all turbines at designated times and during designated seasons, and trialling acoustic deterrents. Specific measures are detailed later in this report and, ultimately, will be incorporated into a project Bat and Avifauna Management (BAM) Plan, to be approved before commissioning, formalising impact triggers for their implementation.

Residual impacts

As activity of WTNT, SBWB and GHFF in the study area is comparatively lower than for other wind farm sites in the region, the cumulative impact to the bat community from the project is assessed as low.

A key element of project design has been to place wind turbines in areas that will minimise potential impacts on bats. This placement of turbines to avoid habitats most used by bats has minimised the likelihood of collisions with turbines. Due to the small number of turbines, the comparatively high rotor swept area height above the ground (64 m) and the low bat activity recorded on site, the risk of a significant impact on listed bird and bat species is considered very low.

A BAM Plan with specific triggers will be implemented to respond to impacts on these species if impacts are higher than anticipated. This will include trigger levels and a hierarchical response to increasing mortality of species of concern, should this occur. As no significant residual impacts are considered likely to occur, an offset strategy is not required.

1 Introduction

The proposed Swansons Lane Wind Farm (SLWF) is located in southwest Victoria, adjacent to the Princes Highway approximately 2 km south-east of Garvoc and 8 km south-west of Terang. The SLWF lies on the border of the Corangamite Shire Council and the Moyne Shire Council. The wind farm proposal consists of up to five wind turbine generators and associated works, buildings and infrastructure required to construct and operate the wind farm.

The SLWF is bounded by Coyles Rd to the north, Sisters- Garvoc Rd to the west, and the Princes Hwy to the east and south. The SLWF boundary is hereafter termed the 'study area'. The SLWF study area consists of fourteen privately owned parcels, together with five adjoining road and/or rail reserves to be used for access and the reticulation and export of electricity. These 19 areas of land have a combined area of approximately 688 ha.

The SLWF development footprint (or construction footprint) is 13 ha and corresponds to 1.8% of the area of the study area. The SLWF activity area, which is the area that will contain all construction activity i.e. permanent works and personnel and machinery traversing the site, is equal to approximately 112 ha, and corresponds to approximately 16.3% of the study area. The activity area is based on the area of the development footprint, plus an additional buffer of 50 m around all temporary and permanent works, except where such a buffer encroaches on an external private property boundary. This ensures all possible areas where works will be carried out within the study area are captured.

The proposed wind farm will consist of up to five horizontal axis wind turbine generators. For the purposes of assessing the potential impacts two configurations of two separate wind turbine models have been considered. Altogether, the overall dimensional envelope encompassing these four wind turbine configurations is as follows:

- A maximum RSA height of 252 metres;
- A minimum RSA height of 64 metres;
- A maximum rotor diameter of 172 metres; and
- A maximum tower height of 166 metres.

The project has been referred under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Australian Minister for the Environment decided on 22nd October 2024 that the project is a Controlled Action, requiring Assessment and Approval under that Act. The Assessment method required was a Bilateral Assessment, administered by the Victorian Department of Transport and Planning (DTP). The controlling provisions (and species of concern) included:

- Listed threatened species and communities (sections 18 and 18A), for impacts on the Southern Bent-wing Bat and White-throated Needletail; and
- Listed Migratory Species (sections 20 and 20A) for impacts on the White-throated Needletail.

The DTP has issued guidance for the preparation of the EPBC Act assessment documentation on 1st November 2024. This report responds to this guidance and is the principal assessment document under this Act. It is presented in the sections listed below.

Section 2 provides information on the policy guidance used in the preparation of this report.

Section 3 presents a description of the project.

Section 4 describes the impacts of the project on MNES.

Section 5 documents the project's proposed impact avoidance and mitigation measures.

Section 6 considers if residual impacts are likely and, therefore if offsetting is required.

Section 7 discusses the social and economic aspects of the project.

Section 8 summarises the environmental record of RE Future Pty Ltd.

Section 9 lists the information sources used in this assessment.

This report was prepared by a team of Nature Advisory Senior Zoologists comprising Dr Danielle Eastick, Dr Robin Leppitt, Dr Sergio Nolanzco Plasier, and Senior Ecologist & Project Manager, Dr Kate Callister.

2 Policy guidance

The following policy documents and guidelines have guided the preparation of this report:

- Threatened Species Scientific Committee (2021). *Conservation Advice Miniopterus orianae bassanii Southern Bent-wing Bat*. Canberra: Department of Agriculture, Water and the Environment, Canberra.
- Department of Energy, Environment and Climate Action (DEECA) (2023). *Action Statement* Southern Bent-wing Bat *Miniopterus orianae bassanii*, Victoria.
- Department of Environment, Land, Water and Planning (2020). *National Recovery Plan for the Southern Bent-wing Bat Miniopterus orianae bassanii*. Victorian Government, Melbourne.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2010) *Survey Guidelines for Australia's Threatened Bats. EPBC Act survey guidelines 6.1*, DEWHA, Canberra.
- Threatened Species Scientific Committee (2021). *Conservation Advice Hirundapus caudacutus White-throated Needletail*. Department of Agriculture, Water and the Environment, Canberra.
- Department of the Environment (DoE) (2015) *(Draft) Referral guideline for 14 birds listed as migratory under the EPBC Act.* DoE, Canberra.

No threat abatement or wildlife conservation plans have been prepared under the EPBC Act for the two species of concern.

3 Project description

The Swansons Lane Wind Farm is located on Sisters – Garvoc Rd at Garvoc, Victoria, approximately 8 km southwest of Terang, Victoria, as shown in Figure 1. The wind farm will consist of up to five wind turbine generators together with ancillary civil and electrical infrastructure required to construct and the operate the wind farm. The proposed point of connection with the national electricity grid is located directly adjacent to the site, in the road reserve of the Princes Hwy, meaning no new powerlines will be required.

The study area consists of two active dairy farms and ancillary areas of land required for access and reticulation of electrical cabling. The site itself is bounded by Coyles Rd to the north, Sisters – Garvoc Rd to the west, and the Princes Hwy to the east and south, and consists of fourteen privately owned parcels, together with five road and/or rail reserves adjoining their boundaries which are to be utilised for access and the reticulation and export of electricity. These nineteen areas of land constituting the study area have a combined area of approximately 688 ha.

The SLWF development footprint (or construction footprint) is 13 ha and corresponds to 1.8% of the area of the study area. The SLWF activity area, which is the area that will contain all construction activity—i.e. permanent works and personnel and machinery traversing the site—is equal to approximately 112 ha and corresponds to approximately 16.3% of the study area. The activity area is based on the area of the development footprint, plus an additional buffer of 50 m around all temporary and permanent works, except where this would encroach on an external private property boundary. This ensures all areas where works will be carried within the study area are captured

The proposed wind farm will consist of up to five horizontal axis wind turbine generators. Two configurations of two separate wind turbine models have been considered in order to assess potential impacts associated with the proposed wind farm. Altogether, the overall dimensional envelope encompassing these four wind turbine configurations is as follows:

- A maximum RSA height of 252 metres;
- A minimum RSA height of 64 metres;
- A maximum rotor diameter of 172 metres; and
- A maximum tower height of 166 metres.

In addition to the five wind turbine generators, the following ancillary infrastructure will also be constructed as part of the wind farm:

- Access tracks;
- Hardstands;
- Substation;
- Electrical cabling;
- Static water supply;
- Fire breaks;
- Site entrances; and
- Meteorological mast.

3.1 Description of proposed works

The proposed works can be broken into four phases: construction, commissioning, operation and decommissioning.

Construction will commence once all regulatory requirements are satisfied, and will begin with civil works including access tracks, hard stands, staging areas, benches for electrical infrastructure, foundations, site entrances, and the drainage system. The second phase of the construction process will involve the delivery and installation of wind turbine generators, which will remain static until the commissioning process. The third phase of construction will involve the delivery and installation of electrical infrastructure, including reticulation, high voltage transformers, high voltage protection systems, a maintenance and control facility, and a high voltage connection at the point of connection with the electricity network. The final phase of the construction process will involve clean-up, a final grade of all access tracks and permanent hardstands, and revegetation of disturbed areas with pasture grass.

The commissioning process will involve testing of mechanical, electrical and computational components of the wind turbine generators and electrical infrastructure connecting it with the national electricity grid. During this time each turbine will be operated on a stop-start basis for the period of time required to complete all engineering checks and deem that it is safe to operate. Depending on the nature of the faults encountered this process can take weeks or even months, however it is generally completed within a week per wind turbine. During the commissioning process wind turbines will only be operated during daylight hours.

During the operational phase of the wind farm very little activity will occur within the study area. The wind turbine generators and electrical infrastructure operate 24 hours a day and will be remotely monitored and controlled. In the event of a fault maintenance crews will visit the site in a passenger vehicle or light truck and attend to the fault in question.

Decommissioning of the wind farm will take place at the end of the life of the project, which will be at least 25 years after the commencement of operation. As part of decommissioning wind turbine generators and ancillary electrical infrastructure will be dismantled and removed from the site and hardstand areas reinstated to pasture, however access tracks will remain in place after decommissioning for the use of landowners. As part of the decommissioning process wind turbines will be dismantled from the top down, with components removed from the site and disposed of at appropriately accredited recycling facilities. Wind turbine foundations will remain in place following decommissioning but will be covered with a suitable depth of topsoil to enable agricultural activities to continue in their vicinity. Above ground electrical infrastructure will be dismantled and recycled in a similar fashion to wind turbines. Hardstands associated with both wind turbines and above ground electrical infrastructure will be reinstated to pasture by removing compacted gravel material from the site to an appropriate location either on or off site (as per current EPA regulations at the time) and the excavations backfilled with certified clean fill and then reseeded with pasture grasses. Underground electrical infrastructure will be excavated in a manner similar to its installation and removed from the site to a suitable recycling facility, with former trenches to be backfilled to ground level with certified clean fill. All buildings and storage units associated with the ongoing operation of the wind farm will be dismantled and removed from the site in a similar fashion to wind turbines.

3.2 Impacts on MNES

The environmental impacts of the project includes those that have the potential to occur during construction and commissioning, those that have the potential to occur during operation, and those that have the potential to occur during decommissioning.

3.2.1 Impacts on MNES during construction, commissioning and decommissioning

Direct impacts during construction will be limited to ground disturbance. The project is currently projected to impact on 0.135 hectares of native vegetation to be removed. This comprises a total of 0.022 hectares of native vegetation patches, two Large Scattered Trees and one Small Scattered Tree. This vegetation is not EPBC listed or part of a TEC. These direct impacts to native vegetation will be offset in accordance with relevant Victorian legislation and regulations. Indirect impacts that have the potential to occur during construction are sediment pollution, introduction of noxious weeds, noise pollution, and general disturbance due to increased human activity. These potential impacts will be temporary and limited to the construction period and will be managed via standard planning permit conditions for wind farms in Victoria. Among other things these conditions will require the preparation and endorsement of a Construction Environmental Management Plan and Noise Management Plan prior to the commencement of construction.

Due to the short period of time over which it will take place, the stop-start nature of turbine operation during this time, and the fact that it will be limited to daylight hours, the commissioning process will have a negligible impact on matters of NES.

During the decommissioning phase direct and indirect impacts will be analogous to those that will occur during the construction phase. While it is not possible to know in advance the amount of native flora, vegetation and/or habitat that will have the potential to be impacted at the time of decommissioning, it will be conducted in accordance with the prevailing environmental protection and biodiversity conservation legislation and regulations at the time.

3.3 Site selection and design response

The project site is a highly suitable location for a wind energy facility and was selected for the following reasons:

- It is located in a region of the national electricity network that has capacity available for the connection of an additional wind farm;
- It is located sufficiently close to a proposed point of connection with the national electricity network such that it is commercially viable to connect the wind farm to the network;
- It is located in an area with sufficient setbacks to neighbouring dwellings to ensure potential impacts to community amenity are acceptable;
- It receives undisturbed wind flow with strong consistent winds;
- It is located in an area dedicated to agricultural land uses that are compatible with a wind energy facility;
- It is well served by existing transport infrastructure;
- It is located away from critical infrastructure that is susceptible to interference from wind energy facilities, such as aerodromes and telecommunications facilities;
- It is located away from significant townships, landscapes, tourist destinations and recreation areas;
- It is located away from national parks, state parks, coastal reserves and significant wetlands;
- It is not located in an area with known significant Aboriginal cultural heritage; and
- It is not located in an area with high Aboriginal archaeological potential.

Figure 1: Location of Swansons Lane Wind Farm

Project No: 22316.03
Project: Swansons Lane Wind Farm
Date: 10/02/2025

- Swansons Lane Wind Farm
- Town
- Road
- Waterway
- DEECA mapped wetland
- Parks and Conservation Reserves

N

Kilometers

0 2 4 6

GDA 1994 MGA Zone 54

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4 Description of the impacts (WF operation)

The proposed SLWF requires assessment and approval under the EPBC Act because it is considered likely to have a significant impact on the following two matters of national significance (MNES):

- White-throated Needletail *Hirundapus caudacutus* (WTNT) – Vulnerable, Marine and Migratory
- Southern Bent-wing Bat *Miniopterus orianae bassanii* (SBWB) – Critically Endangered

Therefore, the relevant, predicted and foreseeable impacts on these species are described below.

4.1 White-throated Needletail

The WTNT is a non-breeding migrant to Australia, with birds ranging throughout eastern Australia from summer to early autumn (Higgins 1999). The *Referral guideline for 14 birds listed as migratory species under the EPBC Act* states that 'an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.' An ecologically significant proportion of a population for the White-throated Needletail is listed as 1% for internationally significant or 0.1% for national significance, which the guidelines list as 100 and 10 birds respectively. Since the publication of these guidelines, the population of WTNTs has been estimated at 41,000 as detailed in the Lotus Creek Notification of Approval (EPBC 2022). This more recent estimate indicates that an ecologically significant proportion of the WTNT population is 410 internationally (1.0%) and 41 (0.1%) nationally

According to the report by Ecology and Heritage Partners (EHP 2024), there is no important habitat present for the species within the study area. The Victorian Biodiversity Atlas (VBA) contains two records of WTNTs. These were observed approximately 7 km from the study area boundary in 1960 and 1977. The Atlas of Living Australia (ALA 2024) contains four records, all made prior to 1978. Bird utilisation surveys conducted during a season in which the species is present in Australia did not record WTNTs (EHP 2024).

The EHP (2024) assessment considers WTNT presence to be 'unlikely' at this site, while their turbine collision risk is 'low'. Whilst observations at operating wind farms in south-eastern Australia indicate that WTNTs occasionally collide with wind turbines (Maloney et al. 2019, Symbolix 2020), the five turbines planned for SLWF make it one of the smaller wind farms planned for the region. A lack of any WTNT records on the site and very few records from the region (the most recent almost 50 years ago) combined with the small number of turbines makes the likelihood of WTNT collisions highly unlikely. Whilst WTNT mortalities from collisions are still possible, the likelihood that the wind farm would impact a nationally significant population (41 birds according to more recent population estimates) is even more unlikely. The small size of the wind farm also reduces any cumulative impacts on WTNTs when combined with other projects in the region to negligible levels.

Nature Advisory has assessed the potential impacts on WTNTs in relation to the MNES significant impact criteria for species listed as migratory and vulnerable under the EPBC Act (Tables 1 and 2). Nature Advisory was unable to generate a collision risk model for WTNTs, as the model requires a minimum number of observations. As no observations of WTNTs occurred, the model could not be generated. Without a collision risk model or a meaningful number of observations, predicting the number of mortalities as a result of turbine collisions is impossible. For the assessments in these tables, no separate important population of this highly mobile species can be identified. It is likely their mobility makes the population well mixed over its range. Given this, impacts are assessed on the whole population, rather than an important sub-population.

These tables indicate that the proposed wind farm will not have a significant impact on the WTNT.

Table 1: Summary of the potential impacts of the project on White-throated Needletails in relation to MNES impact Criteria for *migratory* species

Significant impact criterion "An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:" (DoE 2013, p. 15):	Assessment of impacts
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.	The WTNT is predominantly aerial but uses the dense canopies of tall trees or tree hollows to roost (Higgins 1999). The proposed works will not substantially impact important habitat for this species as there is very little roosting or regular foraging habitat on site, which is cleared for farming and lies in a region with few WTNT records. They do not breed in Australia.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.	WTNTs are almost exclusively aerial (Higgins 1999), only leaving the air to roost at night in tall trees and hollows. WTNT contact with any of the invasive species that are present at the project site is therefore minimal. The wind farm site is currently farmland, so it is unlikely that wind farm construction will result in the possible establishment of any harmful invasive species that are not already present. Regardless, the adoption of best-practice environmental management measures during construction and operation of the wind farm (as per Clean Energy Council 2018) will ensure monitoring and adaptive control of any invasive plant or animal species that may establish because of works.

Significant impact criterion "An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:" (DoE 2013, p. 15):	Assessment of impacts
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	WTNTs do not breed in Australia. The wind farm site does not represent important non-breeding habitat for the WTNT. There are very few records of WTNTs from the study area and no habitat present suitable for them to roost in. The proposed wind farm lies at the southernmost reaches of the WTNTs migration route, and as such is unlikely to impede migration. Disruption of feeding through turbine collisions may happen occasionally though evidence suggests that an increased number of turbines equates to a higher likelihood of collision (Nature Advisory data). The current proposal is a windfarm of five turbines, making it one of the smaller wind farms in Vicotria. Whilst predicting the number of turbine collisions at the windfarm is not possible (collisions risk models require a minimum number of observations of the target bird) the number of WTNT collision mortalities is highly unlikely to be greater than the nationally significant proportion (0.1%) of the population, which is 41 individuals (Table 8). Similarly, the wind farms small size greatly reduces any additions to cumulative impacts that similar projects in the region may have to negligible levels. As such the proposed project will not disrupt the life cycle of the White-throated Needletail.

Table 2: Summary of the potential impacts of the project on White-throated Needletails in relation to MNES impact criteria for *vulnerable* species

Significant impact criterion "An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:" (DoE 2013, p. 10)	Assessment	Significant impact likelihood
*Lead to a long-term **decrease** in the size of an important **population***	The White-throated Needletail population is estimated at 41,000 (Garnett and Baker 2021). They are migrants to the region, present from summer to early Autumn. They are highly mobile and the whole population is likely to be spread over its non-breeding range in Australia. A paucity of historical records, zero detections of WTNTs during on-ground surveys and the lack of any suitable, productive/preferred habitat (i.e. forest) in the study area indicated that they are infrequent visitors to the area. The small number of turbines proposed for the site further lowers the probability of collision-related impacts. If collision mortalities do occur, they will be very infrequent and represent a very small portion of the estimated population, very likely less than the 41 individuals required to be a nationally significant proportion of the population.	Unlikely

Significant impact criterion "An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:" (DoE 2013, p. 10)	Assessment	Significant impact likelihood
	Due to the small size of the wind farm (five turbines), its contribution to cumulative impacts is expected to remain minimal. The SLWF will not lead to a long-term decrease in the size of the population of this species.	
***Reduce** the **area of occupancy** of an important population*	The WTNT is largely aerial in Australia only utilising terrestrial habitats to roost, usually in the dense canopies of tall trees. The proposed study area supports highly modified farmland habitat with no suitable roosting sites. There is no evidence that the WTNT utilises the study area in any capacity on a regular basis. The SLWF will not reduce the area of occupancy of the species' population.	Unlikely
***Fragment** an **existing population** into two or more populations*	The WTNT population in Australia is broad-ranging and at low density. A wind farm the size of SLWF represents a tiny proportion of this range. WTNT can continue to forage and move through the study area. THE SLWF will not fragment the existing WTNT population.	Unlikely
*Adversely **affect habitat critical** to the survival of a species*	Defining habitat critical to a wide-ranging, aerial, non-breeding migrant like the WTNT is difficult. Within Australia, habitat critical to the survival of the species is likely limited to roosts such as forested areas with high-reporting rates. There is no evidence that the proposed SLWF site represents critical habitat to the WTNT.	Unlikely
***Disrupt the breeding cycle** of an important population*	The WTNT is a non-breeding migrant to Australia. The SLWF will not disrupt the breeding cycle of the WTNT.	Unlikely
***Modify, destroy, remove, isolate or decrease** the **availability or quality of habitat** to the extent that the species is likely to decline*	The terrestrial habitat of WTNTs in Australia is tall, canopy-dense trees or tree hollows, of which there is very little present at the SLWF site. There is no evidence that WTNTs regularly use the site for foraging activities, but the low number of turbines at the site (five) means that WTNTs will still be able to forage at the site with low risk when the wind farm is operational. The SLWF will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely
*Result in **invasive species** that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat*	The WTNT is largely aerial, only interacting with terrestrial habitats when roosting high-up in trees. They therefore rarely interact with invasive plants or animals. Regardless, the SLWF will be constructed and operated in accordance with a detailed environmental management plan that will include monitoring and adaptive control of weed and pest animal infestations and agricultural and plant diseases.	Unlikely

Significant impact criterion "An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:" (DoE 2013, p. 10)	Assessment	Significant impact likelihood
	It is unlikely that the SLWF will result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.	
Introduce disease *that may cause the species to decline*	The SLWF will be constructed and operated in accordance with a detailed environmental management plan that will include monitoring and adaptive control of weed and pest animal infestations and agricultural and plant diseases. It is unlikely that the SLWF will introduce disease that may cause the species to decline.	Unlikely
Interfere substantially with the recovery *of the species*	The WTNT are summer migrants to the region, only present from summer to early Autumn. A paucity of historical records, zero detections of WTNTs during on-ground surveys and the lack of productive habitat (i.e. forests) on the site indicates that they are infrequent visitors to the area. The site is therefore not likely to be important habitat for the species. The SLWF will not interfere substantially with the recovery of the species.	Unlikely
Overall assessment of likelihood of significant impact		***Unlikely***

4.2 Southern Bent-wing Bat

The Southern Bent-wing Bat (SBWB) is listed as *critically endangered* under the EPBC Act and *critically endangered* under the FFG Act (TSSC 2021). The SBWB has undergone serious population decline since the 1960s (DELWP 2020). Survival rates assessed by van Harten et al. (2022) in 2016–2019 showed lowered seasonal survival during summer (December–February) and autumn for juveniles and lactating females, with the lowest survival rates coinciding with drought in early 2016. Population modelling predicts a continued population decline, the cause of which remains uncertain, though resource limitation due to loss of foraging habitat and drought are suspected as primary causes (DELWP 2020; van Harten et al. 2022).

Increasing turbine collision risk due to the development of wind farms within the species' range is also considered a potential threat (TSSC 2021; van Harten et al. 2022). In line with this, the FFG Action Statement (DEECA 2023) highlights the importance of avoiding wind turbine placement near key roost sites (maternity and non-maternity caves[1]), within critical foraging areas, and along potential flight routes between these locations, where feasible. The proposed SLWF site lies within the potential movement range of SBWB individuals traveling between the Starlight maternity cave near

[1]SBWBs typically gather at maternity caves in late spring and early summer to give birth and raise their young, then disperse in autumn to use non-maternity caves during the cooler months (Churchill, 2008). However, recent research indicates that roost utilisation is more complex than previously thought, with tracking data showing that non-maternity caves can be used year-round, not just as overwintering sites for extended torpor (TSSC, 2021).

Warrnambool (27 km southwest) and the Pomborneit non-maternity cave. However, the site is not adjacent to maternity or non-maternity caves, and intensive seasonal bat detector surveys conducted in the area have recorded very low activity levels (see further details in Section 4.2.1.1). This suggests it is unlikely that significant numbers of SBWB regularly commute through the SLWF site or use it as a key foraging area.

SBWBs typically gather at maternity caves in late spring and early summer to give birth and raise their young, then disperse in autumn to use non-maternity caves during the cooler months (Churchill 2008). However, recent research indicates that roost utilisation is more complex than previously thought, with tracking data showing that non-maternity caves can be used year-round, not just as overwintering sites for extended torpor (TSSC, 2021).

An assessment of this species at the study area was undertaken from 2021–2023 (Nature Advisory 2024a) using roost cave assessment and bat detector surveys, methods consistent with the relevant survey guidelines (see Section 2). Harp-trapping was not used due to a lack of suitable habitat and locations in which to use these effectively.

A desktop review of historical records of SBWB roosting caves within an 80 km radius found 16 potential historical caves but no new roost caves were confirmed (Nature Advisory, 2024a). A ground survey of 15 potential caves did not find any SBWBs. The remaining cave was not surveyed, as per DEECA's request, as the temporal usage of SBWB at this cave was being monitored at the time. This cave is located within 20 – 30 km from the study area.

Bat-detector surveys of the study area were undertaken to detect SBWB presence based on their echolocation calls. These were conducted during four periods over two years: 1) late September to November 2021, 2) seven weeks from early February until late March 2022 (EHP 2022), 3) December 2022 to February 2023 and 4) late February to April 2023 (Nature Advisory 2024a). The survey effort totalled 1,669 bat detector-nights, recording 108 SBWB-definite and 249 SBWB-complex calls recorded at 20 of the 28 sites (Table 3). In Australia, several insectivorous bats cannot be reliably distinguished to species level based on their echolocation pulses (Milne 2002; Pennay et al. 2004).

During Survey 1 (spring 2021), SBWB calls were recorded once at site 5 (Table 3), representing a very low relative activity level of 0.003 calls per bat detector night. Survey 2 (summer – autumn 2022) recorded SBWB calls at a single site (site 3) on three occasions, a relative activity level of 0.012 calls per bat detector night. Survey 3 (summer 2022–2023) identified SBWB calls at all of the 12 bat detector sites (Table 5). The greatest number of manually identified SBWB-definite calls were recorded at Site 10 (six calls), followed by Site 5 and 11 (four calls each; Nature Advisory, 2024a). Survey 4 (autumn 2023) recorded SBWB calls at 16 of the 22 bat detector sites. Of these, the greatest numbers of SBWB-definite calls were recorded at Sites 5 and 6 (14 calls each) and Sites 3 and 8 (10 calls each).

These sites are located in the northern end of the study area, and close to the Blue Gum plantations and linear eucalypt features (windbreaks and roadside vegetation). Calls were also recorded at several sites close to farm dams (Figure 2). These sites are not characteristic of the areas where turbines will be located for the SLWF development, which are mostly cleared paddocks used for agricultural purposes.

Table 3: Southern Bent-wing Bat calls recorded during bat detector surveys at the SLWF.

Survey	Site	SBWB-definite calls	SBWB-complex calls
1. Spring - Summer 2021	1	0	0
	2	0	0
	3	0	0
	4	0	0
	5	1	0
	6	0	0
2. Summer - Autumn 2022	1	0	0
	2	0	0
	3	3	0
	4	0	0
	5	0	0
	6	0	0
3. Summer 2022 - 2023	1	1	8
	2	0	3
	3	0	4
	4	0	21
	5	4	43
	6	0	14
	7	0	4
	8	1	6
	9	1	9
	10	6	24
	11	4	13
	12	2	7
4. Autumn 2023	1	6	7
	2	8	8
	3	10	11
	4	3	8
	5	14	10
	6	14	15
	7	no data	no data
	8	10	6
	9	6	5
	10	1	4
	11	3	2
	12	2	1
	13	0	1
	14	0	1
	15	0	0

Survey	Site	SBWB-definite calls	SBWB-complex calls
	16	0	0
	17	**4**	**8**
	18	0	0
	19	0	0
	20	0	**3**
	21	0	**3**
	22	**4**	0
Totals		**108**	**249**

4.2.1 Potential impacts

Wind farms are one of nine potential threats listed in The National Recovery Plan, which describes potential impacts of the wind industry on the global population of SBWB as follows (Department of Environment, Land, Water and Planning 2020, pp 12-13):

"The impact of the recent proliferation of wind farms within the range of Southern Bent-wing Bats is currently unclear, however, it is possible that any wind farm built close to a Southern Bent-wing Bat significant roosting site could have a major impact on that population. International studies suggest there may be cumulative impacts of wind farms on migratory species in particular, with the impacts greater at particular times of the year and under certain weather conditions (Johnson et al. 2004; Kunz et al. 2007). The risk increases the closer the wind farm is to an important site, particularly a maternity site or migration path. Risks include cave destruction during construction, mortalities due to collisions, and altered access to foraging areas (Kerr and Bonifacio 2009)."

Potential impacts to SBWB at SLWF are outlined below, and an assessment against the MNES significant impact criteria can be found in Table 4. Due to the limited knowledge on SBWB landscape use, flight heights and documented information on SBWB casualties at operational wind farms, it is difficult to predict accurately the direct and cumulative impacts to the species on a local, state or federal scale. In addition, Section 5 outlines the mitigation hierarchy that has been undertaken at SLWF based on current knowledge to mitigate impacts to the SBWB.

4.2.1.1 Direct impacts

Direct impacts to SBWB from SLWF include potential collisions with turbine blades. As of June 2024, Nature Advisory is aware of a total of 28 SBWB mortalities detected during carcass searches at operational wind farms in Victoria that have been reported to DEECA (Table 4).

The investigation described in this report shows that SBWBs were recorded at multiple sites across the study area, particularly close to water bodies and native treed habitats. Consequently, there is a possibility that SBWB could occasionally collide with operational turbines at SLWF.

Table 4: Total Southern Bent-wing Bat mortalities reported to DEECA up to June 2024

Source	Time period	Number of SBWB mortalities
Moloney et al. (2019) and Stark and Muir (2020)	Up to 2018	8
Bennett et al. (2022) - Cape Nelson North Wind Farm	2018 and 2019	3
"DEECA's submission presented to the Mt Fyans Wind Farm Panel on 3 April 2023 (section 6.24.1)"	Not disclosed	3
"DEECA has been notified of 8 SBWB mortalities being found during post-construction monitoring between March to May 2023." Note – one of the 8 carcasses referred to here was previously included in the 3 carcasses documented in DEECA's submission presented to the Mt Fyans Wind Farm Panel on 3 April 2023. Consequently, only 7 SBWB mortalities are listed here.	March to May 2023	7
Five carcasses detected during scent dog searches at two operational wind farms in south-west Victoria. The wind farm operators have provided information on these carcasses to DEECA, but the details have not yet been made public.	Autumn 2024	5
Email correspondence from DEECA in June 2024 states a total of 28 SBWB carcasses reported. Nature Advisory is currently not aware of details of two of these carcasses.	2022-2024	2
	Total	**28**

These mortalities represent actual carcasses found during searches and the estimated mortality would be higher, considering survey effort, scavenger rates and searcher efficiency.

Nature Advisory has investigated SBWB flight heights at numerous wind farm sites in south-western Victoria. Flight heights are determined by pairs of bat detector microphones, one installed on a meteorological tower (met mast) at ~45 m AGL and the other placed at ground level. To date, Nature Advisory has only recorded SBWB calls at ground level and not at 45 m. There are several limitations in recording echolocation calls at height rather than at ground level, such as greater wind noise. Wind may attenuate high-frequency SBWB calls, reducing their likelihood of being recorded. However, similar high-frequency echolocation calls of other species (e.g. Chocolate Wattled Bat, Little Forest Bat, Large Forest Bat) have been recorded consistently at these heights (Nature Advisory 2022). Similar findings have been reported at other wind farm sites. However, although the preliminary evidence supports that SBWBs may not be at risk of collision with turbines at the SLWF, which are proposed to have a minimum RSA height of 64 m AGL, more long-term evidence across multiple wind farms is required to support this.

The SBWB recovery plan (DELWP 2020) reports that at least 50 SBWB roost caves are known. The SLWF study area is located approximately 27 km north-east of Starlight Cave—Victoria's primary SBWB maternity cave. It is 10 km north-east of the non-maternity Panmure Cave, 28 km east of the non-maternity cave at Grassmere, 23 km north-west of the non-maternity cave at Timboon, 40 km west of non-maternity caves at Pomborneit and Porndon Arch, 65 km north-west of the non-maternity cave at Cape Valley, and 69 km east of the non-maternity caves at Yambuk and Deen Maar. Recent research indicates that SBWBs fly up to 85 km (on average 35 km) from caves each night and frequently move between roosts more than 60 km apart (Bush et al. 2022); they can commute up to 72 km between roosting caves in a few hours (van Harten et al. 2022).

There is no published information on SBWB flight speeds, but, based on the commute time between caves (van Harten et al. 2022) they can be assumed to be similar to the congeneric Eastern Bent-wing Bat (EBWB). The EBWB is one of the fastest insectivorous bats in Australia, known to fly at speeds of 40–50 km/h (Bullen et al. 2016). Mills and Pennay (2017) found that EBWBs may travel 20–25 km from a roost cave to foraging sites in 30–40 minutes. Assuming that SBWB and EBWB flight speeds are similar, the timing of calls recorded in Surveys 3 and 4 suggests most SBWBs recorded in the study area could have been roosting as far as 20–30 km away from the SLWF (Nature Advisory 2024a).

Overall, the intensive bat detector surveys of the study area indicate a low level of SBWB activity (0.003–0.18 calls/night; Nature Advisory, 2024a). This suggests that it is unlikely that large numbers of SBWBs commute across the SLWF site, however due to proximity of the study area to roost caves and potential key foraging areas, collisions with turbine blades may be possible.

4.2.1.2 Indirect impacts

As outlined in The National Recovery Plan (Department of Environment, Land, Water and Planning 2020), indirect impacts to SBWB caused by wind farm development and/or operation could include:

- Disturbance to maternity and non-maternity caves.
- Removal or degradation of foraging habitats.

The proposed SLWF is unlikely to have any indirect impacts to SBWB. No known roost caves are present within the study area (Section 6.1); therefore, no caves will be disturbed during construction or operational phases of the wind farm.

The study area has been extensively cleared and is currently used for agriculture, with 97.1% (647.19 ha) of the site comprised of open grazing paddocks with exotic pasture species used for cattle grazing. There is only one small, isolated patch of remnant eucalypt woodland (1.80 ha, 0.27%) present in the east of the study aera. Temporal activity patterns throughout the night observed during this two-year investigation suggest that SBWB are not roosting anywhere within the study area, including in the small patch of woodland. This patch of woodland will not be disturbed during construction or operational phases of the SLWF project. The closest proposed turbine (turbine 5) would be located approximated 700 m away from this woodland patch (Figure 2). Planted eucalypts present within linear strips along roadsides (5.33 ha) and windbreaks (1.80 ha) comprise a combined 1.1% of the site.

A small amount native vegetation would be removed during the construction phase of the project, including the removal of one mature eucalyptus tree from within the study area close to the proposed location of turbine 3. This vegetation removal is unlikely to have any impact on the SBWB population.

4.2.1.3 Cumulative impacts

Although the proposed SLWF only has five turbines, the study area is located within the south-west Victoria renewable energy zone where a number of other wind farms have also been approved. Therefore, cumulative impacts on SBWB remain a risk when combined with impacts from other wind farms within the SBWB range. However, it is anticipated that the mitigation measure proposed below will minimise impact to this species to a level that is considered not significant.

Studies in the Northern Hemisphere have shown that impacts to bats caused by wind farms can be cumulative, particularly for migratory species (Arnett and Baerwald 2013; Kunz et al. 2007). To address this, Moloney et al. (2019) and Stark and Muir (2020) estimated total mortalities using combined values for carcass counts, persistence rate, searcher efficiency, and turbine search percentage. However, due to the small number of SBWB carcasses detected, plus variable factors across sites where carcass searches were conducted, the resulting mortality estimates have very wide confidence intervals. Moloney et al. (2019) emphasise it is not possible to use carcass detections from one wind farm to accurately predict mortality rate at another wind farm without recorded collisions. Currently, there is currently no total collision estimate to quantify industry wide impacts to the SBWB population, which makes it difficult to predict cumulative impacts.

Table 5 provides a summary of potential impacts to SBWB against the MNES significant impact criteria for species listed under the EPBC Act as *critically endangered* or *endangered*. This assessment has concluded that the project is unlikely to lead to a significant impact on the Southern Bent-wing Bat.

Table 5: Impacts on Southern Bent-winged Bats in relation to MNES impact criteria for *critically endangered* or *endangered* species

Significant impact criterion	Assessment of impacts	Significant impact likelihood
Lead to a long-term ***decrease*** *in the size of a* ***population***	During the 2020/21 breeding season, 17,233 – 18,299 SBWBs were estimated to use the Warrnambool maternity cave. In 2020, 1000 – 1500 SBWBs used the Portland maternity cave. In the 2020/21 breeding season, 28,800–35,200 individuals were estimated to be roosting at Bat Cave in Naracoorte, SA (Southern Bent-wing Bat National Recovery Team 2022). While bat detector surveys cannot give an accurate representation of numbers of individuals in an area, the relatively low number of SBWB definite and SBWB-complex calls recorded compared with other high-frequency calling species indicates that it is unlikely that a significant number of SBWB individuals regularly utilise the study area. However, the species has been confirmed to use the study area. Native vegetation within the SLWF study area has been extensively cleared for agricultural purposes, with open grazing paddocks comprising 97.1% of the site. There is only one small patch of native woodland (1.80 ha, 0.27%). There are several small farm dams within open grazing paddocks, but no natural wetlands with emergent vegetation, which is thought to be their preferred wetland habitat (DELWP 2020; Stratman 2005). Very few SBWB-definite or SBWB-complex calls were recorded in open grazing paddocks where turbines will be located. The minimum RSH of the turbines at SLWF will be 64 m AGL. This would be one of the highest minimum RSHs of turbines at a wind farm in south-western Victoria. Analysis of bat mortalities from 21 windfarms in eastern Australia between 2004 – 2024 shows that the observed mortality rate of bats decreases significantly as turbine minimum rotor swept area (RSA) above ground level increases (Nature Advisory 2024b). Nature Advisory have not been made aware of any SBWB mortalities with turbines with a RSH of 40 metres and above. Furthermore, this RSH is approximately twice the minimum RSH of turbines at operational wind farms in Victoria where the majority of SBWB mortalities have been reported. Systematic monitoring and mitigation measures will be deployed, and their effectiveness assessed, during the operational phase at SLWF through implementation of a Bat and Avifauna Management Plan (BAMP; outlined in Section 5). Proposed mitigation measures in response to recorded mortalities during intensive systematic scent dog surveys include: (i) increasing nighttime cut-in speed during periods of increased SBWB activity (spring and autumn), and (ii) testing the efficacy of ultrasonic acoustic deterrents in reducing bat mortalities. A low number of SBWB calls were detected over two years, likely related to the very small amount of potentially suitable habitat (treed areas and water bodies) that is present across the proposed wind farm site. While the proximity of the study area to roost caves and potential key foraging areas may make the likelihood of collisions with turbine blades	Unlikely

Significant impact criterion	Assessment of impacts	Significant impact likelihood
	possible, the avoidance, minimisation and mitigation measures outlined in Section 5 are expected to mitigate these impacts. These measures include micrositing turbines to avoid SBWB habitat, increasing the rotor swept area to 64 m, and a low wind speed cut-in of 4.5 m/s during SBWB active periods. Having regard to the small number of turbines, the comparatively high rotor swept area height above the ground (64 m) and the low bat activity recorded on the site, the risk of a consistent, ongoing impact of a scale leading to a long-term decline in the total population is considered very low.	
***Reduce** the **area of occupancy** of the species*	The proposed wind farm site supports mostly highly modified habitat comprising open grazing paddocks used for agriculture. Bat detector surveys show that SBWBs are present in the study area at very low levels of activity compared to other bat species with high-frequency calls. The proposed turbine locations and associated infrastructure will be primarily located within grazing paddocks with no trees and therefore will not affect areas that could provide foraging or roosting resources to SBWB. Existing land use and vegetation will remain largely unchanged, and no key habitat for SBWB will be removed during construction and therefore the project will not reduce the overall area of occupancy of the species within its geographic range across south-western Victoria.	Unlikely
***Fragment** an existing **population** into two or more populations*	As the project will not entail substantive alterations to existing habitats, there are no effects or mechanisms that might fragment the existing population. Furthermore, there is similar, and in some instances better quality, habitat in the wider landscape surrounding the study area.	Unlikely
*Adversely **affect habitat critical** to the survival of a species*	Habitat critical to the survival of the species includes the three known breeding caves in South Australia (TSSC 2021), Warrnambool and Portland. The closest of these (Starlight Cave) is approximately 27 km away from the SLWF site. Non-maternity caves are also critical habitat for the SBWB, the closest of these are Panmure, (approximately 10 km from the SLWF site), Timboon (~23 km away) Grassmere (~28 km away). There are no other known non-maternity caves closer to the site and no new caves were discovered during cave assessments conducted during this investigation. No known maternity or non-maternity caves would be directly impacted by the construction or operation of the SLWF. Foraging habitat (e.g. woodland, wetlands with emergent vegetation) in proximity to the above-mentioned caves is also critical habitat to SBWB. None of this critical habitat occurs on the proposed SLWF site.	Unlikely
***Disrupt the breeding cycle** of a population*	The proposed SLWF site is located approximately 27 km from the nearest maternity cave (Starlight Cave, near Warrnambool) and about 116 km from the Portland maternity cave. The construction and operation of the proposed SLWF would not have any direct impact on maternity caves, however collisions by bats roosting in the maternity cave during the breeding season are possible, but unlikely after the avoidance, minimisation and mitigation measures outlined in Section 5 are implemented. As outlined above, the likelihood that the numbers of bats affected would disrupt the breeding cycle of bats using the Starlight Cave is considered very low.	Unlikely
***Modify, destroy, remove, isolate or decrease** the*	The proposed SLWF site does not support any SBWB roosting habitat. There is a very small area of treed habitat, mostly in linear planted features, and there are no permanently inundated or ephemeral wetlands with emergent	Unlikely

Significant impact criterion	Assessment of impacts	Significant impact likelihood
availability or quality of habitat *to the extent that the species is likely to decline*	vegetation that could be used for foraging. For this reason, the construction and operation of the proposed SLWF would not decrease the availability or quality of suitable habitat for SBWB in the region and the overall population would not decline as a result.	
Result in ***invasive species*** *that are harmful to an Endangered species becoming established in the endangered species' habitat*	The Project will be constructed and operated in accordance with a detailed environmental management plan that will include monitoring and adaptive control of weed and pest animal infestations and agricultural and plant diseases. It will therefore not result in an outbreak of any invasive species or diseases on the site.	Unlikely
Introduce disease *that may cause the species to decline*	See previous comment.	Unlikely
Interfere with the recovery *of the species*	The site does not constitute important habitat that could contribute to the recovery of this species – there are no known roost caves, only a very small amount of native woodland, and no wetlands with emergent vegetation. The study area will continue to be used for farming, including grazing, and will not be revegetated in a way that might increase suitable SBWB foraging habitat within south-west Victoria. A low number of SBWB were recorded on the site, therefore without mitigation collisions with turbine blades are possible. However, the avoidance, minimisation and mitigation measures outlined in Section 5 are expected to mitigate these impacts. These measures include micrositing turbines to avoid SBWB habitat, increasing the rotor swept area height to 64 m, and a low wind speed cut-in of 4.5 m/s during SBWB active periods. Therefore, the site is not considered critical to the recovery of the species.	Unlikely
Overall significant impact likelihood		**Unlikely**

4.3 Other listed threatened species or communities

4.3.1 Grey-headed Flying-fox

The Grey-Headed Flying-fox is currently listed as vulnerable under the EPBC Act (DCCEEW 2023a) and threatened under the FFG Act (DEECA 2024e). The species occurs in a coastal belt from south of Gladstone in central Queensland to Adelaide in South Australia (Australasian Bat Society 2024). Only a small proportion of the range is in use at any one time, as the species forages according to food availability. As a result, patterns of occurrence and relative abundance vary greatly between places, seasons and years.

The species typically commutes each day between colony sites and foraging areas, usually within 15–20 km of the day roost site (Tidemann 1999). Grey-Headed Flying-foxes have been recorded foraging up to 50 km from their roosting sites. All individuals typically leave the roosting site synchronously at dusk (Parry-Jones and Augee 1992). The species is primarily a canopy-feeding frugivore and nectivore, most commonly utilising rainforests, open forest, and closed and open woodlands.

A census of the Grey-Headed Flying-fox conducted in May 2005 estimated the population at 674,000 individuals (Birt 2005; Eby 2004). This contrasts with a 2004 census, which estimated it to be 425,000. It has been suggested that this large difference could be due to estimation error or higher survivorship of young in 2004 due to greater food availability and reduced culling (Birt 2005). More recent assessments were conducted as part of the National Flying-fox Monitoring Program (CSIRO 2019), which estimated the population to comprise approximately 700,000 individuals.

The VBA contains no records of Grey-headed Flying-foxes within 10 km of the SLWF boundary. However, the Atlas of Living Australia (ALA 2024) contains 27 records, mostly 8–10 km south of the study area. The nearest known roosting camps for the Grey-headed Flying-fox are the Warrnambool (202) camp, approximately 28 km south-west, and the Hexham (1238) camp, approximately 30 km north. Furthermore, SLWF lies within the mapped GHFF distribution (BatMap 2024) and mapped foraging habitat (DEECA 2024).

Therefore, the SLWF may be within the daily home range of Grey-headed Flying-foxes using these camps.

4.3.1.1 Potential impacts

Wind farm developments pose a risk to the species, which is known to collide with turbine blades (Lumsden et al. 2019). Though there is limited published literature on flight altitude for GHFF, several studies have investigated Pteropodidae flight altitude through available aircraft strike data (e.g. Meade et al. 2019, Parsons et al. 2008, McCracken et al. 2021). Parsons et al. (2008) states that the majority (96%) of aircraft strikes occurred at or below approximately 300m with (63.2%) occurring at 152.4 m (2008). The proposed two configurations of two separate wind turbines have an RSA range of 64 m–252 m, aligning with the majority of aircraft strike altitudes reported in the study. Therefore, based on this flight altitude data there is a potential risk for the species to fly within the height range of the proposed wind turbines. It is important to note that there are few historical records of the GHFF in the study area and the development layout has actively placed turbines away from foraging resources. Given there will only be five turbines installed on site, the potential direct impacts to the Grey-headed Flying-fox global population are predicted to be low.

The Recovery Plan does not outline what constitutes an indirect impact to GHFF, however given there is no foraging or roosting habitat within the study area, the overall indirect and cumulative effects to the GHFF are likely to be low.

Table 6 provides a summary of potential impacts to GHFF to the MNES significant impact criteria for species listed under the EPBC Act as *vulnerable*.

Table 6 Assessment of the Grey-headed Flying Fox (GHFF) at the SLWF against MNES impact criteria for *vulnerable* species

Significant impact criterion	Assessment	Significant impact likelihood
*Lead to a long-term **decrease** in the size of an important **population***	GHFF are highly mobile and individuals have the potential to travel >1000 km seasonally and up to 500 km in a 48-hour period (Vanderduys et al. 2024). The study area does not contain suitable habitat for the GHFF and as such is unlikely to support an important population. The wind farm is located between two camps of GHFFs, and there is the potential for the species to occur on site as they travel to each camp. Therefore, there is a collision risk to	Unlikely

Significant impact criterion	Assessment	Significant impact likelihood
	bats transiting the site though losses are likely to be negligible due the GHFF large population size.	
***Reduce** the **area of occupancy** of an important population*	The SLWF does not contain suitable foraging or roosting habitat and the species is not known to roost at this location. Therefore, it is unlikely the proposed action will reduce the area of occupancy of an important population.	Unlikely
***Fragment** an **existing population** into two or more populations*	Several populations occur throughout Victoria and studies suggest that roost membership is not static, and thus represent a node in a network across the landscape (Vanderduys 2024). GHFF can change roosts frequently, and as mentioned above, they can travel tens to hundreds of kilometres in a night. Though the wind farm is located between two known GHFFs camps, due to their movement to and from multiple roosting sites, it is unlikely that the proposed development will further fragment the existing populations.	Unlikely
*Adversely **affect habitat critical** to the survival of a species*	The SLWF does not contain suitable foraging or roosting habitat thus the proposed development will not affect habitat critical to the survival of the species.	Unlikely
***Disrupt the breeding cycle** of an important population*	Roosts constitute the only breeding sites for the species (Mo *et al.* 2024). Though the wind farm is located between two camps of GHFFs, and poses a collision risk to bats transiting to roost caves, it is unlikely to critically disrupt the breeding cycle.	Unlikely
***Modify, destroy, remove, isolate or decrease** the **availability or quality of habitat** to the extent that the species is likely to decline*	The SLWF does not contain suitable foraging or roosting habitat. Hence, the proposed development will unlikely modify, destroy, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely
*Result in **invasive species** that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*	The SLWF does not contain suitable foraging or roosting habitat thus it is unlikely that invasive species that are harmful to the GHFF will establish in the species habitat.	Unlikely
***Introduce disease** that may cause the species to decline*	The SLWF does not contain suitable foraging or roosting habitat. Therefore, the introduction of a disease that may cause the species to decline is unlikely.	Unlikely
***Interfere substantially with the recovery** of the species*	Though there may be some interference with the recovery of the species based on the proposed location of the windfarm, it is unlikely to have a substantial impact with the recovery of the species.	Unlikely
Overall likelihood of significant impact		***Unlikely***

4.3.2 Other Birds

The guidance from DTP included a requirement to assess project impacts on several bird species listed under the EPBC Act. The first step in any impact assessment is an assessment of the likelihood that those species occur in the study area. A likelihood of occurrence has been completed for these bird species (Table 7). This table includes information on the species' habitat preferences, as well as information on the number and date of records in the Victorian Biodiversity Atlas within a 10-km search region around the SLWF. If no suitable habitat exists in the study area, then occurrence is unlikely. Equally, if there have been no recent records in the search region this indicates it is unlikely to occur regularly in the study area, indicating it is unlikely a significant impact will occur.

Based on the information in Table 7, none of these additional species are considered likely to occur in the study area due to a lack of suitable habitat or a lack of recent nearby records. There were no records of these species on the SLWF site during site assessments (EHP 2024). Consequently, it is not considered that they will be significantly impacted by the proposed SLWF.

Post-construction monitoring including carcass searches will be outlined in a Bam Plan (Section 5.2.3). In the unlikely event that a threatened species previously deemed unlikely to occur is observed, or impacts to a threatened species occur, the adaptive Bam plan will address this in the same manner as is outlined for WTNT (section 5.2.3.1)

Table 7 Likelihood of occurrence of listed birds

Species	EPBC	FFG	Nearest record	Habitat	Likelihood of occurrence
Australasian Bittern *Botaurus poiciloptilus*	E	CE	No records within 10 km of study area.	Terrestrial wetlands, including a range of wetland types but prefers permanent water bodies with tall dense vegetation, particularly those dominated by sedges, rush, reeds or cutting grass (Marchant & Higgins 1990).	No suitable habitat within the study area. Unlikely to occur.
Australian Painted Snipe *Rostratula australis*	E, M	CE	No records within 10 km of study area.	Terrestrial wetlands, including a range of wetland types but prefers permanent water bodies with tall dense vegetation, particularly those dominated by sedges, rush, reeds or cutting grass (Marchant & Higgins 1990).	No suitable habitat within the study area. Unlikely to occur.
Blue-winged Parrot *Neophema chrysostoma*	V		No records within 10 km of study area.	Occupies coastal, subcoastal and inland habitats ranging into semi-arid zones. Throughout much of range inhabits grasslands and grassy woodlands and forest (Higgins 1999).	No recent records. Limited suitable habitat. Unlikely to occur.
Common Greenshank *Tringa nebularia*	E		No records within 10 km of study area.	Occupies a variety of freshwater and marine wetlands, including estuaries, sandy or muddy coastal flats, saltmarshes, mangroves, swamps and lakes; also on artificial wetlands, such as sewage farms, dam lakes, saltworks and inundated rice crops; less often on open coast, sometimes along quiet stretches of rivers (Higgins 1999).	No suitable habitat within the study area. Unlikely to occur.
Curlew Sandpiper *Calidris ferruginea*	CE, M	CE	No records within 10 km of study area.	Inhabits a wide range of coastal or inland wetlands with varying levels of salinity; mainly muddy margins or rocky shores of wetlands (Higgins & Davies 1996).	No suitable habitat within the study area. Unlikely to occur.

Species	EPBC	FFG	Nearest record	Habitat	Likelihood of occurrence
Diamond Firetail *Stagonopleura guttata*	V		No records within 10 km of study area.	Commonly found in box-ironbark forests and woodlands and also occurs along watercourses and in farmland areas. Widespread but scattered. Forages on a wide range of seeds, which in some cases a large portion can be derived from weed species (Read 1994). Populations have declined in Victoria since the 1950s (Emison et al. 1987; Tzaros 2005).	No suitable habitat within the study area. Unlikely to occur.
Eastern Curlew *Numenius madagascariensis*	CE, M	CE	No records within 10 km of study area.	Inhabits sheltered coasts, especially estuaries, embayment, harbours, inlets and coastal lagoons with large intertidal mudflats or sandflats, often with beds of sea grass (Higgins & Davies 1996).	No suitable habitat within the study area. Unlikely to occur.
Eastern Hooded Plover *Thinornis cucullatus cucullatus*		V	No records within 10 km of study area.	Inhabits sandy ocean beaches, especially those that are broad and flat, with a wide wave-wash zone for feeding. Widespread and scattered across coastal Victoria. Numbers reduced due to disturbance by recreational activities on beaches (Marchant & Higgins 1993).	No suitable habitat within the study area. Unlikely to occur.
Gang-Gang Cockatoo *Callocephalon fimbriatum*	E	E	No records within 10 km of study area.	In summer generally in tall mountain forests and woodlands, particularly in heavily timbered, mature wet sclerophyll forests and woodlands. Prefer Eucalyptus-dominated assemblages. Also occurs in subalpine snow gum woodlands and occasionally in temperate rainforests and regenerating forests. In winter occur at lower altitudes in drier, more open Eucalyptus woodland (Higgins 1999).	No recent records. Limited suitable habitat. Unlikely to occur.
Latham's Snipe *Gallinago hardwickii*	V		No records within 10 km of study area.	Occurs in variety of permanent or ephemeral freshwater wetlands, generally with dense cover, including meadows, bogs, swamps, edges of creeks and rivers, flooded areas and rice paddies (Higgins 1999).	No suitable habitat within the study area. Unlikely to occur.

Species	EPBC	FFG	Nearest record	Habitat	Likelihood of occurrence
Plains-wanderer *Pedionomus torquatus*	CE	CE	No records within 10 km of study area.	This species is highly sensitive to changes in grassland cover and density. Typically inhabits treeless native grasslands with sparse cover, with a preference for grasslands composed of wallaby grass and spear grass (Marchant & Higgins 1993). Habitat becomes unsuitable when grassland becomes dense (CA 2016). Evidence suggests it avoids areas of tree cover, with no records of the species within 300m of trees (> 10 m high) in their strongholds in New South Wales or Victoria (CA 2016).	No suitable habitat within the study area. Unlikely to occur.
Swift Parrot *Lathamus discolor*	CE	CE	No records within 10 km of study area.	Prefers a select range of eucalypts in Victoria, including Yellow Gum, Grey Box, White Box, Red Ironbark and Yellow Box, as well as River Red-gum when this species supports abundant 'lerp' (Saunders & Tzaros 2011). The species is also known to forage within planted stands of Spotted Gum and Sugar Gum (Nature Advisory; unpublished data). Breeds in Tasmania and migrates to the mainland of Australia for the autumn, winter and early spring months. It lives mostly north of the Great Dividing Range, passing through two areas of Victoria on migration: the Port Phillip district and Gippsland (Emison et al. 1987; Higgins 1999; Kennedy & Tzaros 2005). Though it is also not uncommonly sighted in urban areas (Nature Advisory; unpublished data). Occurrence of this species on the mainland can substantially change from year to year depending on food availability, giving potential for this species to occur almost anywhere throughout its range (Emison et al. 1987).	No suitable habitat within the study area. Unlikely to occur.

5 Avoidance and mitigation measures

Mortalities due to collision with operational turbines at SLWF are possible for SBWBs, but unlikely for WTNT and GHFF. The proponent is developing proactive avoidance, minimisation and mitigation in consultation with DEECA and DCCEEW, ultimately to be documented in an approved Bat and Avifauna Management Plan to be approved before commissioning of the wind farm.

Table 8summarises the proposed avoidance and mitigation plan for SLWF, which includes minimum RSH of 64 m AGL, micro-siting turbines based on habitat quality, and increasing low cut in speeds when SLWF is operational.

Table 8: Summary of measures proposed for SLWF to minimise impacts to SBWB, GHFF and WTNT

Principle	Area	Targeted species	Measure	Section ref.
Pre-construction and construction measures				
Avoid & minimise	Turbine specifications	SBWB	Minimum RSH 64 m AGL.	5.1.1.1
	No new powerlines	WTNT, SBWB and GHFF	Use of existing powerlines underground transmission lines to avoid more infrastructure above ground.	5.1.1.2
	Micro-siting: turbine habitat buffers	SBWB & GHFF	Microsite the proposed turbines to avoid SBWB/GHFF habitat within 260 m of turbines.	5.1.1.3
			Avoid high quality habitat.	
			Avoid areas with high SBWB and SBWB complex calls.	
			Minimise turbine buffer overlays with medium and low-quality SBWB habitat.	
Operational measures				
Mitigate	Increasing low-windspeed cut-in	SBWB	Increasing nighttime low windspeed cut-in to a minimum of 4.5 m/second during periods when SBWB are most actively moving across the landscape (informed curtailment).	5.2.1.1
	Acoustic deterrents	SBWB	Investigate the feasibility of trials.	5.2.1.2
Monitoring, reporting & adaptive management	BAM Plan implementation	WTNT, SBWB and GHFF	Outlines monitoring protocols and responsibilities, trigger responses to a listed species being impacted by the wind farm, and reporting requirements, as well as a toolbox of possible mitigation measures and investigations to refine those.	5.2.3
	Carcass searches	WTNT & SBWB	Monthly searches at 100% of turbines.	
			More intensive surveys during peak SBWB activity.	

Principle	Area	Targeted species	Measure	Section ref.
	Bat detectors	SBWB	Acoustic monitoring to collect further data on temporal activity patterns of SBWB in the study area in response to continued impacts to inform the development of a refined turbine operating regime to minimise collision risk.	
Assess & Offset	Assessment of residual impacts	WTNT & SBWB	Potential for impacts to SBWB, but unlikely for WTNT. If mortality is recorded, enhanced monitoring and mitigation measures will be put in place.	6
	Offsetting	WTNT & SBWB	As residual impacts are not considered likely to be significant, offsets are not required at this stage. Should impacts occur beyond what is anticipated, species-specific adaptive management procedures outlined in the endorsed BAM Plan will be triggered and further avoidance and mitigation measures developed with the goal of preventing significant impacts to WTNT and SBWB.	
Decommissioning measures				
Mitigate	Decommission	WTNT, SBWB and GHFF	No foreseeable impacts during decommissioning.	5.3

These measures are described below.

5.1 Pre-construction and construction measures

Mortalities due to collision with operational turbines at SLWF are possible for SBWB, but unlikely for GHFF and WTNT. The proponent is developing proactive avoidance and mitigation in consultation with DEECA and DCCEEW. It is proposed that if a mortality of threatened species occurs, the mitigation response will be strengthened and enhanced to a level where no additional mortality is expected to occur.

The proponent recognises that managing the risk of bird and bat collisions with turbines requires a multi-faceted approach that is embedded in the avoidance and mitigation hierarchy but also accounts for the known ecology and behaviour of the species, site features relating to available habitat and foraging opportunities, and the influence of weather and season on activity. This approach aims to achieve a balanced outcome that enables wind farm operations whilst minimising, as far as practicable, the risk to SBWB and other threatened species.

5.1.1 Avoid and minimise

5.1.1.1 Turbine specifications

In the most recent annual update, the SBWBRT acknowledge that there could be a relationship between the physical characteristics of newer model turbines and collision risk to SBWB (Southern Bent-wing Bat National Recovery Team 2022):

"Wind turbine characteristics continue to evolve. Newer proposed turbines are typically higher, with longer blades, and set higher off the ground. These features may alter mortality risk to SBWB however this has yet to be quantified."

The minimum height of blade tips for the proposed turbine model at SLWF is 64 m above the ground. The minimum RSH of turbines at the wind farms where SBWB carcasses have been detected are under 40 m above the ground. Given that information on all SBWB mortalities detected to date at operational wind farms have not been made publicly available, it is unknown if the minimum RSH of 40 m incorporates all turbines where mortalities have occurred.

Nature Advisory is currently undertaking analysis of existing monitoring data to investigate how turbine model specifications influence mortality rates for Australian bat species. Mortality data are being sourced from post-commissioning monitoring conducted at more than a dozen operational wind farms in Victoria, ACT and NSW. Preliminary results to date suggest total bat mortality significantly decreases as minimum RSH increases above 40 m AGL. Further, as turbine blades are raised higher above the ground, the number of microbat species impacted decreases, with open-space adapted taxa accounting for most mortalities (Nature Advisory 2024). These findings are similar to those reported from the Northern Hemisphere, where risk of colliding with turbines has been shown to correlate with wing morphology and echolocation frequency (characteristics that are used to group bats into foraging guilds) and the proportion of time that bats from different foraging guilds spend flying high above the canopy at RSA heights (Arnett et al. 2016; Roemer et al. 2019b 2017).

5.1.1.2 No new powerlines

The proposed point of connection with the national electricity grid is located directly adjacent to the site, in the road reserve of the Princes Hwy, meaning no new powerlines will be required. This removes the potential for birds or bats to collide, or be otherwise affected, by additional above ground infrastructure.

5.1.1.3 Turbine-habitat buffers

There are currently no Australian guidelines that prescribe appropriate buffer distances between turbine blade tips and habitat features that are important for insectivorous bats (e.g. treed areas and water bodies) to reduce collision risks to an acceptable level. Therefore, design of the proposed SLWF considered the EUROBATS guidelines where a minimum 200 m buffer is implemented from the nearest habitat feature (woodland, tree lines, hedgerow networks, wetlands, waterbodies and watercourses) to blade-tips (Rodrigues et al. 2015). Using the formula in the EUROBATS guidelines, a 260 m buffer is required to achieve 200 m separation between blade tip and habitat (Nature Advisory 2024a).

The wind turbine layout of the proposed SLWF has been through three revisions. The first revision consisted of seven wind turbines, two of which were close to the two Blue Gum plantations located adjacent to the study area, one of which was within 260 m of a farm dam, and all of which were located within 260 m of planted windbreaks. The second revision consisted of six wind turbines, two of which were within 260 m of the two Blue Gum plantations located adjacent to the site, one of which was located within 260 m of a farm dam, and four of which were located within 260 m of planted windbreaks. The third, and current, revision of the wind turbine layout consists of five wind turbines, one of which is located within 260 m of a Blue Gum plantation and three of which are located within 260 m of planted windbreaks (Figure 2).

With each revision, all reasonable attempts have been made to place wind turbines further than 260 m from as much potential SBWB habitat as possible, with a hierarchy of habitat types adopted where waterbodies were the highest priority, Blue Gum plantations the next most important habitat type, and planted windbreaks the lowest priority. It is for this reason that, of the final turbine locations selected, only one encroaches within 260 m of a Blue Gum plantation, while three encroach within 260 m of planted windbreaks.

The proportion of habitat features present within the SLWF study are shown in Table 9. Open paddocks comprise 97.1% of the total study area. Wooded areas comprise only 2.7% and farm dams the remaining 0.2% of the total area. Despite the small amount of treed habitat present across the extensively cleared study area, it was simply not possible to locate all five wind turbines further than 260 m from habitat edges (particularly planted windbreaks) while also complying with other, similarly important, regulatory requirements pertaining to potential amenity impacts, in particular shadow flicker and noise emissions, plus maintaining the turbine separation distances required for optimal power generation.

Table 9: Extent and percentage of planted, treed vegetation and other habitats within 260 m of each turbine at the SLWF.

Habitat	Amount of habitat within each 260-turbine buffer zone					
	Entire study area	1	2	3	4	5
Open paddock	647.19 (97.1%)	19.30 (90.9%)	21.24 (100%)	20.65 (97.3%)	21.03 (99.0%)	20.71 (97.5%)
Eucalypt windbreak	9.90 (1.5%)	0	0	0.55 (2.6%)	0.21 (1.0%)	0.40 (1.9%)
Roadside vegetation	5.33 (0.8%)	0.80 (3.8%)	0	0	0	0
Pine windbreak	1.23 (0.2%)	0	0	0	0	0.12 (0.6%)
Blue Gum Forestry plantation	0	1.14 (5.4%)	0	0	0	0
Remnant eucalypt woodland	1.80 (0.3%)	0	0	0	0	0
Farm dam	1.31 (0.2%)	0	0	0.04 (0.2%)	0	0

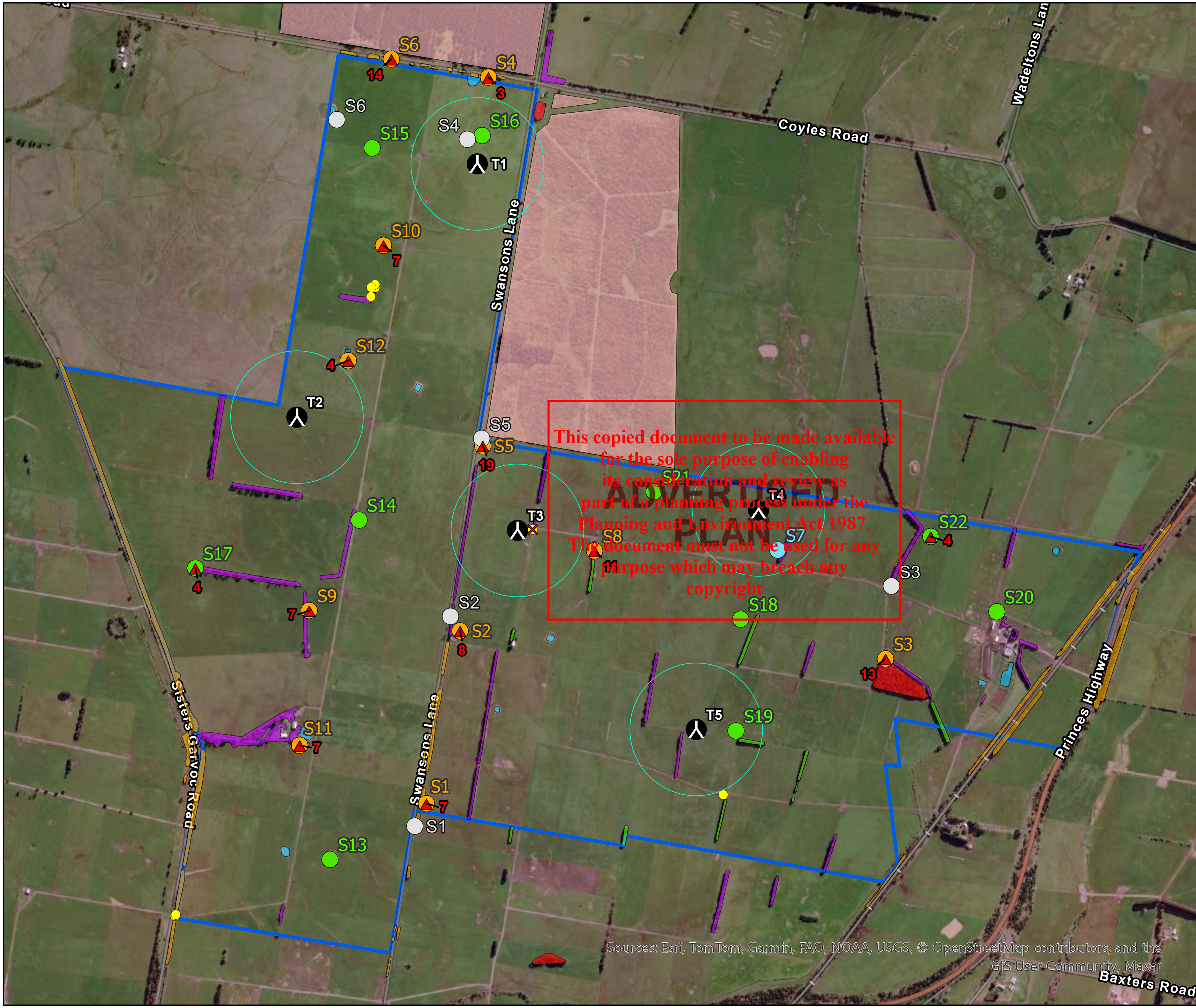

Figure 2a: SLWF turbine buffers, bat detector locations, ecological features and location of SBWB-definite calls

Project No: 22316.03
Project: Swansons Lane Wind Farm
Date: 10/02/2025

Swansons Lane Wind Farm
Wind turbine
SBWB definite call location (labelled with total number of calls)

Bat detectors

EHP: SM4BAT-ZC/Anabat

Bat detectors

NA: SM4BAT-FS
NA: SM4BAT-ZC
NA: MiniBAT-ZC
Turbine buffer (260m radius)
Scattered tree to be removed
Scattered tree (EHP)

Habitat

Eucalypt windbreak
Farm dam
Forestry plantation
Pine windbreak
Remnant native woodland
Roadside vegetation

Meters
0 250 500 750
GDA 1994 MGA Zone 54

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Figure 2b: SLWF turbine buffers, bat detector locations, ecological features and location of SBWB-complex calls

Project No: 22316.03
Project: Swansons Lane Wind Farm
Date: 10/02/2025

Swansons Lane Wind Farm
Wind turbine
SBWB complex call location (labelled with total number of calls)

Bat detectors

EHP: SM4BAT-ZC/Anabat

Bat detectors

NA: SM4BAT-FS
NA: SM4BAT-ZC
NA: MiniBAT-ZC
Turbine buffer (260m radius)
Scattered tree (EHP)
Scattered tree to be removed

Habitat

Eucalypt windbreak
Farm dam
Forestry plantation
Pine windbreak
Remnant native woodland
Roadside vegetation

N
Meters
0 250 500 750
GDA 1994 MGA Zone 54

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5.2 Operational mitigation measures

5.2.1 Mitigation of potential impacts to SBWB

5.2.1.1 Increasing low wind speed cut-in

Low wind-speed curtailment is an approach to mitigate bat mortality at wind farms that involves modifying nighttime turbine operations during periods of elevated risk to bats (Arnett et al. 2011). This is achieved by adjusting turbine blade orientation to align with the wind (known as feathering) and increasing the cut-in speed of the turbines. Feathering involves rotating the blades parallel to the wind to reduce the amount of wind they catch and therefore slow or stop rotation. Increasing the cut-in speed above the manufacturer's specified speed, which is the wind speed at which electricity generation begins, stops blades rotating until a designated, higher wind-speed occurs. Increasing turbine cut-in speed can reduce bat fatalities because bats tend to be less active at higher wind speeds (Arnett et al. 2011; Baerwald et al. 2009).

The effectiveness of nighttime low wind-speed curtailment in significantly reducing mortality among insectivorous bats is recognised on a global scale (Arnett et al. 2016; Lloyd et al. 2023; Whitby et al. 2021). Results from a meta-analysis of bat fatalities at wind energy facilities in the United States showed that, for every 1.0 m/second increase in nighttime cut-in speed, total bat fatalities were reduced by approximately 33% (Whitby et al. 2021).

Only one study has investigated the effectiveness of nighttime low wind-speed curtailment in reducing bat impacts at an operational wind farm in Australia. The study by Bennett et al. (2022) was undertaken in response to SBWB mortalities resulting from collisions with turbines at Cape Nelson North Wind Farm, near Portland, Victoria. Bennett et al. (2022) experimented with implementing seasonal and nightly turbine curtailment during periods of low wind speeds. Turbines were set to start operating at wind speeds of 4.5 m/s, which was a 1.5 m/second increase from the manufacturer's default cut-in speed of 3.0 m/s. This adjustment resulted in a 54% decrease in overall bat mortality. The potential loss in total annual energy generation as a result of applying the increased cut-in speed was estimated to be 0.16%, accompanied by a revenue loss of 0.09% (Bennett et al. 2022). These wind turbines have a minimum RSH of 34 m AGL and are located on the coast approximately 10 km from the maternity cave near Portland.

The project proponent proposes to implement the following low wind speed curtailment regime in order to mitigate the potential risk posed to SBWB by the project. The details of this curtailment regime are as follows:

- Curtailment to consist of increasing the cut-in wind speed for all wind turbines from 3.0 m/s to 4.5 m/s.
- Curtailment to be implemented during spring, summer and autumn (nine months in total).
- Curtailment to commence from the commencement of commercial operation of the wind farm (i.e. following commissioning).
- Curtailment to commence 30 minutes following sunset and extend until 30 minutes before sunrise.

The proponent will commit to this curtailment regime as part of a broader BAM Plan in the view that the curtailment regime will be reviewed at regular intervals, in line with the overarching BAM Plan, and redesigned where warranted in light of intervening developments in scientific research, government policy and alternative mitigation measures, such as acoustic deterrence.

It is estimated that this curtailment regime will result in a reduction in energy generation of 0.25% – 0.50%, however the financial implications of this reduction in generation cannot be accurately predicted prior to the finalisation of contracts pertaining to the sale of electricity.

5.2.1.2 Acoustic deterrents

Ultrasonic acoustic deterrent systems have been proposed as a method to reduce activity of echolocating bats to mediate bat-human conflicts (Zeale et al. 2016), including close to wind turbines. These systems generate ultrasonic sound within the frequency range used by bats that is designed to mask returning echoes from the bat's echolocation signal, forcing them to leave the airspace (Arnett et al. 2013). Findings presented by Weaver et al. (2020) and Good et al. (2022) provide promising evidence that ultrasonic acoustics deterrents can reduce bat collisions, but the effectiveness appears to be species-specific. While this technology has the potential to play a role in impact reduction for at least some bats species, its efficacy for reducing impacts to Australian bats needs to be systemically tested.

In the interests of furthering the understanding of this potential mitigation measure, the project proponent is committed to conducting a feasibility trial of a commercially available acoustic deterrent system. It is acknowledged that as an emerging technology, the application and effectiveness of these devices is largely inconclusive, particularly for Australian bat species. However, it is also recognised that without efficacy trials of available technologies it is impossible to know whether they may yield acceptable results for future use as a formal mitigation measure. Accordingly, the proponent proposes to include a trial of this technology as part of BAM Plan, with continuation of the technique should it prove effective.

5.2.1.3 Other technologies in development or testing

Potential methods for deterring bats from airspace within turbine RSAs include light, radar and sound (Werber et al. 2023). Most technologies in the active deterrent space appear to be in early testing phases, with limited evidence of efficacy when implemented at-scale at operational wind facilities. Consequently, while there are some promising developments, most of these technologies are not yet commercially available as off-the-shelf products ready for use at operational wind farms. These include:

- Electromagnetic radiation produced by marine radar as a deterrent (Gilmour et al. 2020).
- Using drones to disturb wildlife (Kuhlmann et al. 2022; Werber et al. 2023).
- Creating ultrasonic noise by ejecting compressed air from nozzles as a supersonic jet (Romano et al. 2019).
- Attaching passive ultrasonic whistle directly onto turbine blades (Zeng and Sharma, 2023).
- Attaching miniaturised speakers directly onto turbine blades (Cooper et al. 2020).
- Visual deterrents, such as dim ultraviolet light (Gorresen et al. 2015).
- Automated monitoring systems incorporating thermal video, radar and/or echolocation to trigger short-term curtailment when target species are detected approaching a turbine (McClure et al. 2021; Rabie et al. 2022).

The evolution of these emerging technologies may help manage collision risk and residual impacts on threatened species but will require further assessment for their applicability to any emerging problem and as such are not considered as part of this report.

5.2.2 Mitigation of Potential Impacts to WTNT

Species-specific WTNT mitigation measures will be considered as part of the BAM Plan, including but not limited to:

- *Targeted turbine curtailment or temporary shutdown*, including two hours before dawn and two hours after dusk during high risk periods; and
- Smart curtailment systems utilising optical or radar technologies.

These mitigation measures will be implemented in the event that a significant impact trigger is reached for the species, where a significant impact trigger is defined as 0.1% of the population in accordance with the EPBC Act policy statement on listed migratory species and the definition of an important population at a national level (Commonwealth of Australia 2017). Mitigation measures will be defined within a stepwise hierarchical approach to address impact triggers (strikes) as part of the species-specific management strategy for WTNT within the BAM Plan

5.2.3 Monitoring, reporting and adaptive management

5.2.3.1 Overview of BAM Plan

Monitoring, reporting and mitigation measures will be implemented for species of concern through a framework outlined in a Bat and Avifauna Management Plan (BAM Plan). The following listed species will require dedicated management strategies as they are identified as species of concern at SLWF:

- Southern Bent-wing Bat (EPBC: Critically Endangered, FFG: Critically Endangered).
- White-throated Needletail (EPBC Act: Vulnerable & Migratory; FFG Act: Vulnerable).

The species-specific management strategies will follow a hierarchical framework of impact triggers and responses, scaled proportionally to the frequency of mortalities and the conservation status of the species. These strategies will aim to enhance mitigation effectiveness in response to mortality events, with the goal of preventing significant impacts on the population or subpopulation level. Any further mitigation measures for WTNT and SBWB considered by the BAM Plan will be supplementary to those outlined immediately above, including the low wind speed curtailment regime.

The BAM Plan will establish an operational-phase monitoring program that will involve bird utilisation surveys and a carcass detection program. The bird utilisation surveys will monitor the utilisation of the site by birds, including WTNT, once the wind farm becomes operational using fixed-point bird surveys to record flight height, location and flight paths for each observation. The carcass monitoring program will involve regular searches beneath every turbine by scent detection dogs to detect mortalities, including SBWB and WTNT.

The BAM Plan will stipulate species-specific adaptive management strategies in the event that a mortality involving a species of concern is detected. The species-specific management strategies follow a hierarchical framework of impact triggers and responses, scaled proportionally to the frequency of mortalities and the conservation status of the species. These strategies aim to enhance mitigation effectiveness in response to mortality events, with the goal of preventing significant impacts on the population or subpopulation level. These strategies will be finalised as part of the BAM Plan endorsement process.

5.2.3.2 Endorsement and Implementation of BAM Plan

In order to avoid the potential for duplication of conditions of approval under both Commonwealth and State legislation, it is proposed that the BAM Plan is endorsed and reviewed by the Victorian Department of Energy, Environment, and Climate Change, in consultation with the Commonwealth Department of Climate Change, Energy, the Environment and Water.

Under such an arrangement the BAM Plan would be prepared in accordance with a range of standard conditions concerning the preparation and endorsement of BAM Plans in Victoria, including but not limited to the requirement for the BAM Plan to be endorsed prior to the commencement of the permitted use.

Finally, it is proposed that the BAM Plan include an annual or biannual review procedure to ensure that monitoring and mitigation measures are updated in line with intervening developments in scientific research, government policy and mitigation technologies.

5.3 Decommissioning measures

As WTNT, SBWB or GHFF do not roost within the study area the decommissioning process will not result in further removal of any WTNT, SBWB and GHFF roosting habitat. Accordingly, there are no potential impacts predicted from the decommissioning process.

6 Residual impacts

Residual impacts to WTNTs and SBWB at the SLWF are not considered to be significant given the avoidance and mitigation measures outlined above, and the likely efficacy of the measures committed to as part of an approved BAM Plan. Therefore, an offset strategy is not required. However, in the event that residual impacts are greater than predicted, the species-specific adaptive management procedures outlined in the endorsed BAM Plan will be triggered and avoidance and mitigation measures developed with the goal of preventing significant impacts to WTNT, SBWB or any other threatened species detected.

7 Social and economic considerations

7.1 Economic Considerations

The proposed wind farm will not impact surrounding land uses or infrastructure. The proposal is located in an area dominated by agriculture, with major infrastructure in the vicinity including roads, rail, and agroforestry. The landscape of the surrounding area is not a key point destination for tourism or of cultural significance. There are no significant land use conflicts between the proposed facility and surrounding land uses, nor with other major infrastructure of roads, rail and airports. The site is well positioned to take advantage of existing transport and electricity infrastructure, and will not have a detrimental impact on either during operation. Potential impacts through construction will be suitably managed via industry standard management measures.

The proposed facility is located in an area dominated by dairy farming and grazing, is not located in the vicinity of other sensitive agricultural land uses, and will not have a significant impact on the current agricultural productivity of the site. Moreover, by adding a new and drought-proof income stream for the owners of the agricultural properties involved in the wind farm, the proposed use and development of the site will contribute towards the diversification and resilience of agriculture in the state of Victoria.

Further, the proposed wind farm will contribute to the strengthening and diversification of the regional and Victorian economy. Construction of the proposed wind farm will support the Victorian wind industry via the supply and installation of wind turbine generators and ancillary infrastructure, and the Victorian high voltage electrical industry via the supply and installation of high voltage electrical plant and the completion of high voltage line works. Construction of the wind farm will support local manufacturers, heavy industry and small business via the supply of concrete, road building materials, electrical cabling, equipment hire, accommodation, consumables and hospitality services.

Maintenance and operation of the wind farm will contribute to ongoing employment in the Victorian wind industry and high voltage electrical industry, much of which benefits rural townships where personnel are required.

Further, in line with the objectives of the *Community Engagement and Benefit Sharing in Renewable Energy Developments – A Guide for Renewable Energy Developers*, the proposed wind farm will be accompanied by a community benefit scheme. While the details of this scheme will ultimately be determined in consultation with the local community, it will include as a minimum the following measures which will contribute to the diversity and strength of the local economy:

- Annual cash payments to immediate neighbours;
- Subsidies for energy efficiency measures for nearby dwellings;
- An annual fund for support of general community projects; and
- An annual fund for support of local education.

7.2 Social Considerations

To date a number of consultation activities have been undertaken to inform the community of the proposal and give local residents an opportunity to meet face-to-face with a company representative, including:

- The distribution of detailed information packages to all residents located within 5 km of a proposed wind turbine location;

- The launch of a project website; and
- Face-to-face house visits for all dwellings located within 3 km of a wind turbine location, and anywhere else that a house visit is requested.

As part of the planning permit application process, a similar range of consultation activities will be undertaken to further inform the surrounding community of the proposal, including but not limited to the distribution of additional information pamphlets, updates to the project website, further house visits, and community information sessions.

Further, as part of the development process, a community benefit scheme will be developed which will provide direct payments to neighbouring landowners, subsidies for energy efficiency measures, and a fund for community projects and local education.

The impact of the proposal on community amenity will be low and acceptable, as detailed in planning permit application. With only one non-participating dwelling located within 1.5 km of a proposed wind turbine location (at a distance of 1.4 km), the wind farm will comply with the high amenity noise limit of the relevant noise standard (even though it does not apply to the proposal), and will result in no shadow flicker at surrounding dwellings. Further, landscape screening will be provided to owners of non-participating dwellings as part of the development process, further mitigating the amenity impact of the proposal.

8 Environmental record of RE Future Pty Ltd

The applicant is Swansons Lane Wind Farm Pty Ltd, a special purpose project company wholly owned by REF Developments Pty Ltd, the registered business name of which is RE Future. RE Future is an Australian owned and funded enterprise operated by a small group of seasoned wind industry professionals. With over 60 years of combined experience in the wind industry the REF team contains extensive experience in wind farm development. Since 2001 the REF team have worked independently or as partners and successfully developed over 840 MW of wind projects that are now built and operating.

REF Developments Pty Ltd is an Australian owned and funded company which is based out of Geelong Victoria. Neither REF Developments Pty Ltd nor any of its directors have ever been the subject of an investigation, complaint or fine in relation to environmental management practices.

9 Information sources provided in the assessment documentation

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Appendix 1: Summary of literature on mitigation measures for bat impacts of wind farms.

Mitigation method	Citation	Title	Study type	Method investigated	Brief summary
Acoustic deterrent	Weaver et al. (2020) Global Ecology and Conservation, 24, e01099	Ultrasonic acoustic deterrents significantly reduce bat fatalities at wind turbines	Trial at operational wind farm	Ultrasound	Deterrents mounted on the nacelles significantly reduced bat fatalities at a wind farm in US (Texas) for *Lasiurus cinereus* and *Tadarida brasiliensis* by 78% and 54%, respectively. We observed no significant reduction in fatalities for other species in the genus *Lasiurius*.
Acoustic deterrent	Sievert et al. (2021) Report by University of Massachusetts. Report for US Department of Energy. Report No. DE-EE0007032.	A Biomimetic Ultrasonic Whistle for Use as a Bat Deterrent on Wind Turbines	Trial outside wind farms	Ultrasound	Passively activated (blown by the wind) ultrasonic deterrent that is intended to be implemented on turbine blades. The developed deterrent produce ultrasound in the 25-35 kHz, 35-45 kHz, and 45-55 kHz ranges. Researchers played recordings of these sounds to bats in a laboratory setting, and showed that flight paths of Mexican free-tailed bats *Tadarida brasiliensis* were affected, but tricolored bats *Perimyotis subflavus* were not.
Acoustic deterrent	Good, R. E., Iskali, G., Lombardi, J., McDonald, T., Dubridge, K., Azeka, M., & Tredennick, A. (2022) The Journal of Wildlife Management, 86(6), e22244.	Curtailment and acoustic deterrents reduce bat mortality at wind farms	Trial at operational wind farm	Smart curtailment	Tested with curtailment combined with acoustic deterrent. Curtailment alone reduced bat mortality by 42.5%. Curtailment plus deterrent reduced mortality by 66.9% (species dependent, ranging from 58.1% in some species to 94.4% in others.
Acoustic deterrent	Arnett, E. B., Hein, C. D., Schirmacher, M. R., Huso, M. M., & Szewczak, J. M. (2013). PloS One, 8(6), e65794.	Evaluating the Effectiveness of an Ultrasonic Acoustic Deterrent for Reducing Bat Fatalities at Wind Turbines	Trial at operational wind farm	Ultrasound emission	Used waterproof box (~45x45 cm, 0.9 kg) that housed 16 transducers that emitted continuous broadband ultrasound from 20–100 kHz (manufactured by Deaton Engineering, Georgetown, Texas). 21–51% fewer bats were killed per treatment turbine than per control turbine.
Acoustic deterrent	Cooper, D., Green, T., Miller, M., & Rickards, E. (2020). Frontier Wind LLC, Rocklin, CA (United States).	Bat Impact Minimization Technology: An Improved Bat Deterrent for the Full Swept Rotor Area of Any Wind Turbine (No. DE-EE0007034; CEC-500-2020-008)	Trial at operational wind farm	Ultrasound emission	The Strike Free system developed for this project extended the ultrasonic coverage to the entire area swept by the turbine blades, not just the centre of the turbine. Did this by attaching transmitters onto the blades of the turbines. Saw approx. 73.5% less fatalities at turbines with treatment in contrast to control turbines.
Acoustic deterrent	Gilmour, L. R., Holderied, M. W., Pickering, S. P., & Jones, G. (2021). Journal of Experimental Biology, 224(20), jeb242715.	Acoustic deterrents influence foraging activity, flight and echolocation behaviour of free-flying bats	Trial not on wind farm	Ultrasound emission, thermal video	Used stereo thermal videogrammetry and acoustic methods. Filmed bats using two synchronised thermal imaging cameras (Optris PI640 thermal imaging camera). Deaton ultrasonic speakers, emitted ultrasound at a frequency range of 20–100 kHz. Overall bat activity was reduced by 30%.

Mitigation method	Citation	Title	Study type	Method investigated	Brief summary
Acoustic deterrent	Kinzie, K., Hale, A., Bennett, V., Romano, B., Skalski, J., Coppinger, K., & Miller, M. F. (2018). General Electric Co., Schenectady, NY (United States).	Ultrasonic Bat Deterrent Technology (No. DOE-GE-07035)	Trial at operational wind farm	Ultrasound emission, thermal video	Tried different setup but found no statistically significant benefit compared to previously existing systems. Up to 60% bat activity reduction.
Acoustic deterrent	NRG Systems (2021)	Exploring How Attenuation Affects NRG Systems' Bat Deterrent System	Trial at operational wind farm	Ultrasound emission	Investigates attenuation of ultrasound, study showed a 6db loss of sound volume for every doubling of radius. Also showed ultrasound devices performed better with lower humidity and temperature.
Acoustic deterrent	Romano, W. B., Skalski, J. R., Townsend, R. L., Kinzie, K. W., Coppinger, K. D., & Miller, M. F. (2019). Wildlife Society Bulletin, 43(4), 608-618.	Evaluation of an Acoustic Deterrent to Reduce Bat Mortalities at an Illinois Wind Farm	Trial at operational wind farm	Ultrasound emission	29.2% - 32.5% reduction in bat mortality, air jet ultrasonic emitters mounted on turbine nacelles. The deterrent system jets (nozzles) produced a broad-band sound designed to overlap the entire range of frequencies (~30–100 kHz) generated by and audible to most bat species
Acoustic deterrent	Zeng, Z., & Sharma, A. (2023). arXiv preprint arXiv:2302.08037.	Novel ultrasonic bat deterrents based on aerodynamic whistles	Lab	Ultrasound emission	Explores single to six whistle acoustic design outputting 20 Hz - 50 kHz frequency range.
Radar and acoustic deterrent	Gilmour et al. (2020) Plos One, 15(2), e0228668.	Comparing acoustic and radar deterrence methods as mitigation measures to reduce human-bat impacts and conservation conflicts	Trial outside wind farms	Radar and ultrasound	Ultrasonic speakers were effective as bat deterrents at foraging sites, but radar was not. In riparian sites (border of England and Wales), ultrasonic deterrents decreased overall bat activity (filmed on infrared cameras) by ~80% when deployed alone and in combination with radar. Species responded differently to the ultrasound treatments.
Visual and acoustic deterrent	Werber et al. (2023) Remote Sensing in Ecology and Conservation, 9(3), 404-419.	Drone-mounted audio-visual deterrence of bats: implications for reducing aerial wildlife mortality by wind turbines	Trial outside wind farms	Drone	A drone with auditory and visual signals decreases bat activity. Activity decreases significantly (~40%) below and significantly above (~50%) the drone flight altitude at Northern Israel. LIDAR was used to assess the drone impact below its flight altitude and RADAR to assess impact above its flight altitude.
Visual and acoustic deterrent	Kuhlmann, K., Fontaine, A., Brisson-Curadeau, É., Bird, D. M., & Elliott, K. H. (2022). Methods in Ecology and Evolution, 13(4), 842-851.	Miniaturization eliminates detectable impacts of drones on bat activity	Trial at operational wind farm	Drone	Found that smaller UAV models had negligible impact on bat activity, suggest that when employing drones as a deterrent, the size of the drone should be taken into consideration.
Visual deterrent	Cryan et al. (2022) Animals, 12(1), 9.	Influencing activity of bats by dimly lighting wind turbine surfaces with ultraviolet light	Trial at operational wind farm	Ultraviolet light	No significant change in nighttime bat, insect, or bird activity at wind turbines when lit with UV light compared with that of unlit nights (US, Colorado).

Mitigation method	Citation	Title	Study type	Method investigated	Brief summary
Visual deterrent	Gorresen, P. M., Cryan, P. M., Dalton, D. C., Wolf, S., Johnson, J. A., Todd, C. M., & Bonaccorso, F. J. (2015). Endangered Species Research, 28(3), 249-257.	Dim ultraviolet light as a means of deterring activity by the Hawaiian hoary bat *Lasiurus cinereus semotus*	Trial not on wind farm	Ultraviolet light	44% reduction in bat detections in treatments with dim, flickering UV light compared to control, despite increased insect biomass with UV treatment. Duty cycle of flickering was 0.1-5sec, peak wavelength 365nm, spectral spread 10nm, power density of 1 microwatt cm^-2 over circular area of 20m. Hawaii.
Curtailment	Bennett et al. (2022) Austral Ecology, 47(6), 1329-1339.	Curtailment as a successful method for reducing bat mortality at a southern Australian wind farm	Trial at operational wind farm	Low wind-speed curtailment	Increasing turbine cut-in speed from 3.0 to 4.5 ms-1 from dawn to dusk at a southern Australian wind farm significantly reduced bat fatalities by 54%.
Curtailment	Anderson et al. (2022) Facets, 7, 1281-1297.	Effects of turbine height and cut-in speed on bat and swallow fatalities at wind energy facilities	Correlational at operational wind farms	Low wind-speed curtailment	Raising cut-in speeds result in fewer bat fatalities in Canada (Ontario). Turbines under nocturnal mitigation killed 33% fewer bats than turbines without cut-in adjustments in late summer.
Curtailment	Adams et al. (2021) PloS ONE, 16(11), e0256382.	A review of the effectiveness of operational curtailment for reducing bat fatalities at terrestrial wind farms in North America	Trials at operational wind farms	Low wind-speed curtailment	Meta-analysis of experimental studies (n = 36 control-treatment studies from 17 wind farms in US) 63% decrease in fatalities. A non-linear model shows that fatality rates decreased when the difference in curtailment cut-in speeds was 2m/s or larger.
Curtailment	Martin et al. (2017) Journal of Mammalogy, 98(2), 378-385.	Reducing bat fatalities at wind facilities while improving the economic efficiency of operational mitigation	Trial at operational wind farm	Low wind-speed and high T curtailment	Raising cut-in speed of turbines (from 4 to 6 m/s) reduced bat fatalities by 62% (CI 34–78%) at a US wind farm (Vermont). Cut-in speed at 6.0 m/s was always done at T > 9.5 °C, unlike cut-in at 4 m/s (wind speed only).
Curtailment	Baerwald et al. (2009) Journal of Wildlife Management, 73(7), 1077-1081.	A Large-Scale Mitigation Experiment to Reduce Bat Fatalities at Wind Energy Facilities	Trial at operational wind farm	Low wind-speed curtailment and turbine modifications	Increasing turbine cut-in speed from 4.0 to 5.5 m/s resulted in a significant 60% reduction in bat fatalities. Comparing turbines with cut-in speed at 4.0 m/s against turbines with modified angles to reduce rotor speed (blades near motionless in low-wind speeds), resulted in a significant reduction in bat fatalities by 57.5%. Study conducted at a wind farm in Canada (Alberta).

Mitigation method	Citation	Title	Study type	Method investigated	Brief summary
Curtailment	Rnjak et al. (2023) Mammalia, 87(3), 259-270.	Reducing bat mortality at wind farms using site-specific mitigation measures: a case study in the Mediterranean region, Croatia	Trial at operational wind farm	Low wind-speed curtailment	Wind turbine curtailment was implemented in the high collision risk period at a wind farm in Croatia. Estimated total number of bat fatalities decreased by 78% when implementing curtailment from sunset to sunrise at variable turbine cut-in speeds (5.0 - 6.5 m/s).
Curtailment	Whitby, M. D., Schirmacher, M. R., & Frick, W. F. (2021). Bat Conservation International, Austin, Texas.	The State of the Science on Operational Minimization to Reduce Bat Fatality at Wind Energy Facilities. A report submitted to the National Renewable Energy Laboratory.	Trial across multiple wind farms.	Low wind-speed curtailment	33-79% fatality reduction estimate based on 5m/s increase in cut in speed (extrapolated). 0.06-3.2% annual energy production loss.
Curtailment	Rabie, P. A., Welch-Acosta, B., Nasman, K., Schumacher, S., Schueller, S., & Gruver, J. (2022). PloS ONE, 17(4), e0266500.	Efficacy and cost of acoustic-informed and wind speed-only turbine curtailment to reduce bat fatalities at a wind energy facility in Wisconsin	Trial at operational wind farm	Low wind-speed curtailment	Used Turbine Integrated Mortality Reduction (TMIR) system reduced bat fatalities by 75-84%, compared to wind-speed only curtailment (WOC) (47%). Using software and acoustic detection of bats in real time.
Curtailment	Arnett, E. B., Schirmacher, M., Huso, M. M., & Hayes, J. P. (2009). Bat Conservation International. Austin, Texas, USA.	Effectiveness of Changing Wind Turbine Cut-in Speed to Reduce Bat Fatalities at Wind Facilities. An annual report submitted to the Bats and Wind Energy Cooperative	Trial at operational wind farm	Low wind-speed curtailment	Tested curtailment at low wind speeds. Found now difference between cut-in speeds of 5m/s vs 6.5m/s. Fully operation turbines had ~5.2 times as many fatalities as curtailed ones. Pennsylvania, USA.
Curtailment	Arnett, E. B., Huso, M. M., Schirmacher, M. R., & Hayes, J. P. (2011). Frontiers in Ecology and the Environment, 9(4), 209-214.	Altering turbine speed reduces bat mortality at wind-energy facilities	Trial at operational wind farm	Low wind-speed curtailment	Bat mortality 5.4 and 3.6 times that of 2008 & 2009 compared to turbines employing low wind speed curtailment in this study, with less than a 1% loss of power generation annually. Pennsylvania, USA.
Curtailment	Maclaurin, G., Hein, C., Williams, T., Roberts, O., Lantz, E., Buster, G., & Lopez, A. (2022). Wind Energy, 25(9), 1514-1529.	National-scale impacts on wind energy production under curtailment scenarios to reduce bat fatalities	Trial at operational wind farm	Low wind-speed curtailment	Focusses more on implications for annual energy production rather than mitigating bat fatalities. Compares smart curtailment against blanket curtailment, under low, medium and high levels of curtailment. USA.

Mitigation method	Citation	Title	Study type	Method investigated	Brief summary
Curtailment	Măntoiu, D. Ş., Kravchenko, K., Lehnert, L. S., Vlaschenko, A., Moldovan, O. T., Mirea, I. C., & Voigt, C. C. (2020). European Journal of Wildlife Research, 66(3), 1-13.	Wildlife and infrastructure: impact of wind turbines on bats in the Black Sea coast region	Trial at operational wind farm	Low wind-speed curtailment	Found that WT in Romania in migration corridor killed approx. 30 bats/WT/year, curtailment reduced fatality rates by 78%. Used hydrogen stable isotope rations to est. Origin of some bats, came from as far away as Ukraine, Belarus & Russia. Test involved raising cut-in speeds from 4m/s to 6.5m/s, applied during high-risk migration periods.
Curtailment	Smallwood, K. S., & Bell, D. A. (2020). The Journal of Wildlife Management, 84(4), 685-696.	Effects of Wind Turbine Curtailment on Bird and Bat Fatalities	Trial at operational wind farm	Shut down curtailment	Found that curtailment helped reduce bat fatalities significantly but had substantially less effect on reducing bird fatalities. Found that bats were twice as likely to pass through the rotors of operating turbines compared to inoperable ones, suggesting again that some species may be attracted to operating rotors. Findings also suggest that designing turbines without accessible interior spaces could reduce fatalities of cavity-nesting and cavity-roosting birds.
Curtailment	Squires, K. A., Thurber, B. G., Zimmerling, J. R., & Francis, C. M. (2021). Animals, 11(12), 3503.	Timing and Weather Offer Alternative Mitigation Strategies for Lowering Bat Mortality at Wind Energy Facilities in Ontario	Data from operational wind farms	Multiple weather variables for curtailment	Rain and low temperatures saw reduced bat activity and fatalities. Wind conditions, moon illumination, and rain to primarily influence migration flights, while temperature, humidity, air pressure, and rain to influence foraging. Mortality and activity were lower when it rained, highest with above-average temperatures, and declined with wind speed.
Curtailment	Hayes, M. A., Hooton, L. A., Gilland, K. L., Grandgent, C., Smith, R. L., Lindsay, S. R., & Goodrich-Mahoney, J. (2019). Ecological Applications, 29(4), e01881.	A smart curtailment approach for reducing bat fatalities and curtailment time at wind energy facilities	Trial at operational wind farm	Smart curtailment	A new system of tools for analysing bat activity and wind speed data to make near real-time curtailment decisions when bats are detected treatment turbines (N=10) vs. control turbines (N=10) at a US wind farm (Wisconsin). Overall reductions in bat fatalities (~74% to 91% per species). ~3.2% loss in power output, 48% reduction in downtime compared to other USA windfarms using standard curtailment.
Curtailment (Smart)	Matzner, S., Warfel, T., & Hull, R. (2020). Ecological Informatics, 57, 101069.	ThermalTracker-3D: A thermal stereo vision system for quantifying bird and bat activity at offshore wind energy sites	Trial with drone	Smart curtailment	Thermal tracking to predict flight paths of flying animals. Software was able to estimate drone within +-20m of actual position against GPS for 90% of data points.
Curtailment (Smart)	Barré, K., Froidevaux, J. S., Sotillo, A., Roemer, C., & Kerbiriou, C. (2023). Science of the Total Environment, 866, 161404.	Drivers of bat activity at wind turbines advocate for mitigating bat exposure using multicriteria algorithm-based curtailment	Trial at operational wind farm	Smart curtailment	Investigated algorithm controlled curtailment compared to traditional blanket curtailment. Reduces fatal collisions by 7-31% compared to blanket curtailment.

Mitigation method	Citation	Title	Study type	Method investigated	Brief summary
Curtailment (Smart)	Hayes, M. A., Lindsay, S. R., Solick, D. I., & Newman, C. M. (2023). Wildlife Society Bulletin, 47(1), e1399.	Simulating the influences of bat curtailment on power production at wind energy facilities	Trial at operational wind farm	Low wind-speed curtailment and smart curtailment	Focusses more on implications for annual energy production, comparing blanket curtailment to smart curtailment, rather than any impacts on mortality. Energy losses ranged between 0.2 and 1.7% for blanket curtailment, vs 0.0 to 0.9% for smart curtailment. Canada.
Thermal video detection	Georgiev, M., & Zehtindjiev, P. (2022) Wind Europe.	Real-Time Bird Detection and Collision Risk Control in Wind Farms	Trial at operational wind farm	Thermal imaging	Used thermal imaging to detect birds. Testing detection rates of birds, 83.1 to 91.8% correct detection rates. Detection ranges: 60cm wingspan at 350m, 100cm at 600m, 150cm at 1050m.Detection rates of bats looks <10%.