RE Future

Swansons Lane Wind Farm

Application for Planning Permit

Appendix I – Aviation Impact Assessment

May 2025

May 2025

AVIATION IMPACT ASSESSMENT

SWANSONS LANE WIND FARM

Prepared for RE Future (Australia) Pty Ltd

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ACRONYMS

AAAA	Aerial Agricultural Association of Australia
AC	Advisory Circular
AFAC	Australasian Fire and Emergency Services Council
AGL	above ground level
AHD	Australian Height Datum
AIA	aviation impact assessment
AIP	Aeronautical Information Package
AIS	aviation impact statement
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
AS	Australian Standards
AsA	Airservices Australia
ATSB	Australian Transport Safety Bureau
BoM	Bureau of Meteorology
CAO	Civil Aviation Orders
CAR	Civil Aviation Regulation (1988)
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation (1998)
CFIT	controlled flight into terrain
CNS	communications, navigation and surveillance
DAH	Designated Airspace Handbook
EIS	environmental impact statement
ERC-H	en-route chart high
ERC-L	en-route chart low
ERSA	En Route Supplement Australia
GA	general aviation
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions

LGA	local government area
LSALT	lowest safe altitude
MOC	minimum obstacle clearance
MOS	Manual of Standards
MSA	minimum sector altitude
NASAG	National Airports Safeguarding Advisory Group
NASF	National Airports Safeguarding Framework
NDB	non-directional (radio) beacon
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
PSR	primary surveillance radar
RAAF	Royal Australian Air Force
RFDS	Royal Flying Doctor Service
RPT	regular public transport
RSR	route surveillance radar
SSR	secondary surveillance radar
VFR	visual flight rules
VFRG	visual flight rules guide
VMC	visual meteorological conditions
WMTs	wind monitoring towers
WTGs	wind turbine generators

UNITS OF MEASUREMENT

ft	feet	(1 ft = 0.3048 m)
km	kilometres	(1 km = 0.5399 nm)
m	metres	(1 m = 3.281 ft)
nm	nautical miles	(1 nm = 1.852 km)

DEFINITIONS

Definitions of key aviation terms are included in Annexure 2

EXECUTIVE SUMMARY

Introduction

RE Future (Australia) Pty Ltd (RE Future) is proposing to develop the Swansons Lane Wind Farm (the Project), located approximately 32 kilometres (km) northeast of Warrnambool, Vic, and 7.3 km southwest of Terang, Vic.

RE Future has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) to support the proposed development application and formally consult with aviation agencies.

This AIA assesses the potential aviation impacts, provides aviation safety advice in respect of relevant requirements of air safety regulations and procedures, and informs and documents consultation with relevant aviation agencies.

Two models of Wind Turbine Generator (WTG) are being considered for this project:

- Vestas V162 HH150/HH166; and
- Vestas V172 HH150/HH166.

The Vestas V172 has a maximum height of 252 m AGL and is the subject of this assessment. The V162 WTG has a lower maximum height.

This AIA report includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting.

Aviation Impact Assessment

Based on the Project WTG layout and maximum blade tip height of up to 252 m AGL, with the highest WTGs (T1 and T2) at 361 m AHD (1184.4 ft AMSL), the Project:

- would not infringe any OLS surfaces
- would not infringe the PANS-OPS surfaces related to Warrnambool Airport
- would not infringe the Grid LSALT or IFR Route LSALT protection surface
- wake turbulence effects are unlikely to impact on aircraft operating in the vicinity of the Thornton Rd West uncertified aerodrome. The owners of these facilities should be contacted to determine any impacts
- standard circuit heights will not be impacted by the height of the wind turbines within the circuit area of the Thornton Rd West uncertified aerodrome
- would be wholly contained within Class G airspace (outside controlled airspace) and not located within any special use airspace
- would be outside the clearance zones associated with civil aviation navigation aids and communication facilities.

Obstacle lighting risk assessment

Aviation Projects has undertaken a safety risk assessment of the Project and concludes that WTGs and temporary/permanent WMTs that are installed in close proximity to a WTG will not require obstacle lighting to maintain an acceptable level of safety to aircraft.

Temporary WMTs that are installed prior to WTG installation, and WMTs that are not in close proximity to a WTG, will require obstacle lighting to maintain an acceptable level of safety.

Consultation

An appropriate and justified level of consultation will be undertaken with relevant parties after acceptance of the final draft report and authorisation from RE Future.

Refer to Section 5 for details of the stakeholders consulted and a summary of the consultation.

Summary of key recommendations

A summary of the key recommendations of this AIA is set out below.

1. CASR 139.165 requires the owner of a structure (or proponents of a structure) that will be 100 m or more above ground level to inform CASA. This must be given in written notice and contain information on the proposal, the height and location(s) of the object(s) and the proposed timeframe for construction. This is to allow CASA to assess the effect of the structure on aircraft operations and determine whether or not the structure will be hazardous to aircraft operations.
   The proponent is required to report the WMT to CASA in accordance with CASR 139.165, as soon as practicable after forming the intention to construct or erect the proposed object or structure. The notification should be provided to CASA via email to Airspace.Protection@casa.gov.au .
2. Details of the final layout provided for construction of WTGs and WMTs (coordinates and elevation of each) should be provided to Airservices Australia, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com . Ideally this should only be done if potential impacts have been considered – through an aviation impact assessment or by sending the details to Airservices Australia in advance of the mast being erected, at this email address: airport.developments@airservicesaustralia.com .
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office so that a NOTAM can be published until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
   a. The planned operational timeframe and maximum height of the crane; and
   b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
4. Details of the wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations.
5. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs, WMTs and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Operation

6. Whilst not a statutory requirement, the Proponent should consider engaging with any aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project.

Marking of WTGs

7. The rotor blades, nacelle and the mast supporting the WTGs should be painted in a non-reflective shade of white, typical of most WTGs operational in Australia. No additional marking measures are required for WTGs.

Marking of wind monitoring towers

8. Consideration should be given to marking any temporary and permanent WMTs according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D). Specifically:

   a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires

   b. paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast

   c. ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation.

Lighting of WTGs

9. Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.

Lighting of wind monitoring towers

10. Consideration should be given to lighting temporary and permanent WMTs installed prior to WTG installation and WMTs that are not in close proximity (within 900 m) to a WTG, with medium intensity steady red obstacle lighting at the top of the WMT mast. Characteristics for medium-intensity obstacle lighting are contained in MOS 139, Section 9.33.

Micrositing

11. The potential micrositing of the WTGs and WMTs has been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the nominal WTG and WMT positions. Providing the micrositing is within 100 m of the WTGs and WMTs is likely to not result in a change in the maximum overall blade tip height of the Project, no further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Overhead transmission line

12. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial application operators and marked in accordance with Part 139 MOS 2019 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8).

Triggers for review

13. Triggers for review of this risk assessment are provided for consideration:

   a. prior to construction to ensure the regulatory framework has not changed

   b. following any significant changes to the context in which the assessment was prepared, including the regulatory framework

c. following any near miss, incident or accident associated with operations considered in this risk assessment.

1. INTRODUCTION

1.1. Situation

RE Future (Australia) Pty Ltd (RE Future) is proposing to develop the Swansons Lane Wind Farm (the Project), located approximately 32 km northeast of Warrnambool, Vic, and 7.3 km southwest of Terang, Vic.

RE Future has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) to support the proposed development application and formally consult with aviation agencies.

This AIA assesses the potential aviation impacts, provides aviation safety advice in respect of relevant requirements of air safety regulations and procedures, and informs and documents consultation with relevant aviation agencies.

This AIA report includes an Aviation Impact Statement (AIS) for consideration by Airservices Australia and a qualitative risk assessment to determine the need for obstacle lighting.

1.2. Purpose and Scope

The purpose and scope of work is to prepare an AIA for consideration by Airservices Australia, CASA and Department of Defence and support the development application.

The assessment specifically responds to the:

- Victorian Government, Department of Environment, Land Water and Planning, *Development of Wind Energy Facilities in Victoria – Policy and Planning Guidelines* – September 2023
- Civil Aviation Safety Authority
    - *Civil Aviation Safety Regulations 1998* (CASR)
    - Advisory Circular (AC) 91-10 v1.3 *Operations in the vicinity of non-controlled aerodromes*
    - AC 139.E-01 v1.0 *Reporting of Tall Stuctures*
    - AC 139.E-05 v1.1 *Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome*
- NASF Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*
- Aeronautical Impact Statement requirements as advised by Airservices Australia at https://www.airservicesaustralia.com/industry-info/airport-development-assessments/

Assistance will be provided in support of stakeholder consultation and engagement in preparing the assessment and negotiating acceptable mitigation to identified impacts.

1.3. Methodology

Aviation Projects conducted the task in accordance with the following methodology:

1. Confirm the scope and deliverables with the Proponent (or representative)
2. Review client material
3. Review relevant regulatory requirements and information sources
4. Prepare a draft AIA and supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified
5. Prepare an AIS for consideration by Airservices Australia
6. Prepare a qualitative risk assessment to determine need for obstacle lighting and marking
7. Identify risk mitigation strategies that provide an acceptable alternative to night lighting. The risk assessment was completed following the guidelines in *ISO 31000:2018 Risk Management –Guidelines*
8. Consult with relevant Certified Aerodrome Operators, Part 173 procedure designers (Airservices Australia) and aerodrome operators of the affected aerodrome/s to seek endorsement for possible changes to instrument flight procedures to accommodate the wind farm
9. Consult/engage with stakeholders to negotiate acceptable outcomes (if required)
10. Finalise the AIA report for client acceptance when responses received from stakeholders for client review and acceptance.

1.4. Aviation Impact Statement (AIS)

The AIS included in this report (see Section 6) includes the following specific requirements as advised by Airservices Australia:

Aerodromes:

- Specify all certified aerodromes that are located within 30 nm (55.6 km) of the project site
- Nominate all instrument flight procedures
- Nominate visual flight procedures and likely impacts
- Review the potential effect of the Project operations on the operational airspace of the aerodrome(s).

Air Routes:

- Nominate air routes which are located near/over the project site and review potential impacts of Project operations on aircraft using those air routes

Airspace:

- Nominate the airspace classification – A, C, D, E, G etc where the project site is located

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

Material provided by the Proponent for preparation of this assessment include:

- 20230714 SWA WTG REV 6 Final.shp20230412 SWA WTG layout.kml
- 20230719 SWA WTG Locations Rev 6.xlsx
- 20230719 SWA Site Plan Rev 6.pdf.

2. BACKGROUND

2.1. Site overview

The Project site is located approximately 32 km (17.5 nm) northeast of Warrnambool Airport and 7.3 km southwest of Terang in Victoria.

An overview of the Project site is provided in Figure 1 (source: RE Future, Google Earth).

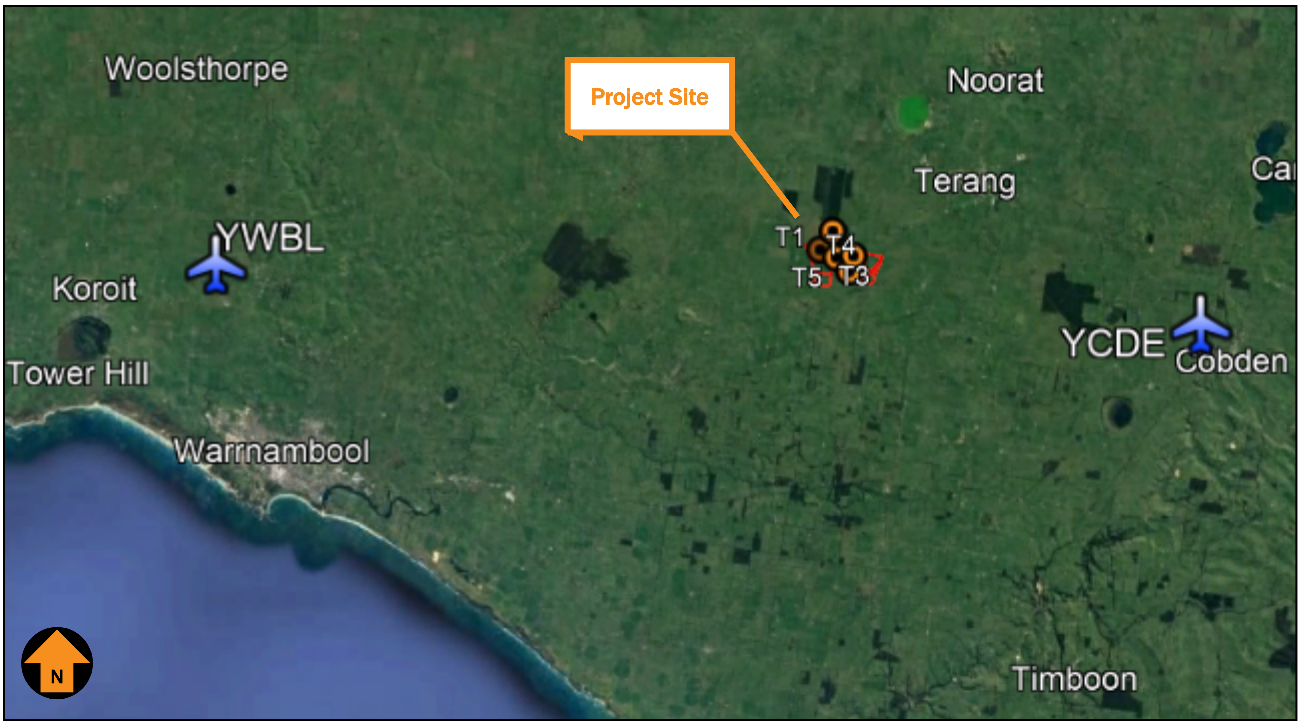

Figure 1 Project site location overview

2.2. Project Description

The Project involves the construction, operation, and maintenance of the Swansons Lane Wind Farm, including a preliminary layout provided in the Scoping Report:

- Up to 5 Wind Turbine Generators (WTG) with:
  - a collective generating capacity of approximately 40 MW
  - three blades mounted to a rotor hub (hub height of 166 m) on a nacelle above a tubular steel tower, with a blade tip height (blade length plus hub height) of up to 252 m above ground level (AGL)
  - a gearbox and generator assembly housed in the nacelle; and
  - adjacent hardstands for use as crane pads, assembly and laydown areas.
- A WMT with a maximum height of 140 m AGL may be included at the location indicated.

- Electrical infrastructure:
  - One (1) electrical substation including control room, transformers, circuit breakers, switches and other ancillary equipment
  - underground electrical reticulation connecting the WTGs to the onsite substation
  - up to 270 m of overhead transmission line, which would form the physical connection between the main substation, and the electricity network along the Princes Highway to the east of the project.

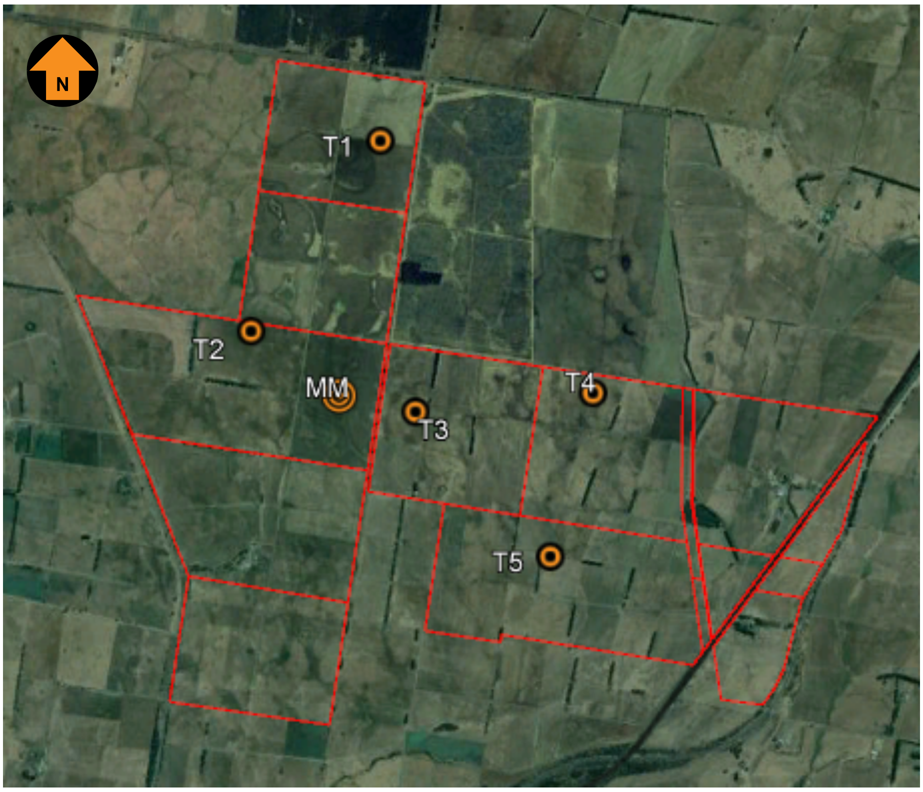

Figure 2 Project layout

3. EXTERNAL CONTEXT

3.1. Victorian Planning Context

The Victorian Government supports the development of the renewable energy sector as an important contributor to the sustainable delivery of Victoria's future energy needs.

The current Department of Transport and Planning (DTP), formerly DELWP, includes the protection of airports and their operations, especially in relation to:

- Aircraft noise
- Protected airspace
- Wildlife strikes
- Lighting distractions to pilots
- Wind turbines
- Building generated windshear/turbulence.

DTP has published a *"Policy and planning guidelines for development of wind energy facilities in Victoria"* dated September 2023 which includes "*Aircraft safety* ".

Section 4.3.5 Aircraft Safety Issues

> *The height of wind energy turbines can be substantial, resulting in potential impacts upon nearby airfields and air safety navigation. Applicants should address aircraft safety issues by considering the proximity of the site to airports, aerodromes, or landing strips.*
>
> *Applicants should consult with the Civil Aviation Safety Authority (CASA) for wind energy facility proposals that:*
>
> - *are within 30 kilometres of a declared aerodrome or airfield*
> - *infringe the obstacle limitation surface around a declared aerodrome*
> - *include a building or structure the top of which will be 110 metres or more above natural ground level (height of a wind turbine is that reached by the tip of the turbine blade when vertical above ground level).*
>
> *Early engagement with aviation safety organisations like CASA is encouraged as aviation safety is a complex area of wind energy facility assessment.*
>
> *In addition to CASA consultation, the following is relevant for anemometers and other pre-permit infrastructure.*
>
> *The Aeronautical Information Service of the Royal Australian Air Force (RAAF AIS) maintains a database of tall structures in the country. The RAAF AIS should be notified of all tall structures meeting the following criteria:*
>
> - *30 metres or more above ground level for structures within 30km of an aerodrome; or*
> - *45 metres or more above ground level for structures located elsewhere.*
>
> *The contact details for the RAAF AIS are: Tel: (03) 9282 5750; ais.charting@defence.gov.au.*

Operators of certified aerodromes are required to notify CASA if they become aware of any development or proposed construction near the aerodrome that is likely to create an obstacle to aviation, or if an object will infringe the Obstacle Limitation Surfaces (OLS) or Procedures for Air Navigation Services –Operations (PANS-OPS) surfaces of an aerodrome. Operators of registered aerodromes should advise CASA if the proposal will infringe the OLS; CASA will ask Airservices to determine if there is an impact on published flight procedures for the aerodrome.

Section 5.1.5 Aircraft Safety

The height of wind energy turbines can be substantial, resulting in potential impacts upon nearby airfields and air safety navigation. A responsible authority should consider the proximity of the site to airports, aerodromes or landing strips, and ensure that any aircraft safety issues are identified and addressed appropriately.

Although the Civil Aviation Safety Authority (CASA) is not a formal referral authority for wind energy facility permit applications, a responsible authority should nevertheless consult with CASA in relation to aircraft safety impacts of a wind energy facility proposal, particularly proposals that:

- *are within 30 kilometres of a declared aerodrome or airfield;*
- *infringe the obstacle limitation surface around a declared aerodrome;*
- *include a building or structure the top of which will be 110 metres or more above natural ground level (height of a wind turbine is that reached by the tip of the turbine blade when vertical above ground level).*

Other private airstrips may not be identified by consultation with CASA. These may be identified using aerial photographs, discussions with the relevant council, or consultation with local communities.

A responsible authority should ensure that the proponent has consulted appropriately with CASA in relation to aircraft safety and navigation issues. It is recommended that the proponent consults and receives approval from CASA prior to lodging their application for ease of process. Refer to Section 4.3.6 of these guidelines for more detail.

CASA may recommend appropriate safeguards to ensure aviation safety. These may include changes to turbine locations, turbine heights and/or the provision of aviation safety lighting. A responsible authority should ensure that any concerns raised by CASA are appropriately reflected in permit conditions.

Aviation safety lighting can have an impact on the amenity of the surrounding area. Responsible authorities may consider the following impact reduction measures (subject to CASA requirements and advice):

- *reducing the number of wind turbines with obstacle lights;*
- *specifying an obstacle light that minimises light intensity at ground level;*
- *specifying an obstacle light that matches light intensity to meteorological visibility;*
- *mitigating light glare from obstacle lighting through measures such as baffling.*

3.2. National Airports Safeguarding Framework

The National Airports Safeguarding Advisory Group (NASAG) was established by Commonwealth Department of Infrastructure and Transport to develop a national land use planning framework called the National Airports Safeguarding Framework (NASF). The purpose of the NASF is to enhance the current and future safety, viability, and growth of aviation operations at Australian airports through:

- the implementation of best practice in relation to land use assessment and decision making in the vicinity of airports
- assurance of community safety and amenity near airports
- better understanding and recognition of aviation safety requirements and aircraft noise impacts in land use and related planning decisions
- the provision of greater certainty and clarity for developers and landowners
- improvements to regulatory certainty and efficiency
- the publication and dissemination of information on best practice in land use and related planning that supports the safe and efficient operation of airports.

NASF Guideline D: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers*, provides guidance to State/Territory and local government decision makers, airport operators and developers of wind farms to jointly address the risk to civil aviation arising from the development, presence and use of wind farms and WMTs.

The methodology for preparing the risk assessment is contained in the NASF Guideline D.

The risk assessment will have regard to all potential aviation activities within the vicinity of the Project site including recreation, commercial, civil (including for agricultural purposes) and military operations.

The AIS of this report identifies high level risks, risk mitigation measures and development constraints that are likely to be applicable to the aviation risk assessment.

3.3. Aircraft operations at non-controlled aerodromes

There are several uncontrolled aerodromes in the vicinity of the Project Area. Advisory Circulars (ACs) provide advice and guidance from CASA to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements.

Advisory Circular (AC) 91-10 v1.1 *Operations in the vicinity of non-controlled aerodromes* provides guidance for pilots flying at or in the vicinity of non-controlled aerodromes, with respect to CASR 91.

A conventional circuit pattern and heights are provided in AC 91-10 v1.1. The standard circuit consists of a series of flight paths known as *legs* when departing, arrival or when conducting circuit practice. Illustrations of the standard aerodrome traffic circuit procedures provided in AC 91-10 v1.1. are shown in Figure 3 and Figure 4.

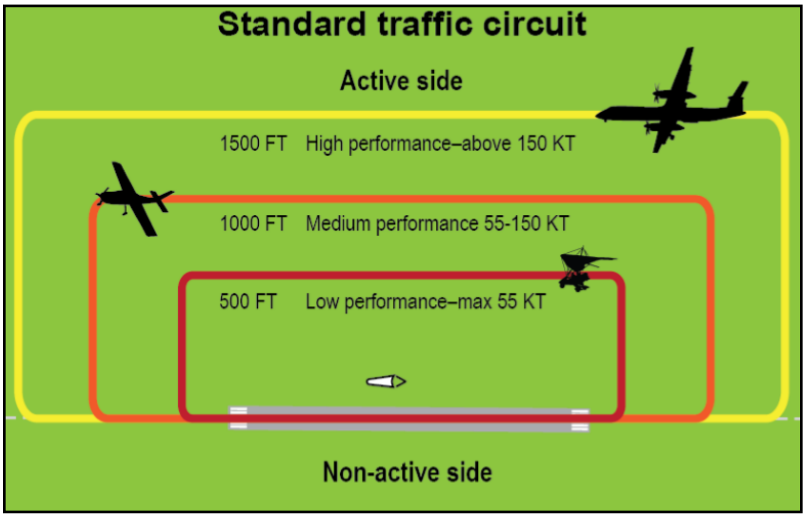

Figure 3 Lateral and vertical separation in the standard aerodrome traffic circuit

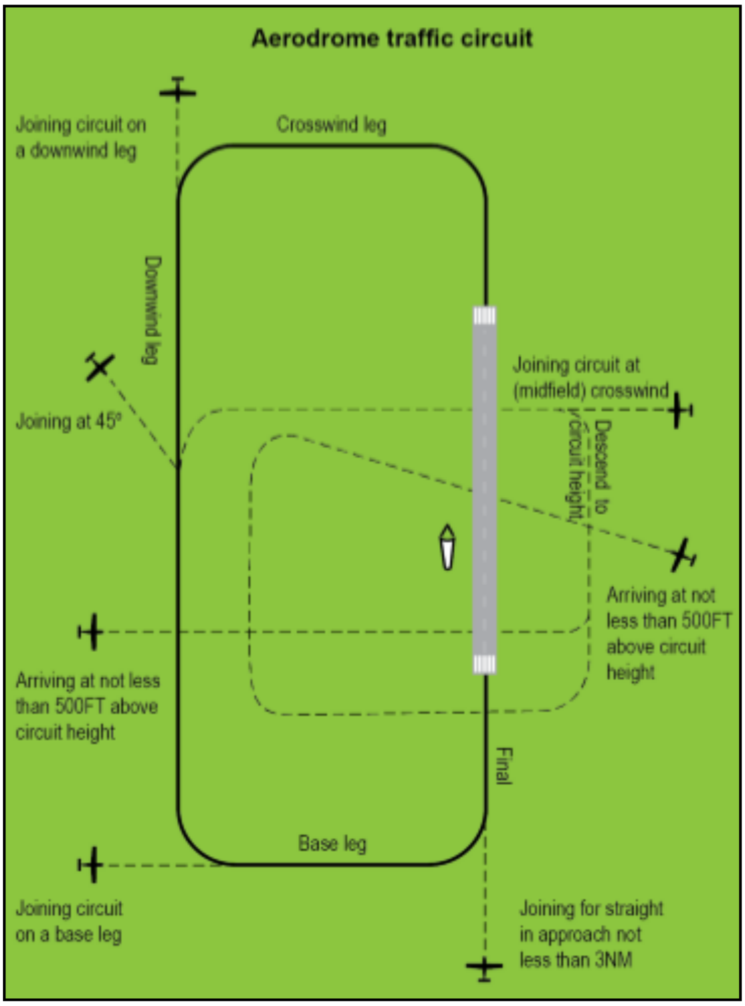

Figure 4 Aerodrome standard traffic circuit, showing arrival and joining procedures

AC 91-10 v1.1. paragraph 7.10 makes reference to a distance that is “normally” well outside the circuit area and where no traffic conflict exists, which is at least 3 nm (5556 m). The paragraph is copied below:

> *7.10 Departing the circuit area*
>
> *7.10.1 Aircraft should depart the aerodrome circuit area by extending one of the standard circuit legs or climbing to depart overhead. However, the aircraft should not execute a turn to fly against the circuit direction unless the aircraft is well outside the circuit area and no traffic conflict exists. This will normally be at least 3 NM from the departure end of the runway, but may be less for aircraft with high climb performance. In all cases, the distance should be based on the pilot’s awareness of traffic and the ability of the aircraft to climb above and clear of the circuit area.*

3.4. Rules of flight

3.4.1. Flight under Day Visual Flight Rules (VFR)

According to Aeronautical Information Publication (AIP) the meteorological conditions required for visual flight in the applicable (Class G) airspace at or below 3000 ft AMSL or 1000 ft AGL whichever is the higher are: 5000 m visibility, clear of clouds and in sight of ground or water.

Civil Aviation Safety Regulation (1998) 91.267 (Minimum height rules—other areas) prescribes the minimum height for flight. Generally speaking, and unless otherwise approved, aircraft are restricted to a minimum height of 500 ft AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas, and 1000 ft AGL over built up areas (within a horizontal radius of 600 m of the point on the ground or water immediately below the aeroplane).

These height restrictions do not apply if through stress of weather or any other unavoidable cause it is essential that a lower height be maintained.

Flight below these height restrictions is also permitted in certain other circumstances.

3.4.2. Night VFR

With respect to flight under the VFR at night, Civil Aviation Safety Regulations (1998) 91.277 requires that the pilot in command of an aircraft flying VFR at night must not fly below the following heights (unless during take-off and landing operations, within 3 nm of an aerodrome, or with an air traffic control clearance):

a) *the published lowest safe altitude for the route or route segment (if any);*

b) *the minimum sector altitude published in the authorised aeronautical information for the flight (if any);*

c) *the lowest safe altitude for the route or route segment;*

d) *1,000 ft above the highest obstacle on the ground or water within 10 nautical miles ahead of, and to either side of, the aircraft at that point on the route or route segment;*

e) *the lowest altitude for the route or route segment calculated in accordance with a method prescribed by the Part 91 Manual of Standards for the purposes of this paragraph.*

3.4.3. Instrument Flight Rules (IFR) (Day or night)

According to CASR Part 91, flight under the instrument flight rules (IFR) requires an aircraft to be operated at a height clear of obstacles that is calculated according to an approved method. Obstacle lights on structures not within the vicinity of an aerodrome are effectively redundant to an aircraft being operated under the IFR due to the minimum obstacle clearance requirement for a flight path above the highest terrain or obstacles within the relevant flight path segment.

3.5. Aircraft operator characteristics

Flying training may be conducted under either the instrument flying rules (IFR) or visual flying rules (VFR). Other general aviation operations under either IFR or VFR are also likely to be conducted at various aerodromes in the area.

Operations conducted under VFR are required to remain in visual meteorological conditions (VMC) (at least 5,000 m horizontal visibility at a similar height of the WTGs) and clear of the highest point of the terrain by 500 ft vertical distance and 300 m horizontal distance.

In Visual Meteorological Conditions (VMC), the WTGs will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. VFR operators will most likely avoid the Project Area once WTGs are erected.

Flight under day VFR is conducted above 500 ft (152.4 m) above the highest point of the terrain within a 300 m radius unless the operation is approved to operate below 500 ft AGL.

It is expected that the WTGs will be easily recognised by pilots conducting VFR operations within the vicinity of the Project to enable appropriate obstacle avoidance manoeuvring.

IFR and Night VFR (which are required to conform to IFR applicable altitude requirements) aircraft operations are addressed in Section 6.

3.6. Passenger transport operations

Scheduled and non-scheduled passenger carrying operations are generally operated under the IFR and are therefore protected by the PANS-OPS surfaces relevant to their flight path.

3.7. Private operations

Private operations are generally conducted under day or night VFR, with some IFR. Flight under day VFR is conducted above 500 ft AGL.

3.8. Military operations

There may be some high-speed low-level military jet aircraft and helicopter operations conducted in the area. Military operations are conducted under separate but compatible regulations and standards, including obstacle separation requirements.

3.9. Aerial application operations

Aerial application operations including such activities as fertiliser, pest and crop spraying are generally conducted under day VFR below 500 ft AGL: usually between 6.5 ft (2 m) and 100 ft (30.5 m) AGL.

Aerial application operations are conducted in the area.

Due to the nature of the operations conducted, aerial application pilots are subject to rigorous training and assessment requirements to obtain and maintain their licence to operate under these conditions.

The Aerial Application Association of Australia (AAAA) has a formal risk management program (which is recommended for use by its members) to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained.

The impact of the proposed WTGs on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the Project site was assessed.

3.10. Aerial Application Association of Australia (AAAA)

In previous consultation with the AAAA, Aviation Projects has been directed to the AAAA Windfarm Policy (dated March 2011), now superseded by the AAAA Tall Structures Policy dated March 2024, which states in part:

> *The development of tall structures in agricultural and bush fire prone areas can pose a direct threat to aviation safety, particularly where fixed and rotary aircraft may be requested to operate for agricultural or bush/grass fire control.*
> *The absence of historical aircraft use in an area is considered an insufficient reason to discount the threat to Aviation Operations.*
>
> *The AAAA will oppose any development application or similar process unless the proponent has:*
> - *Identified the structure as posing a low-level flying risk that needs to be managed on an ongoing basis,*
> - *Consulted honestly and in detail with local aerial application operators or the AAAA where a local operator cannot be identified,*
> - *Consulted with adjoining landowners regarding the impact on adjacent properties,*
> - *Included appropriate lighting and marking in the development proposal, consistent with providing a warning to low level flying,*
> - *Identified the process for advising of the location height and presence of the structure to the relevant authorities, and*
> - *Ensure that the proposal is in keeping with CASA requirements for structures near aerodromes, including temporary landing areas.*

3.11. Local aerial application operators

Aerial application operations including such activities as fertiliser, pest and crop spraying are generally conducted under day VFR below 500 ft AGL: usually between 6.5 ft and 100 ft AGL.

Due to the nature of the operations conducted, aerial agriculture pilots are subject to rigorous training and assessment requirements to obtain and maintain their licence to operate under these conditions.

Aerial application operators generally align their positions with the AAAA policies, and the utilise the AAAA formal risk management programme.

Based on previous studies for other wind farm projects undertaken by Aviation Projects, and the results of consultation with AAAA and local aerial application operators, it is reasonable to conclude that safe aerial application operations would be possible on properties within the Project site and on neighbouring properties, subject to final WTG locations and by implementing recommendations provided in this report at Section 12.

To facilitate the flight planning of aerial application operators, details of the Project, including location and height information of WTGs, wind WMTs and overhead powerlines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

The use of helicopters enables aerial application operations to be conducted in closer proximity to obstacles than would be possible with fixed wing aircraft due to their greater manoeuvrability.

3.12. Aeromedical services

Royal Flying Doctor Service (RFDS) and other emergency services operations are generally conducted under the IFR, except when arriving/departing a destination that is not serviced by instrument approach aids or procedures, in which case they would be operating under day or night VFR.

Most emergency aviation services organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained.

For example, pilots and crew require specific training and approvals, additional equipment is installed in the aircraft, and special procedures are developed.

Refer to Section 5 for detailed responses from emergency service stakeholders.

3.13. Aerial firefighting

Aerial firefighting operations (firebombing in particular) are conducted under Day VFR, often below 500 ft AGL. Under certain conditions visibility may be reduced/limited by smoke/haze.

Aerial firefighting organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained. For example, pilots require specific training and approvals, additional equipment is installed in the aircraft, and special procedures are developed.

The Australasian Fire and Emergency Services Council (AFAC) has developed a national position on wind farms, their development and operations in relation to bushfire prevention, preparedness, response and recovery, set out in the document titled *Wind Farms and Bushfire Operations*, version 3.0, dated 25 October 2018.

Of specific interest in this document is the section extracted verbatim from under the 'Response' heading, copied below:

> *Wind farm operators should be responsible for ensuring that the relevant emergency protocols and plans are properly executed in an emergency event. During an emergency, operators need to react quickly to ensure they can assist and intervene in accordance with their planned procedures.*
>
> *The developer or operator should ensure that:*
>
> - *liaison with the relevant fire and land management agencies is ongoing and effective*
> - *access is available to the wind farm site by emergency services response for on-ground firefighting operations*
> - *wind turbines are shut down immediately during emergency operations – where possible, blades should be stopped in the 'Y' or 'rabbit ear' position, as this positioning allows for the maximum airspace for aircraft to manoeuvre underneath the blades and removes one of the blades as a potential obstacle.*
>
> *Aerial personnel should assess risks posed by aerial obstacles, wake turbulence and moving blades in accordance with routine procedures.*

Aviation Projects considers that it may be impractical to stop and lock the turbine blades in a Y configuration due to the time needed to stop and lock the turbine and the risk to personnel having to climb into the WTG tower as a bush fire approaches. WTG blades can be feathered to effectively stop or reduce the rotation rate of the turbine to a very slow speed.RE Future intends to consult with fire services (aerial and ground) before making any commitment to operational procedures.

4. INTERNAL CONTEXT

4.1. Wind farm site description

The Project site is located approximately 32 km (17.5 nm) northeast of Warrnambool Airport and 7.3 km southwest of Terang in Victoria.

The topography is undulating pastoral land predominantly used for dairy farming and agroforestry.

A site visit was conducted on 13 April 2023. The area is divided into several paddocks of various dimensions, some of which could support aviation activity, but careful consideration of the landing conditions would be required prior to any flight operations. There currently is no flight operations conducted within the boundary, or immediately adjacent to the project site.

Figure 5 shows the typical landscape for the Project site.

Figure 5 Typical landscape for the project site

4.2. Wind turbine generator (WTG) description

The Project site is to comprise of 5 WTGs. The maximum blade tip height of the proposed WTGs will be 252 m above ground level (AGL).

Two models of Wind Turbine Generator (WTG) are being considered for this project:

- Vestas V162 HH150/HH166; and
- Vestas V172 HH150/HH166.

This AIA considers the V172 WTG as the highest under consideration by the proponent.

The ground elevation for the highest WTG (WTGs T1 and T2) is 109 m above mean seal level (AMSL) which, with a 252 m WTG height, results in a maximum overall height of 361 m AMSL (1184.4 ft AMSL).

Figure 6 illustrates the preliminary Project layout identifying the highest WTG. (Source: RE Future, Google Earth).

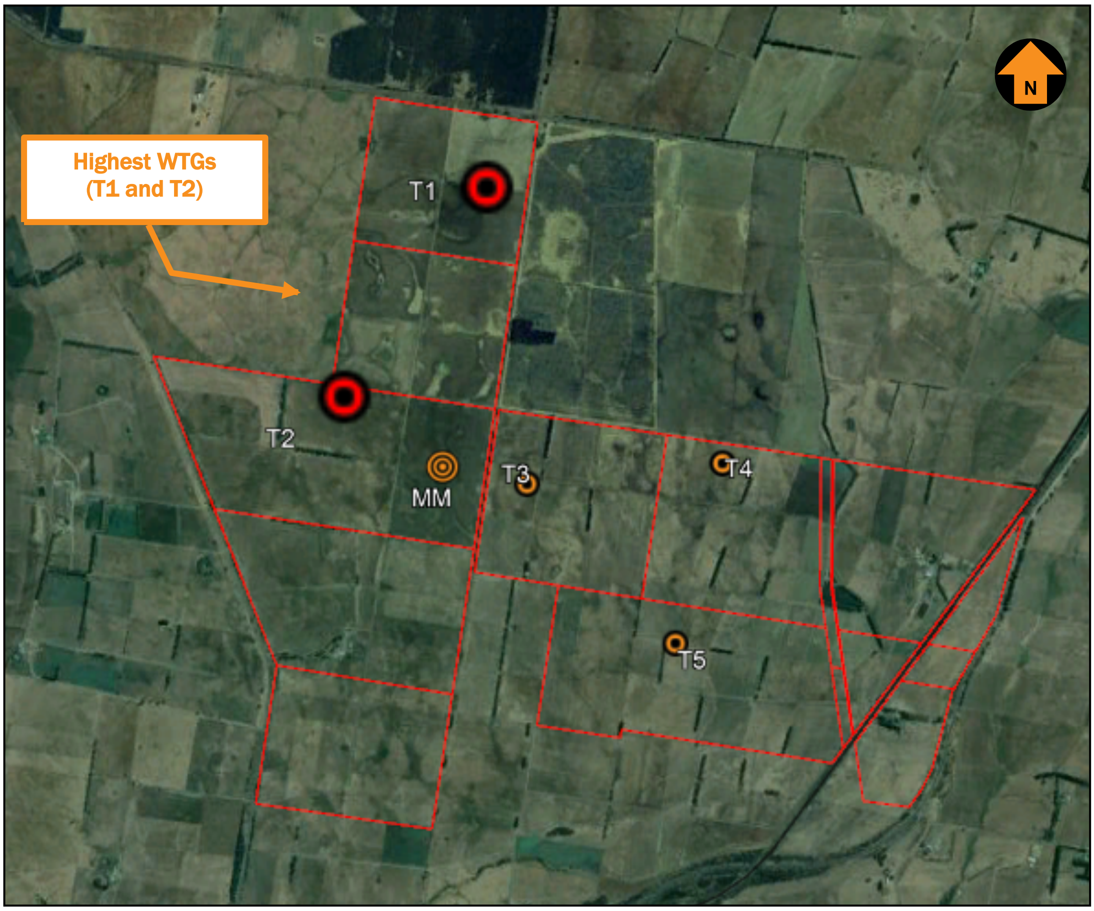

Figure 6 Project layout and highest WTG

The coordinates and ground elevations of the proposed WTGs analysed are listed in Annexure 5.

The potential micrositing of the WTGs has been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the nominal WTG position.

'Micrositing' of WTGs means an alteration to the siting of a WTG by not more than 100 m and any consequential changes to access tracks and internal power cable routes.

The micrositing of the WTGs is not likely to result in a change in the maximum overall blade tip height of the Project. This AIA assumes that a maximum blade tip height of 252 m AGL is implemented at all WTG locations.

4.3. Grid transmission

Electrical infrastructure contained within the Project site as stated in the Scoping Report is proposed to consist of:

- One (1) electrical substation including control room, transformers, circuit breakers, switches and other ancillary equipment

- underground electrical reticulation connecting the WTGs to the onsite substation
- up to 270 m of overhead transmission line, which would form the physical connection between the main substation, and the electricity network along the Princes Highway to the east of the project

The final design and location of the substation and electrical overhead powerline has been determined. Further design work will be undertaken in the EIS phase and will be informed by detailed technical and environmental studies.

5. CONSULTATION

The following list of stakeholders were identified as requiring consultation:

- Airservices Australia
- Department of Defence
- Royal Flying Doctor Service
- Victorian Country Fire Authority
- Victorian Police Airwing
- Ambulance Victoria
- Border Airservices Pty Ltd – Camperdown
- Air Apply Pty Ltd – Warrnambool.

Details and results of the consultation activities will be incorporated into Table 1 once received.

Table 1 Stakeholder consultation details (TBC)

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices Australia	20 May 2025		*Responses not yet received.*	
Department of Defence	20 May 2025		*Responses not yet received.*	
Royal Flying Doctor Service	20 May 2025		*Responses not yet received.*	
VIC CFA	20 May 2025		*Responses not yet received.*	
VIC Police Airwing	20 May 2025		*Responses not yet received.*	
Ambulance Victoria	20 May 2025		*Responses not yet received.*	
Border Air Services Pty Ltd	20 May 2025		*Responses not yet received.*	
Air Apply Pty Ltd	20 May 2025		*Responses not yet received.*	

6. AVIATION IMPACT STATEMENT

6.1. Overview

The NASF Guideline D: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* provides information to proponents and planning authorities to help identify any potential safety risks posed by WTG and wind monitoring installations from an aviation perspective.

Potential safety risks include (but are not limited to) impacts on flight procedures and aviation communications, navigation, and surveillance (CNS) facilities which require assessment by Airservices Australia.

To facilitate these assessments all wind farm proposals submitted to Airservices Australia must include an Aviation Impact Statement (AIS).

This analysis considers the aeronautical impact of the WTGs on the following:

- The operation of nearby certified aerodromes
- The operation of nearby aircraft landing areas (uncertified aerodromes)
- Grid and air route LSALTS
- Airspace protection
- Aviation facilities
- Radar installations
- Local aircraft operations.

6.2. Nearby certified aerodromes

The area of 30 nm (56 km) from a certified airport's aerodrome reference point (ARP) is used to identify possible constraints from the Project.

There are two certified airports within 30 nm of the Project site:

- Warrnambool Airport (YWBL) located approximately 17.5 nm to the southwest of the Project's boundary
- Peterborough/Great Ocean Road Airport (YPBH) located approximately 19.7 nm to the south of the Project's boundary.

The locations of the certified airports are shown in Figure 7 (source: RE Future, OzRunways).

Figure 7 Warrnambool and Peterborough Airports within 30 nm of the Project site

6.3. Warrnambool Airport

Warrnambool Airport (YWBL) is a certified aerodrome, which is operated by the Warrnambool City Council.

It is provided with instrument approach procedures that are published in the AIP.

6.3.1. Instrument Approach Procedures

A check of Aeronautical Information Package (AIP) via the Airservices Australia website showed that Warrnambool Airport is served by non-precision instrument flight procedures (source: AsA, effective 12 June 2025).

Table 2 identifies the aerodrome and procedure charts for Warrnambool Airport, designed by Airservices Australia (AsA) as indicated.

Table 2 Warrnambool Airport (YSWH) aerodrome and procedure charts

Chart name	Effective date
Aerodrome Chart	7 September 2023 (Am 176)
RNP RWY 13	20 March 2025 (Am 182)
RNP RWY 31	20 March 2025 (Am 182)

25 nm Minimum Safe Altitude

A minimum safe altitude (MSA) is applicable for each instrument approach procedure at Warrnambool Airport.

The 25 nm MSA determines the altitude that all instrument approach procedures commence from and therefore the descent gradient applicable to each procedure.

An image of the MSA published for Warrnambool Airport is shown in Figure 8 (source: AIP 12 June 2025).

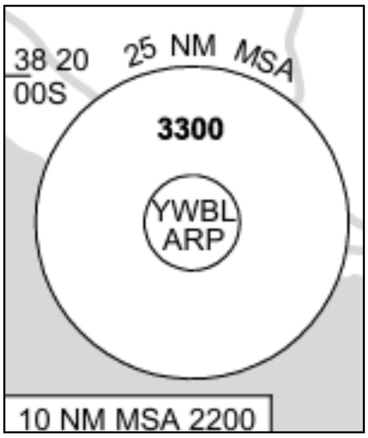

Figure 8 Warrnambool MSA diagram

International Civil Aviation Organisation (ICAO) and the CASR Part 173 Manual of Standards describes the design criteria applicable to instrument approach procedures, requires that a minimum obstacle clearance (MOC) of 984 ft above the highest obstacle within the protection area is applied.

Obstacles within the 10 nm MSA (within 15 nm of the reference point) and within the 25 nm MSA (within 30 nm of the reference point) define the lowest height at which an IFR aircraft can fly when within 10 nm and 25 nm when visual reference to the airport and local terrain has not been established.

The proposed Project is located within the 25 nm MSA limits (30 nm). The MSA of 3300 ft AMSL has a PANS-OPS surface elevation of 2316 ft AMSL (701 m AHD). (See Figure 9)

The maximum height of the WTGs is 1181.4 ft AMSL (361 m AHD).

This is lower than the PANS-OPS surface and therefore the project does not impact the 25 nm MSA minimum altitude.

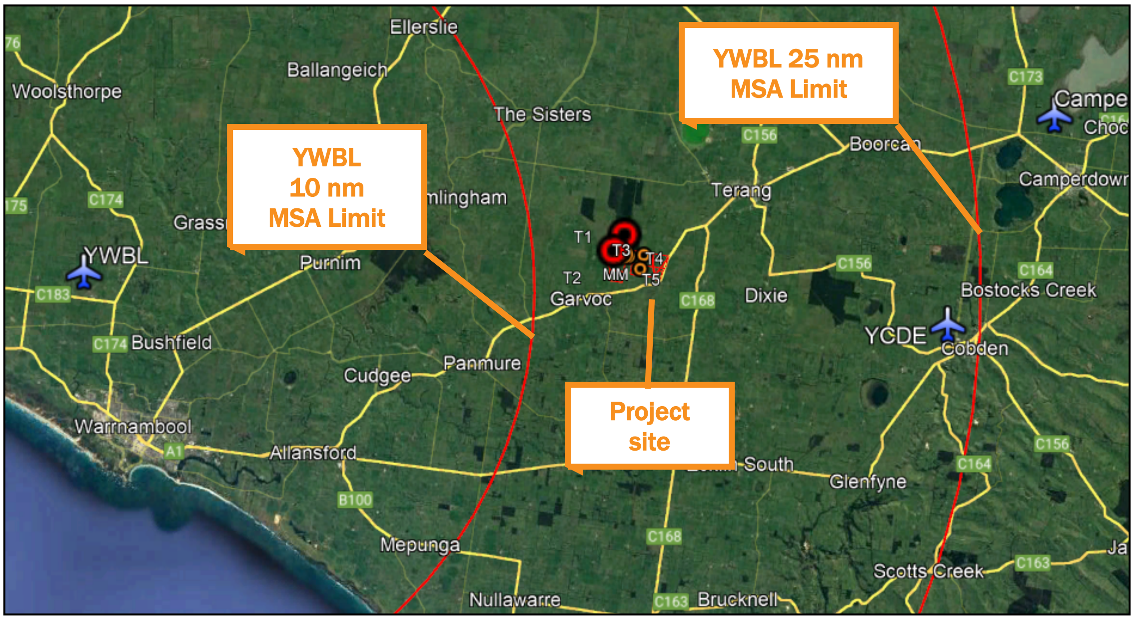

Figure 9 Location within 25 nm MSA limits

Circling Areas

Warrnambool Airport is capable of accepting aircraft operations up to Performance Category C aircraft such as large turbo-prop aircraft such as Dash-8 and ATR airliners.

The maximum horizontal distance that the Category C circling area may extend for an aerodrome in Australia is 4.2 nm (7.85 km) from the threshold of each usable runway.

The entire project is located outside the horizontal extent of the IFR circling areas at Warrnambool Airport.

The circling areas are not infringed.

Instrument Approach Procedures

All instrument approach procedures commence approximately 15 nm from the airport.

The instrument approach procedures flight paths are not located over any part of the proposed wind farm.

6.3.2. Summary

The Swansons Lane Wind Farm project will not infringe any PANS-OPS surface associated with instrument flight procedures at Warrnambool Airport.

6.3.3. OLS

OLS are established for each runway. They are based on the runway code.

Warrnambool Airport's Runway 13/31 are designated as code 3 non-precision instrument approach runways.

For the Code 3 non-precision instrument runway at Warrnambool Airport, the maximum lateral extent of some segments of the OLS is up to 15 km from a runway.

The Project site is located beyond the horizontal extent of the OLS. Therefore, the Project site will not impact the Warrnambool Airport OLS.

6.4. Peterborough/Great Ocean Road Airport

Peterborough/Great Ocean Road airport is a certified aerodrome, which is operated by Glenample Air Pty Ltd.

It is not provided with instrument approach procedures.

It is primarily used for scenic flights along the Great Ocean Road and for parachuting operations within 2 nm of the airport.

6.4.1. OLS

OLS are established for each runway.

Peterborough/Great Ocean Road Airport has Code 1 non-instrument runways with OLS extending to 1600 m from a runway end.

The Project site is located beyond the horizontal extent of the OLS. Therefore, the Project site will not impact the Peterborough/Great Ocean Road Airport OLS.

6.5. Nearby uncertified aerodromes

An area of 3 nm (5.6 km) radius of an uncertified aerodrome is used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the uncertified aerodrome.

Uncertified aerodromes can be anything from a properly organised and recognisable aerodrome to a cut strip of grass in a paddock on a property that is suitable for the aircraft using it.

A search of Airservices Australia (AIP), Ozrunways Electronic Flight Bag software program and the Australian Government National Map website did not identify any uncertified aerodrome within 3nm from the Project site. The aeronautical data provided by OzRunways is approved under CASR Part 175.

The project is located in both the Corangamite Shire Council and the Moyne Shire Council (the LGA boundary runs up the middle of the site.

Uncertified aerodromes in the vicinity of the Project site are shown in Figure 10 (source: OzRunways, National Map, RE Future, Google Earth).

Figure 10 Uncertified aerodromes in the vicinity of the Project site

Several uncertified aerodromes are located in the region surrounding the project.

The closest uncertified aerodrome is located at 155 Thornton Road, Dixie, approximately 5.1 nm (9.5 km) from the nearest WTG, T6.

6.5.1. Summary

No uncertified aerodromes are located within 3 nm of any WTG.

6.6. Grid and Air routes LSALT

CASR Part 173 MOS requires that the published LSALT, for a particular airspace grid or air route, provides a minimum of 1000 ft clearance above the controlling (highest) obstacle within the relevant airspace grid or air route tolerances.

6.6.1. Grid LSALT

The Project site located within a grid with LSALT of 2500 ft AMSL which provide clearance above obstacles with heights up to 1500 ft AMSL.

The highest WTGs, at a maximum height of 1184.4 ft AMSL does not infringe the Grid LSALT protection surface.

Figure 11 shows the Grid LSALT and air route W635 with its LSALT of 2500 ft.

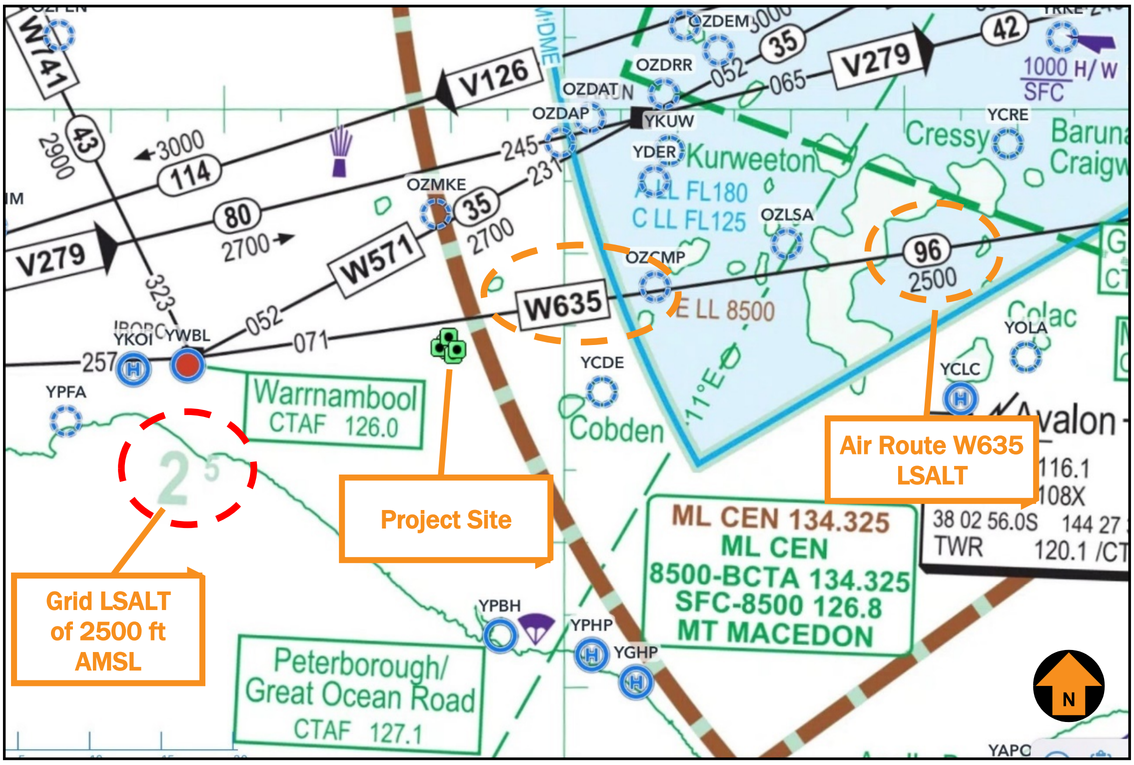

Figure 11 Grid LSALTs in proximity to the Project site

6.6.2. Air Route LSALTs

A protection area of approximately 7 nm laterally either side of an air route is used to assess the LSALT for the air route.

There is one air routes with a protection surface above the wind farm site the Project Site, W635 from Warrnambool to Avalon. It has a LSALT of 2500 ft AMSL and a protection surface of 1500 ft AMSL, as shown in Figure 11 below (source: ERC Low Tasmania, OzRunways, 6 May 2025).

An impact analysis of the surrounding air routes is provided in Table 3.

Table 3 Air route impact analysis

Air route	*Waypoint pair*	*Route LSALT*	*Obstacle Height Limit*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
W635	YWBL to YMAV	2500 ft AMSL	1500 ft AMSL	Nil	N/A	Nil

With a maximum height of 1184.4 ft, the WTGs are lower than the W762 obstacle height limit.

The project will not impact the Grid LSALT or air route LSALTs.

6.7. Airspace Protection

The Project area is located outside of controlled airspace (wholly within Class G airspace) and are not located in any Prohibited, Restricted and Danger areas.

Therefore, the Project area will not have an impact on controlled or designated airspace.

6.8. Aviation navigation and communication facilities

The Project area is located sufficient distance away from nearby aviation navigation aids and communications facilities and will not have an impact on the aviation facilities.

6.9. ATC Radar installations

The closest ATC radar facility to the Project site is the Mt Macedon Secondary Surveillance Radar (SSR), which is located approximately 98 nm/181 km to the northeast.

The Project site is outside the line of sight of the Mt Macedon radar and will not impact this facility.

6.10. AIS Summary

Based on the Project layout with a maximum height of up to 361 m/1184.4 ft AHD, the Project:

- would not infringe the OLS at Warrnambool Airport
- would not infringe the PANS-OPS surface related to the Warrnambool Airport 25 nm MSA
- would not have an impact on the relevant Grid LSALT or nearby air route LSALTs
- would not affect the nearest uncertified aerodrome is outside the area suggested by NASF Guideline D in which downwind turbulence from the wind farm could be experienced
- would not infringe standard aerodrome circuit operations at the closest uncertified aerodrome
- is wholly contained within Class G airspace
- is outside the clearance zones associated with civil aviation navigation aids and communication facilities.

The list of WTGs (obstacles), showing coordinates and elevation data that are applicable to this AIS, are provided in Annexure 5.

7. POTENTIAL WAKE TURBULENCE IMPACTS

NASF Guideline D states:

> *Wind farm operators should be aware that wind turbines may create turbulence which noticeable up to 16 rotor diameters from the turbine. In the case of one of the larger wind turbines with a diameter of 150 metres, turbulence may be present two kilometres downstream. At this time, the effect of this level of turbulence on aircraft in the vicinity is not known with certainty. However, wind farm operators should be conscious of their duty of care to communicate this risk to aviation operators in the vicinity of the wind farm…*

The key wording in the NASF guidance is "*noticeable*" and that "*the level of turbulence in the vicinity is not known with certainty.*"

There are many situations in aviation where pilots "notice" their aircraft moving away from the desired flight path or altitude and take appropriate action to maintain control of the aircraft with minimal input.

Pilot training standards are regulated by CASA to ensure that all qualified pilots have demonstrated to a suitably qualified and authorised check pilot that they can maintain control of their aircraft along the chosen flight path, across a significant range of atmospheric conditions that cause the aircraft to deviate from the pilot's chosen flight path.

Aircraft are designed to withstand a significant variation in atmospheric disturbances to ensure airframe integrity is maintained. The limits of the airframe's integrity are known by the pilot and considered in every flight activity. Significant weather events such as thunderstorms are avoided because of the likelihood of airframe limits being exceeded by the strong wind shear type conditions within, beneath and surrounding thunderstorm cells.

Wind turbines have been assessed in a limited number of studies, in which the highest classification of hazard is considered to be medium only within about 7 rotor diameters (RD) downwind of the wind turbine. There are no assessments that consider that the downwind turbulence is significant and outside the ability of the aircraft to endure the impacts and for the pilot to be able to control the aircraft using normal control inputs.

There also have been no reported aircraft accidents or incidents involving an aircraft encounter with the turbulence downwind of a wind turbine.

Assessment

A 162 m R D has been used for the wake turbulence analysis. Based on this scenario, NASF Guideline D suggests the effects of wake turbulence could be noticeable from the WTGs within 2592 m of the runway and the nominal circuit area, depending on wind direction.

Based on the results of published scientific studies which indicate that any medium level of turbulence would in most circumstances be confined to within 7 RD of a WTG, Aviation Projects considers that a conservative area of 10 RD is likely to be the maximum area where wake turbulence from WTGs would be noticed by pilots of light aircraft operating downstream of a WTG.

These studies also indicated that where any such turbulence is experienced, the pilot would be able to control the aircraft using normal control inputs.

Two of those studies are referred to below.

The *European Academy of Wind Energy* published an open access report titled "*Do wind turbines pose roll hazards to light aircraft?*" dated 2 November 2018. This study concluded:

In neutral conditions, the largest of these hazards are classified as medium hazards and exist 6.5 D downwind of the turbine in the bottom-left portion of the rotor disk. The highest hazards in the stable case also remained within the medium threshold and are located in two separate regions of the wake: approximately 4 D downwind in the bottom-right quadrant of the rotor and 6 D downwind in the top-left quadrant of the rotor.

The United Kingdom (UK) Civil Aviation Authority commissioned the University of Liverpool to conduct a *Wind Turbine Wake Encounter Study*, the results of which were published in March 2015.

At University of Liverpool, a full CFD method [4] was used with the HMB solver to study wind turbine wakes. The CFD results showed good agreement for the blade surface pressure distributions and flow field velocities with the wind tunnel measurements. The wake was then solved on a very fine mesh able to capture the wake vortices up to 8 radii downstream of the blades on the MEXICO wind turbine rotor.

In general, the LIDAR measurements captured the regular wake mean velocity patterns. Statistic LIDAR data indicate that the effects of wind turbine rotor wake, in term of velocity deficit, are limited within a downwind distance of 5D. This is generally in agreement with the results of the full CFD method and the velocity deficit models.

For a wind turbine with size similar to the WTN250, and using the Beddoes circulation formula, the off-line simulation results indicate that the wind turbine wake did not pose any hazards to the encountering aircraft 5 diameters further from the wind turbine. The dominant upset that the wake generated is a yawing moment on the aircraft. The wake generated crosswind, is smaller than the maximum crosswind of 17.75 ft/s for an airport (codes A-I or B-I) that is expected to accommodate single engine aircraft. These conclusions are in line with that found in the piloted flight simulation.

These two studies are the only major studies of their kind.

Wind farm designers and developers recognise the impact of downwind changes in wind strength and direction when designing the overall wind farm to ensure that the turbines are located at minimum distances from each other in order to prevent turbulence from one or more turbines affecting the operational efficiency of a downwind turbine or causing damage to the downwind turbine blades. The minimum distance between turbines at typical wind farms is about 800 m, a significantly shorter distance than either 16 RD or 10 RD presents.

The turbulence from a wind turbine could be described as a shear type turbulence which is caused by the difference of the free flow wind speed at the edge of the turbine rotor (the blade tip) being disrupted by the turbine blade being rotated by the wind and altering the wind speed within the rotor diameter moving downwind from the turbine. This shear type turbulence descends and weakens as it gets further away from the turbine. It is not a stream of turbulence being generated by the blades being turned by a mechanical force such as occurs with an aircraft propellor or ceiling fan in a house or factory.

The WTG blades change pitch, dependent on the wind strength, to maintain a constant rotor speed. They interfere with the natural wind flow and cause some degree of turbulence downwind of the WTG. A consistent theme among the studies was that the higher turbulence exists very close to the WTG and rapidly dissipates due to the effect of convection, mechanical turbulence from other sources such as the wind flowing over trees, buildings and terrain undulations.

The studies indicate that turbulence is likely to dissipate below a level that could be felt by pilots within 7 RD from the WTG. Aviation Projects considers that a more conservative value of 10 RD is best used to assess areas where the likely turbulence created downwind of a WTG would not be felt by or impact pilots of light aircraft.

The studies referenced above also indicate that aircraft controllability is maintained when experiencing the likely turbulence when the aircraft is about 6 RD from a WTG.

Table 4 Wake Turbulence Distances

1 RD (m)	*7 RD (m)*	*10 RD (m)*	*16 RD (m)*
162	1134	1620	2592

In conditions of high wind speed the WTGs are “parked” with the blades in a “feathered” condition to reduce the wind impact upon them. Turbulence from the “feathered” blades still exists but would be less than when the turbine is rotating. Other mechanical turbulence generated by trees, hills and other objects during high winds would significantly exceed and break up any minor turbulence from a stationary WTG.

Aircraft are designed to withstand significant turbulence according to aviation meteorological standards that are recognised and accepted worldwide. Even in recent circumstances with an airliner experiencing severe turbulence which injured passengers, the aircraft was controllable (except for the first part of the event where it descended rapidly) and has not suffered any significant damage (although it would undergo a major inspection). It was an encounter with severe turbulence far greater than normally experienced and is avoided wherever areas of severe turbulence is forecast or known to exist.

The downwind turbulence from WTGs beyond 7 RD may be felt by the pilot of a light aircraft but the pilot would only need to make minor control adjustments to maintain control of the aircraft’s attitude, altitude and heading. Such turbulence is likely to be classified as Light on an intensity scale published by the Australian Bureau of Meteorology (BoM) shown in Figure 12.

Within the 7 RD boundary the turbulence is considered to create a medium hazard which is likely to equate to pilots experiencing “Moderate” turbulence in which the *“Pilot remains in control at all times.”* (Figure 12)

Intensity	Airspeed Fluctuat-ions (kt/s)	Vertical Gust (ft/s)	G Load	Aircraft Reaction	Reaction Inside Aircraft
Light	5 – 14	5 - 19	0.15 – 0.49	Momentary slight and erratic changes in attitude and/or altitude. Rhythmic bumpiness.	Little effect on loose objects.
Moderate	15 – 24	20 - 35	0.50 – 0.99	Appreciable changes in attitude and/or altitude. Pilot remains in control at all times. Rapid bumps or jolts.	Unsecured objects move. Appreciable strain on seatbelts.
Severe	≥ 25	36 -49	1.0 – 1.99	Large abrupt changes in attitude and/or altitude. Momentary loss of control.	Unsecured objects are tossed about. Occupants violently forced against seatbelts.
Extreme	≥ 25	≥ 50	> 2.0	Very difficult to control aircraft. May cause structural damage.	

Figure 12 Turbulence intensities[1]

[1] Bureau of Meteorology – Hazardous Weather Phenomena – Turbulence

Light and moderate turbulence can be generated by lines of trees near runways.

> *Turbulence may disturb an aircraft's attitude about its major axis, and cause rapid bumps or jolts to be experienced, but in most cases it does not significantly alter the aircraft's flight path.* [2]

Adverse turbulence from any source is most critical during initial climb after take-off until the aircraft is established in a climb and at the appropriate speed, and during final approach where the aircraft is configured for landing and operating at a slow speed prior to landing. The research studies indicate that adverse or severe turbulence is not created by wind turbines outside the 5 RD distance.

Based on the 162 m RD the maximum extent of downwind wake turbulence referred to in the NASF guideline is 2592 m. There are no known certified or uncertified aerodromes within this distance from the project boundary.

Aircraft operations would not be impacted by downwind turbulence from the Swansons Lane Wind Farm.

[2] Bureau of Meteorology – Hazardous Weather Phenomena – Turbulence

8. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 10 it is concluded that aviation lighting is not required for WTGs and WMTs that are in close proximity to a WTG. Obstacle lighting is required for WMTs that are installed prior to WTG installation and WMTs that are not in close proximity to a WTG.

For completeness, relevant lighting standards and guidelines are summarised in Annexure 3.

Once the details of the wind farm, along with this report, are provided by the planning authority to CASA, CASA is likely to recommend obstacle lighting be fitted to sufficient obstacles to delineate the outline of the wind farm and the highest WTGs within it.

The Aviation Projects risk assessment for obstacle lighting should also be assessed by CASA.

8.1. Wind monitoring towers (WMTs)

It has not been confirmed that WMTs will be installed at the Swansons Lane Wind Farm. Any WMT installed within the project site is likely to be located as indicated in Figure 2.

This section describes the requirements for obstacle marking and/or lighting for WMTs should they be installed.

Given that aerial operators might use the airspace within the Project site and that it is expected that WMTs will be constructed prior to WTGs, the WMTs may be free-standing and not surrounded by any other obstacles. Therefore, the proposed temporary and permanent WMTs should be marked or lit as per the content of NASF Guideline D.

In terms of obstacle marking and lighting requirements, relevant requirements set out in MOS 139 and NASF are provided below.

Consideration must be given to marking the WMTs according to the requirements set out in MOS 139 Chapter 8 Division 10 Obstacle Markings; specifically:

> *8.109 Obstacles and hazardous obstacles*
>
> *(1) The following objects or structures at an aerodrome are obstacles and must be marked in accordance with this Division unless CASA determines otherwise under subsections (3) and (5):*
>
> > *any fixed object or structure, whether temporary or permanent in nature, extending above the obstacle limitation surfaces. Note an ILS building is an example of a fixed object;*
> >
> > *any object or structure on or above the movement area that is removable and is not immediately removed.*
>
> *8.110 Marking of hazardous obstacles*
>
> *(5) long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that:*
>
> > *(a) the darker colour is at the top; and*
> >
> > *(b) the bands:*
> >
> > > *i. are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and*
> > >
> > > *ii. have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of:*

(A) 1/7 of the height of the structure; or

(B) 30 m.

(7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects.

(8) The objects mentioned in subsection (7) must:

(a) be approximately equivalent in size to a cube with 600 mm sides; and

(b) be spaced 30 m apart along the length of the wire or cable.

NASF Guideline D suggests consideration of the following measures specific to the marking and lighting of WMTs:

- *the top 1/3 of wind monitoring towers to be painted in alternating contrasting bands of colour. Examples of effective measures can be found in the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998. In areas where aerial agriculture operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers;*
- *marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires;*
- *ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation;* ***or***
- *a flashing strobe light during daylight hours.*

It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the Project permanent WMTs that are in close proximity to a WTG without obstacle lighting on the WMTs.

For temporary WMTs installed prior to WTG installation and WMTs that are not in close proximity to a WTG, there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision provided obstacle lighting is fitted with medium intensity lighting at the top of the mast to ensure visibility in low light and deteriorating atmospheric conditions.

Characteristics of medium-intensity lights are specified in MOS 139 Section 9.33:

1) *Medium-intensity obstacle lights must:*
    a) *be visible in all directions in azimuth; and*
    b) *if flashing — have a flash frequency of between 20 and 60 flashes per minute.*
2) *The peak effective intensity of medium-intensity obstacle lights must be 2 000 25% cd with a vertical distribution as follows:*
    a) *for* ***vertical beam spread*** *— a minimum of 3 degrees;*
    b) *at -1 degree elevation — a minimum of 50% of the lower tolerance value of the peak intensity;*
    c) *at 0 degrees elevation — a minimum of 100% of the lower tolerance value of the peak intensity.*
3) *For subsection (2),* ***vertical beam spread*** *means the angle between 2 directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity.*

4) *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m² or greater.*

8.2. Overhead transmission line

There is no regulatory requirement to mark or light power poles or overhead transmission lines.

According to the AAAA *Powerlines Policy* dated March 2011:

> *Most agricultural land in Australia is crisscrossed with powerlines and aerial application companies and pilots put enormous effort into managing these hazards safely, generally using a risk identification, assessment and management process in line with Australian Standard AS4360/ISO 3[1]000.*
>
> *The agricultural pilot curriculum mandated by CASA includes training for the safe management of powerlines and AAAA has been active in providing ongoing professional development for application pilots that includes a focus on planning, risk management and a knowledge of human factors relevant to managing powerlines in a low-level aviation environment.*
>
> *AAAA runs a specific training course for aerial application pilots entitled 'Wire Risk Management' to address these issues.*

Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial application operators and marked in accordance with MOS 139 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8):

> *8.110 Marking of hazardous obstacles*
>
> *(7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects.*
>
> *(8) The objects mentioned in subsection (7) must:*
> *(a) be approximately equivalent in size to a cube with 600 mm sides; and*
> *(b) be spaced 30 m apart along the length of the wire or cable.*

Following consultation with aerial operators, if a risk assessment is required, the Proponent should follow standards outlined in the AS 3891.2:2018 *Air navigation – Cables and their supporting structures – Marking and safety requirements Part 2: Low level aviation operations.*

9. ACCIDENT STATISTICS

This section establishes the external context to ensure that stakeholders and their objectives are considered when developing risk management criteria, and that externally generated threats and opportunities are properly taken into account.

9.1. General aviation operations

The general aviation (GA) activity group is considered by the Australian Transport Safety Bureau (ATSB) to be all flying activities that do not involve commercial air transport (activity group), which includes scheduled (RPT) and non-scheduled (charter) passenger and freight type. It may involve Australian civil (VH) registered aircraft, or aircraft registered outside of Australia. General aviation/recreational encompasses:

- Aerial work (activity type). Includes activity subtypes: agricultural mustering, agricultural spreading/spraying, other agricultural flying, photography, policing, firefighting, construction – sling loads, other construction, search and rescue, observation and patrol, power/pipeline surveying, other surveying, advertising, and other aerial work.
- Own business travel (activity type).
- Instructional flying (activity type). Includes activity subtypes: solo and dual flying training, and other instructional flying.
- Sport and pleasure flying (activity type). Includes activity subtypes: pleasure and personal transport, glider towing, aerobatics, community service flights, parachute dropping, and other sport and pleasure flying.
- Other general aviation flying (activity type). Includes activity subtypes: test flights, ferry flights and other flying.

9.2. ATSB occurrence taxonomy

The ATSB uses a taxonomy of occurrence sub-type. Of specific relevance to the subject assessment are terms associated with **terrain collision**. Definitions sourced from the ATSB website are provided below:

- **Collision with terrain**: Occurrences involving a collision between an airborne aircraft and the ground or water, where the flight crew were aware of the terrain prior to the collision.
- **Controlled flight into terrain (CFIT):** Occurrences where a serviceable aircraft, under flight crew control, is inadvertently flown into terrain, obstacles, or water without either sufficient or timely awareness by the flight crew to prevent the event.
- **Ground strike:** Occurrences where a part of the aircraft drags on, or strikes, the ground or water while the aircraft is in flight, or during take-off or landing.
- **Wirestrike:** Occurrences where an aircraft strikes a wire, such as a powerline, telephone wire, or guy wire, during normal operations.

9.3. National aviation occurrence statistics 2010-2019

The Australian Transport Safety Bureau (ATSB) recently published a summary of aviation occurrence statistics for the period 2010-2019 (AR-2020-014, Final - 29 April 2020).

According to the report, there were no fatalities in high or low capacity RPT operations during the period 2010-2019. In 2019, 220 aircraft were involved in accidents in Australia, and a further 154 aircraft involved in serious incidents (an incident with a high probability of becoming an accident). In 2019 there were 35 fatalities from 22 fatal accidents. There have been no fatalities in scheduled commercial air transport in Australia since 2005.

Of the 326 fatalities recorded in the 10-year period, almost two thirds (175 or 53.68%) occurred in the general aviation segment. On average, there were 1.51 fatalities per aircraft associated with a fatality in this segment. The fatalities to aircraft ratio ranges from 1.09 to 177:1. Whilst it can be inferred from the data that the majority of fatal accidents are single person fatalities, it is reasonable to assert that the worst credible effect of an aircraft accident in the general aviation category will be multiple fatalities.

A breakdown of aircraft and fatalities by general aviation sub-categories is provided in Table 5 (source: ATSB).

Table 5 Number of fatalities by General Aviation sub-category – 2010 to 2019

Sub-category	*Aircraft assoc. with fatality*	*Fatalities*	*Fatalities to aircraft ratio*
Aerial work	37	44	1.18:1
Instructional flying	11	19	1.72:1
Own business travel	3	5	1.6:1
Sport and pleasure flying	53	94	1.77:1
Other general aviation flying	11	12	1.09:1
Totals	115	174	1.51:1

Figure 13 refers to Fatal Accident Rate by operation type per million departures over the 6-year period (source: ATSB). Note the rates presented are not the full year range of the study (2010–2019). This was due to the availability of exposure data (departures and hours flown) which was only available between these years. According to the ATSB report, the number of fatal accidents per million departures for GA aircraft over the 6-year reporting period ranged between 6.6 in 2014 and 4.9 in 2019.

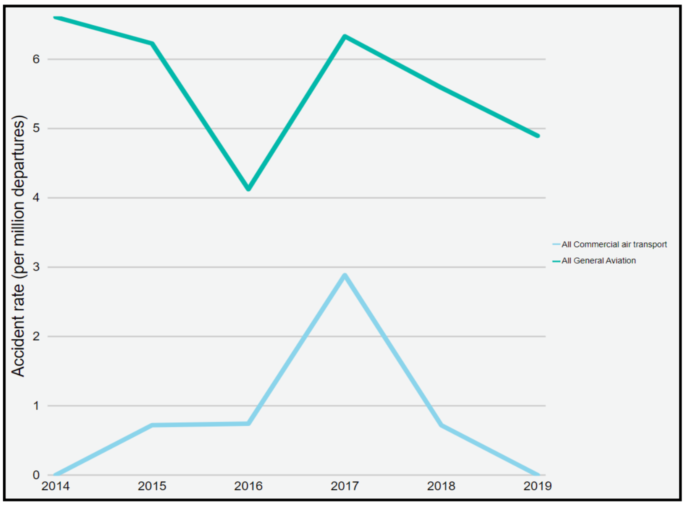

Figure 13 Fatal Accident Rate (per million departures) by Operation Type

In 2018, there were 9 fatal accidents and 9 fatalities involving GA aircraft, resulting in a rate of 5.6 fatal accidents per million departures and 7.7 fatal accidents per million hours flown.

In 2019, there were 1,760,000 landings, and 1,320,000 hours flown by VH-registered general aviation aircraft in Australia, with 8 fatal accidents and 17 fatalities. Based on these results, in 2019 there were 4.9 fatal accidents per million departures and 6.4 fatal accidents per million hours flown. A summary of fatal accidents from 2010-2019 by GA sub-category is provided in Table 6 (source: ATSB).

Table 6 Fatal accidents by GA sub-category – 2010 -2019

Sub-category	*Fatal accidents*	*Fatalities*
Agricultural spreading/spraying	13	13
Agricultural mustering	11	12
Other agricultural	1	1
Survey and photographic	5	10
Search and rescue	2	2
Firefighting	2	2
Other aerial work	3	4
Instructional flying	11	19
Own business travel	3	5
Sport and pleasure flying	53	94
Other general aviation flying	11	12
Total	115	174

Over the 10-year period, and since, no aircraft collided with a WTG or a WMT in Australia.

Of the 20,529 incidents, serious incidents and accidents in GA operations in the 10-year period, 1,404 (6.83%) were terrain collisions.

The underlying fatality rate for GA operations discussed above is considered tolerable within Australia's regulatory and social context.

9.4. Worldwide accidents involving wind farms

Worldwide since aviation accident statistics have been recorded, there have been a total of 5 aviation accidents involving a wind farm (i.e. where WTGs were erected). To provide some perspective on the likelihood of a VFR aircraft colliding with a WTG, a summary of the 5 accidents and the relevant factors applicable to this assessment is incorporated in this section.

Based on the statistics set out in the Global Wind Energy Council (GWEC) report 2016, there were 341,320 WTGs operating around the world at the end of 2016.

Based on the Australia's Clean Energy Council statistics there were 102 wind farms in Australia at the end of 2019. Aviation Projects has researched public sources of information, regarding aviation safety occurrences associated with wind farms. Occurrence information published by Australia, Canada, Europe (Belgium, Denmark, France, Germany, Norway, Sweden and The Netherlands), New Zealand, the United Kingdom and the United States of America was reviewed.

The 5 recorded aviation accidents involving a wind farm are summarised as follows:

- One accident occurred in Texas, United States in October 2019 resulting in minor aircraft damage no injury to the pilot and significant injury to a person on the ground. The aircraft, an Air Tractor AT502, was returning from a local aerial application flight and was flown deliberately at low-level in close vicinity to a wind turbine generator (WTG) because the pilot believed his friend was working on the turbine. The aircraft collided with a tagline rope that was attached to a blade of the WTG and which was being held by a person working on the ground. The worker was thrown about 20 ft in the air and experienced significant non-life-threatening injuries. The aircraft sustained minor damage however the pilot landed the aircraft without further incident.
- One accident, which resulted in 2 fatalities, occurred in Palm Springs in 2001. This accident involved a wind farm but was not caused by the wind farm. The cause of the accident was the inflight separation of the majority of the right canard and all of the right elevator resulting from a failure of the builder to balance the elevators per the kit manufacturer's instructions. The accident occurred above a wind farm, and the aircraft struck a WTG on its descent and therefore the cause of the accident was not attributable to the wind farm and not applicable to this AIA.
- Two accidents involving collision with a WTG were during the day, as follows:
  - One accident occurred in Melle, Germany in 2017 as the result of a collision with a WTG mounted on a steel lattice tower at a very low altitude during the day with good visibility and no cloud. The accident resulted in one fatality. If the tower was solid and painted white, as is standard on contemporary wind farms, then it more than likely would have been more visible than if it were to be equipped with an obstacle light which in all likelihood would not have been operating during daylight with good visibility conditions.
  - One accident occurred in Plouguin, France in 2008 when the pilot decided to descend below cloud in an attempt to find the destination aerodrome. The aircraft was flying in conditions of significantly reduced horizontal visibility in fog where the top of the WTGs were obscured by cloud. The WTGs became visible too late for avoidance manoeuvring and the aircraft made contact with two WTGs. The aircraft was damaged but landed safely. No fatalities were recorded.
  - In both of the above cases, it is difficult to conclude that obstacle lighting would have prevented the accidents.
- One fatal accident, near Highmore, South Dakota in 2014 occurred at night in Instrument Meteorological Conditions (IMC).

There is one other accident mentioned in a database compiled by an anti-wind farm lobby group (wind-watch.org), which suggests a Cessna 182 collided with a WTG near Baraboo, Wisconsin, on 29 July 2000. The NTSB database records details of an accident involving a Cessna 182 that occurred on 28 July 2000 in the same area. For this particular accident, NTSB found that the probable cause of the accident was VFR flight into IMC encountered by the pilot and exceeding the design limits of the aircraft. A factor was flight to a destination alternate not performed by the pilot. No mention in the NTSB database is made of WTGs or a wind farm.

10. RISK ASSESSMENT

A risk management framework is comprised of likelihood and consequence descriptors, a matrix used to derive a level of risk, and actions required of management according to the level of risk.

The risk assessment framework used by Aviation Projects and risk event description is provided in Annexure 4.

10.1. Risk Identification

The primary risk being assessed is that of aviation safety associated with the height and location of WTGs and WMTs proposed by the Project.

Based on an extensive review of accident statistics data (see summary in Section 8 above) five identified risk events associated with WTGs and WMTs relate to aviation safety or potential visual impact, and are listed as follows:

1. potential for an aircraft to collide with a WTG, controlled flight into terrain (CFIT) (related to aviation safety)
2. potential for an aircraft to collide with a WMT (CFIT) (related to aviation safety)
3. potential for a pilot to initiate abrupt manoeuvring in order to avoid colliding with a WTG or WMT resulting in loss of control of the aircraft resulting in collision with terrain (related to aviation safety)
4. potential for the hazards associated with the Project to invoke operational limitations or procedures on operating crew (related to aviation safety)
5. Potential effect of obstacle lighting on neighbours (related to potential visual impact).

It should be noted that according to guidance provided by the Commonwealth Department of Infrastructure, Transport, Regional Development and Communications, and in line with generally accepted practice, the risk to be assessed should primarily be associated with passenger transport services. Therefore, the risk being assessed herein is primarily associated with smaller aircraft likely to be flying under the VFR, and so the maximum number of passengers exposed to the nominated consequences is likely to be limited.

The five risk events identified here are assessed in detail in the following section.

10.2. Risk Analysis, Evaluation and Treatment

For the purpose of considering applicable consequences, the concept of worst credible effect has been used. Untreated risk is first evaluated, then, if the resulting level of risk is unacceptable, further treatments are identified to reduce the residual level of risk to an acceptable level.

A summary of the level of risk associated with the Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in

Table 7 through to Table 11.

Table 7 Aircraft collision with wind turbine generator (WTG)

<table>
<tr><td>*Risk ID:*</td><td colspan="2">1. Aircraft collision with wind turbine generator (WTG) (CFIT)</td></tr>
<tr><td colspan="3">

Discussion

An aircraft collision with a WTG would result in harm to people and damage to property. Property could include the aircraft itself, as well as the WTG.

There have been 5 reported occurrences worldwide of aircraft collisions with a component of a WTG structure since the year 2000 as discussed in Section 1. These reports show a range of situations where pilots were conducting various flying operations at low level and in the vicinity of wind farms in both IMC and VMC. No reports of aircraft collisions with wind farms in Australia have been found.

In consideration of the circumstances that would lead to a collision with a WTG:

- GA VFR aircraft operators generally don't individually fly a significant number of hours in total, let alone in the area in question
- There is a very small chance that a pilot, suffering the stress of weather, will continue into poor weather conditions (contrary to the rules of flight) rather than divert away from it, is not aware of the wind farm, will not consider it or will not be able to accurately navigate around it.
- If the aircraft was flown through the wind farm, there is still a very small chance that it would hit a WTG.

Refer to the discussion of worldwide accidents in Section 8.

There are no known aerial application operations conducted at night in the vicinity of the Project site.

If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing:

(a) whether the object or structure will be a hazard to aircraft operations

(b) whether it requires an obstacle light that is essential for the safety of aircraft operations

The Project site is clear of the obstacle limitation surfaces (OLS) of any aerodrome.

</td></tr>
<tr><td colspan="3">

Consequence

If an aircraft collided with a WTG, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.

</td></tr>
<tr><td colspan="2">*Consequence*</td><td>Catastrophic</td></tr>
<tr><td colspan="3">

Untreated Likelihood

There have been 5 reports of aircraft collisions with WTGs worldwide, which have resulted in a range of consequences, where aircraft occupants sustained minor injury in some cases and fatal injuries in others (see Section 8). Similarly, aircraft damage sustained ranged from minor to catastrophic. One of these accidents resulted from structural failure of the aircraft before the collision with the WTG. Only two relevant accidents occurred during the day, and only one resulted in a single fatality. It is assessed that collision with a WTG resulting in multiple fatalities and damage beyond repair is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

</td></tr>
<tr><td colspan="2">*Untreated Likelihood*</td><td>Possible</td></tr>
<tr><td colspan="3">*Current Treatments (without lighting)*</td></tr>
</table>

• The Project site is clear of the obstacle limitation surfaces (OLS) of any aerodrome. • Aircraft are restricted to a minimum height of 500 ft (152.4 m) AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. The proposed WTGs will be a maximum of 252 m (826.8 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 99.6 m (326.8 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • If cloud descends below the WTG hub (assumed to be approximately 200 m AGL), obstacle lighting would be obscured and therefore ineffective. • At night, aircraft are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles (including terrain) which are within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night). • Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities undertaken specifically for and prior to undertaking such authorised flights. Any obstacle including WTGs in the path of the authorised flight would be specifically risk assessed during that process. • The WTGs are typically coloured white so they should be visible to pilots during the day. • The final layout and 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of all WTGs can be noted on aeronautical maps and charts. • Because the Project WTGs are proposed to be above 100 m AGL, there is a statutory requirement to report the WTGs to CASA and notified to Airservices Australia prior to construction.

Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8 (Unacceptable).	
Current Level of Risk	8 - Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Details of the Project should be communicated to local and regional aircraft operators (refer to Section 5) prior to construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically: ○ Engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the WTG blades prior to the commencement of the subject aircraft operations within the Project site.	

○ Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, which would involve notification to Airservices Australia.	
Residual Risk With the implementation of the Recommended Treatments listed above, the likelihood of an aircraft collision with a WTG resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 - Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. The level of risk with the implementation of the Recommended Treatments is considered **As Low As Reasonably Practicable (ALARP).** **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a Project WTG without obstacle lighting on the WTGs.**	
Residual Risk	7 - Tolerable

Table 8 Aircraft collision with wind monitoring tower (WMT)

Risk ID:	2. Aircraft collision with a wind monitoring tower (WMT) (CFIT)

Discussion

An aircraft collision with a WMT would result in harm to people and damage to property.

There may be one WMT located within the project boundary.

The WMTs will be free standing at a maximum height of 140 m (460 ft) AGL.

The proposed masts will be marked in accordance with NASF Guideline D recommendations and CASA Part 139 MOS requirements.

The location of the proposed temporary and permanent WMT locations and other applicable details will be provided to Airservices Australia prior to construction.

There are a few instances of aircraft colliding with a WMT, but they were all during the day with good visibility. None were in Australia.

There is a relatively low rate of aircraft activity in the vicinity of the Project site.

There are no known aerial application operations conducted at night in the vicinity of the wind farm.

If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal will be referred to CASA for CASA to determine, in writing:

- whether the object or structure will be a hazard to aircraft operations
- whether it requires an obstacle light that is essential for the safety of aircraft operations.

Consequence

If an aircraft collided with a WMT, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.

Consequence	Catastrophic

Untreated Likelihood

There are a few occurrences of an aircraft colliding with a WMT, but all were during the day with good visibility when obstacle lighting would arguably be of no effect, and none were in Australia. It is assessed that collision with a WMT without obstacle lighting that would be effective in alerting the pilot to its presence is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments

- The mast locations will be advised to CASA and Airservices Australia prior to construction.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built up areas. The highest permanent WMT may be at a maximum height of 140 m (460 ft), which will be 40 ft (12.4 m) below the minimum height of 500 ft AGL for an aircraft flying in this area.
- At night, aircraft operating in visual flight are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles within 10 nm of the aircraft.

• The WTGs and masts will be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart. • Aircraft authorised to intentionally fly below 152.4 m (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. • Since the masts will be higher than 100 m AGL, there is a statutory requirement to report them to CASA and Airservices Australia prior to construction.	
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.	
Current Level of Risk	8 - Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Details of any WMTs when they are constructed will be advised to Airservices Australia. • Consideration could be given to marking any wind monitoring towers according to the requirements set in MOS 139 Chapter 8 Division 10 Obstacle Markings (as modified by the guidance in NASF Guideline D); specifically: *8.110 (5) As illustrated in Figure 8.110 (5), long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that the darker colour is at the top; and the bands are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of: 1/7 of the height of the structure; or 30 m.* *8.110 (7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects. (8) The objects mentioned in subsection (7) must: be approximately equivalent in size to a cube with 600 mm sides; and be spaced 30 m apart along the length of the wire or cable.* • WMTs that are installed prior to WTG installation (Temporary WMTs) and WMTs that are not in close proximity to a WTG, should be fitted with a medium intensity steady red obstacle light at the top of the tower to ensure visibility in low light and deteriorated atmospheric conditions. Characteristics of medium-intensity lights are specified in MOS 139 Section 9.33: *5) Medium-intensity obstacle lights must:* *c) be visible in all directions in azimuth; and* *d) if flashing — have a flash frequency of between 20 and 60 flashes per minute.*	

6) *The peak effective intensity of medium-intensity obstacle lights must be 2 000   25% cd with a vertical distribution as follows:*

   d) *for* **vertical beam spread** *— a minimum of 3 degrees;*

   e) *at -1 degree elevation — a minimum of 50% of the lower tolerance value of the peak intensity;*

   f) *at 0 degrees elevation — a minimum of 100% of the lower tolerance value of the peak intensity.*

7) *For subsection (2),* **vertical beam spread** *means the angle between 2 directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity.*

8) *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m² or greater.*

- Ensure details of any additional WMTs at the Project site have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction.

Residual Risk

With the additional Recommended Treatments listed above, the likelihood of an aircraft collision with a WMT resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**.

It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified.

Under these circumstances, the level of risk under the proposed treatment plan is considered **ALARP.**

It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the Project masts that are in close proximity to a WTG without obstacle lighting on the WMTs.

For masts installed prior to WTG installation and those that are not in close proximity to a WTG, there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision provided obstacle lighting is fitted to ensure visibility in low light and deteriorating atmospheric conditions.

Residual Risk	7 - Tolerable

Table 9 Harsh manoeuvring leading to controlled flight into terrain

Risk ID:	**3. Harsh manoeuvring leads to controlled flight into terrain (CFIT)**

Discussion

An aircraft colliding with terrain following loss of control as a result of harsh manoeuvring to avoid colliding with a WTG would result in harm to people and damage to property.

There are a few ground collision accidents resulting from manoeuvring to avoid wind farms, but none in Australia, and all were during the day.

The Project is clear of the OLS of any aerodrome.

Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built up areas.

The proposed WTGs will be a maximum of 252 m (826.8 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 99.6 m (326.8 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL.

Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.

If cloud descends below the WTG hub, obstacle lighting would be obscured and therefore ineffective.

Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).

Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.

Assumed risk treatments

- The WTGs are typically coloured white so they should be visible during the day.
- The final layout and 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of WTGs can be noted on aeronautical maps and charts.
- Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the WTG to CASA.

Consequence

If an aircraft collided with terrain, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.

Consequence	Catastrophic

Untreated Likelihood

There are a few ground collision accidents resulting from manoeuvring to avoid WTGs, but none in Australia, and all were during the day (see Section 8). It is assessed that a ground collision accident following manoeuvring to avoid a WTG is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments (without lighting)

- The Project is clear of the OLS of any aerodrome.

- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas.
- WTGs will be a maximum of 252 m (826.8 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 99.6 m (326.8 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.
- The WTGs and masts will be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart.
- If cloud descends below the WTG hub, obstacle lighting would be obscured and therefore ineffective.
- At night, aircraft operating in visual flight are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles within 10 nm of the aircraft.
- Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The WTGs are typically coloured white, typical of most WTGs operational in Australia, so they should be visible during the day.
- The final layout and 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the WTGs to CASA.

Level of Risk

The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.

Current Level of Risk	8 – Unacceptable

Risk Decision

A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.

Risk Decision	Unacceptable

Recommended Treatments

The following treatments which can be implemented at little cost will provide an acceptable level of safety:

- Ensure details of the Project WTGs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction.

• Although there is no requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the Project site.	
Residual Risk With the additional Recommended Treatments listed above, the likelihood of ground collision resulting from manoeuvring to avoid a WTG resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable.** It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. In the circumstances, the level of risk under the proposed treatment plan is considered **ALARP.** **It is assessed that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a Project WTG without obstacle lighting on the WTGs.**	
Residual Risk	7 - Tolerable

Table 10 Effect of the Project on operating crew

Risk ID:	4. Effect of the Project on operating crew
Discussion Introduction or imposition of additional operating procedures or limitations can affect an aircraft's operating crew. There are no known aerial application operations conducted at night in the vicinity of the Project site.	
Consequence The worst credible effect a wind farm could have on flight crew would be the imposition of operational limitations, and in some cases, the potential for use of emergency procedures. This would be a Minor consequence.	
Consequence	Minor
Untreated Likelihood The imposition of operational limitations is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.	
Untreated Likelihood	Possible
Current Treatments • The Project is clear of the OLS of any aerodrome. • Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. • The WTGs and masts will be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart. • WTGs will be a maximum of 252 m (826.8 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 99.6 m (326.8 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs by the required margin. • If cloud descends below the WTG hub, obstacle lighting would be obscured and therefore ineffective. • At night, aircraft operating in visual flight are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles within 10 nm of the aircraft. • Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. • The WTGs are typically coloured white so they should be visible during the day.	

• The final layout and 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts. • Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the WTGs to CASA.	
Level of Risk The level of risk associated with a Possible likelihood of a Minor consequence is 5.	
Current Level of Risk	5 - Tolerable
Risk Decision A risk level of 5 is classified as Tolerable: Treatment action possibly required to achieve ALARP - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.	
Risk Decision	Accept, conduct cost benefit analysis
Recommended Treatments Given the current treatments and the limited scale and scope of flying operations conducted within the vicinity of the Project site, there is likely to be little additional safety benefits to be gained by installing obstacle lighting for WTGs and Permanent WMTs which are in close proximity to WTGs. WMTs installed prior to WTG installation and those that are not in relatively close proximity to a WTG should be lit to ensure they are visible in low light and deteriorating atmospheric conditions. (see Risk ID: 2) The following additional treatments will provide an additional margin of safety: • Ensure details of the Project WTGs and masts have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction. • Although there is no requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for such aircraft operations in the vicinity of the Project site.	
Residual Risk Notwithstanding the current level of risk is considered **Tolerable,** the additional Recommended Treatments listed above will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **ALARP.** **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew, without obstacle lighting on the Project WTGs and Permanent WMTs in close proximity to a WTG, and with obstacle lighting for temporary WMTs installed prior to WTG installation and WMTs that are not in close proximity to a WTG.**	
Residual Risk	5 – Tolerable

Table 11 Effect of obstacle lighting on neighbours

Risk ID:	5. Effect of obstacle lighting on neighbours
Discussion This scenario discusses the consequential impact of a decision to install obstacle lighting on the wind farm. Installation and operation of obstacle lighting on WTGs or masts can have an effect on neighbours' visual amenity and enjoyment, specifically at night and in good visibility conditions. If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing: (a) whether the object or structure will be a hazard to aircraft operations (b) whether it requires an obstacle light that is essential for the safety of aircraft operations. In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.	
Consequence The worst credible effect of obstacle lighting specifically at night in good visibility conditions would be: • Moderate site impact, minimal local impact, important consideration at local or regional level, possible long-term cumulative effect. Not likely to be decision making issues. Design and mitigation measures may ameliorate some consequences. This would be a Moderate consequence.	
Consequence	Moderate
Untreated Likelihood The likelihood of moderate site impact, minimal local impact is Almost certain - the event is likely to occur many times (has occurred frequently).	
Untreated Likelihood	Almost certain
Current Treatments If the WTGs or masts will be higher than 150 m (492 ft) AGL, they must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.	
Level of Risk The level of risk associated with an Almost certain likelihood of a Moderate consequence is 8.	
Current Level of Risk	8 - Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable

Recommended Treatments Not installing obstacle lighting would completely remove the source of the impact. As per the above safety risk assessment, the provision of lighting for the WTGs and permanent masts is not necessary to provide an acceptable level of safety. For temporary WMTs installed prior to WTG installation and masts that are not in close proximity to a WTG, obstacle lighting is recommended to ensure visibility in low light and deteriorating atmospheric conditions. If CASA or a planning authority decide that obstacle lighting is required there are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours, including: • reducing the number of WTGs with obstacle lights • specifying an obstacle light that minimises light intensity at ground level • specifying an obstacle light that matches light intensity to meteorological visibility • mitigating light glare from obstacle lighting through measures such as baffling. These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to residents within and around the Project site. Consideration may be given to activating the obstacle lighting via a pilot activated lighting system. An option is to consider using Aircraft Detection Lighting Systems (referred in the United States Federal Aviation Administration Advisory Circular AC70/7460-1L CHG1 – *Obstruction Marking and Lighting*). Such a system would only activate the lights when an aircraft is detected in the near vicinity and deactivate the lighting once the aircraft has passed. This technology reduces the impact of night lighting on nearby communities and migratory birds and extends the life expectancy of obstruction lights.
Residual Risk Not installing obstacle lights would clearly be an acceptable outcome to those potentially affected by visual impact. If lighting is required, consideration of visual impact in the lighting design should enable installation of lighting that reduces the impact to neighbours. The likelihood of a **Moderate** consequence remains **Likely**, with a resulting risk level of **7 – Tolerable**. **It is our assessment that visual impact from obstacle lights can be negated if they are not installed.** If obstacle lights are to be installed, they can be designed so that there is an acceptable risk of visual impact to neighbours.

Residual Risk	7 - Tolerable

11. CONCLUSIONS

The key conclusions of this AIA are summarised as follows:

11.1. Aviation Impact Statement

Based on the Project WTG layout with a maximum height of up to 361 m/1184.4 ft AMSL:

- would not penetrate any OLS surfaces
- would not infringe the PANS-OPS surfaces related to the Warrnambool Airport
- would not have an impact on the relevant Grid LSALT
- would not have an impact on nearby designated air routes
- the nearest uncertified aerodrome is outside the area suggested by NASF Guideline D in which downwind turbulence from the wind farm could be experienced
- standard circuit heights would not be impacted by the height of the wind turbines within the circuit area at the closest uncertified aerodrome's circuit area
- is wholly contained within Class G airspace
- is outside the clearance zones associated with civil aviation navigation aids and communication facilities.

11.2. Aircraft operator characteristics

Aircraft will be required to navigate around the Project site where the aircraft needs to fly at 500 ft AGL or below the top of the WTGs.

WTGs are generally not a safety concern to aerial agricultural operators. WMTs remain the primary safety concern to aerial agricultural operators, who have expressed a general desire for these towers to be more visible.

11.3. Hazard marking and lighting

The following conclusions apply to hazard marking and lighting:

- With respect to CASR Part 139, the proposed WTGs and WMTs must be reported to CASA.
- WTGs must be lit in accordance with CASR Part 139 MOS, unless an aeronautical study assesses they are of no operational significance, which this study reports.
- With respect to marking of WTGs, a white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- Temporary and permanent WMTs should be marked according to the requirements set out in The CASR Part 139 MOS (as modified by the guidance in NASF Guideline D). Aviation marker balls and painting the top 1/3 of WMTs structures in red and white bands is considered to be an acceptable mitigation strategy.

- WTGs and permanent WMTs that are installed in close proximity (300 m) to a WTG located within the wind farm boundary, will not require obstacle lighting to maintain an acceptable level of safety to aircraft.
- WMTs that are installed prior to WTG installation, and WMTs that are not in close proximity to a WTG, or are located outside the wind farm boundary, will require obstacle lighting to maintain an acceptable level of safety. These WMTs should be lit with medium intensity steady red obstacle lighting at the top of the WMT mast. Characteristics of medium intensity obstacle lighting in CASR MOS 139.

11.4. Summary of risks

A summary of the level of residual risk associated with the Project with the Recommended Treatments implemented, is provided in Table 12.

Table 12 Summary of Residual Risks

Identified Risk	Consequence	Likelihood	Risk	Actions Required
Aircraft collision with wind turbine generator (WTG)	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Communicate details of the Project WTGs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with wind monitoring tower (WMT)	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Although there is no obligation to do so, consideration has been made for marking the WMTs according to the requirements set out in MOS 139 Chapter 8 Division 10 Obstacle Markings, specifically 8.110 (5), (7) and (8). Communicate details of WMTs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes following construction.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Communicate details of the Project WTGs and WMTs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Effect on crew	Minor	Possible	5	**Acceptable without obstacle lighting (ALARP)** Communicate details of the Project WTGs and WMTs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights	Moderate	Likely	7	**Acceptable without obstacle lighting** (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact.

12. RECOMMENDATIONS

Recommended actions resulting from the conduct of this assessment are provided below.

Notification and reporting

1. CASR 139.165 requires the owner of a structure (or proponents of a structure) that will be 100 m or more above ground level to inform CASA. This must be given in written notice and contain information on the proposal, the height and location(s) of the object(s) and the proposed timeframe for construction. This is to allow CASA to assess the effect of the structure on aircraft operations and determine whether or not the structure will be hazardous to aircraft operations.
   The proponent is required to report the WMT to CASA in accordance with CASR 139.165, as soon as practicable after forming the intention to construct or erect the proposed object or structure.
   The notification should be provided to CASA via email to Airspace.Protection@casa.gov.au .

2. 'As constructed' details of WMT coordinates and elevation should be provided to Airservices Australia, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com .
   Ideally this should only be done if potential impacts have been considered – through an aviation impact assessment or by sending the details to Airservices Australia in advance of the mast being erected, at this email address: airport.developments@airservicesaustralia.com.
   Details of the wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations.

3. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs, WMTs and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Operation

4. Whilst not a statutory requirement, the Proponent should consider engaging with any aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project.

5. The proponent should notify landowners of the identified landing ground within 3nm south of the Project Site to determine any impacts from the WTG proximity and potential wake turbulence effects, and with the owner of Dixie uncertified aerodrome to determine any impacts from WTG wake turbulence effects.

Marking of WTGs

6. The rotor blades, nacelle and the mast supporting the WTGs should be painted white, typical of most WTGs operational in Australia. No additional marking measures are required for WTGs.

Lighting of WTGs

7. Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.

Marking of WMTs

8. Consideration should be given to marking the temporary and permanent WMTs according to the requirements set out in CASR Part 139 MOS (as modified by the guidance in NASF Guideline D). Specifically:

    a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires

    b. paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast

    c. ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation.

Lighting of wind monitoring towers

9. Consideration should be given to lighting temporary WMTs installed prior to WTG installation and WMTs that are not in close proximity to a WTG with medium intensity steady red obstacle lighting at the top of the WMT mast. Characteristics for medium-intensity obstacle lighting are contained in CASR Part 139 MOS.

Micrositing

10. The potential micrositing of the WTGs and WMTs has been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the nominal WTG and WMT positions. Providing the micrositing is within 100 m of the WTGs and WMTs is likely to not result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Overhead transmission line

11. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial application operators and marked in accordance with CASR Part 139 MOS.

Triggers for review

12. Triggers for review of this risk assessment are provided for consideration:

    a. prior to construction to ensure the regulatory framework has not changed

    b. following any significant changes to the context in which the assessment was prepared, including the regulatory framework

    c. following any near miss, incident or accident associated with operations considered in this risk assessment.

ANNEXURES

1. References
2. Definitions
3. CASA regulatory requirements – Lighting and Marking
4. Risk Framework
5. WTG coordinates and heights

ANNEXURE 1 – REFERENCES

References used or consulted in the preparation of this report include:

- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures, Designated Handbook and En Route Supplement Australia dated 12 June 2025
- Civil Aviation Safety Authority
    - Civil Aviation Regulations 1988 (CAR)
    - Civil Aviation Safety Regulations 1998 (CASR)
    - *CASR Part 139 (Aerodromes)* Manual of Standards
    - Civil Aviation Safety Authority, Advisory Circular (AC) 91-10 v1.1: *Operations in the vicinity of non-controlled aerodromes*
    - Advisory Circular 139.E-01 v1.0—*Reporting of Tall Structures*
    - Advisory Circular (AC) 139.E-05 v1.1 *Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome*
    - Manual of Standards Part 173 – *Standards Applicable to Instrument Flight Procedure Design*.
- Department of Infrastructure, Transport, Regional Development, Communications and the Arts, National Airport Safeguarding Framework, Guideline D *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/ Wind Monitoring Towers*
- International Civil Aviation Organization (ICAO) Doc 8168 *Procedures for Air Navigation Services—Aircraft Operations* (PANS-OPS)
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes
- OzRunways, aeronautical navigation charts extracts, dated 6 May 2025
- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*

ANNEXURE 2 – DEFINITIONS

Term	*Definition*
Aerial Agricultural Operator	Specialist pilot and/or company who are required to have a commercial pilot's licence, an agricultural rating and a chemical distributor's licence
Aerodrome	A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure, and surface movement of aircraft.
Aerodrome facilities	Physical things at an aerodrome which could include: a. the physical characteristics of any movement area including runways, taxiways, taxilanes, shoulders, aprons, primary and secondary parking positions, runway strips and taxiway strips; b. infrastructure, structures, equipment, earthing points, cables, lighting, signage, markings, visual approach slope indicators.
Aerodrome reference point (ARP)	The designated geographical location of an aerodrome.
Aeronautical Information Publication (AIP)	Details of regulations, procedures, and other information pertinent to the operation of aircraft
Aeronautical Information Publication En-route Supplement Australia (AIP ERSA)	Contains information vital for planning a flight and for the pilot in flight as well as pictorial presentations of all licensed aerodromes
Civil Aviation Safety Regulations 1998 (CASR)	Contain the mandatory requirements in relation to airworthiness, operational, licensing, enforcement.
Instrument meteorological conditions (IMC)	Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minimum specified for visual meteorological conditions.
Manual of Standards (MOS)	The means CASA uses in meeting its responsibilities under the Act for promulgating aviation safety standards
National Airports Safeguarding Framework (NASF)	The Framework has the objective of developing a consistent and effective national framework to safeguard both airports and communities from inappropriate on and off airport developments.
Obstacles	All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

Term	Definition
Runway	A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.
Safety Management System	A systematic approach to managing safety, including organisational structures, accountabilities, policies and procedures.

ANNEXURE 3 – CASA REGULATORY REQUIREMENTS – LIGHTING AND MARKING

In considering the need for aviation hazard lighting and marking, the applicable regulatory context was determined.

The Civil Aviation Safety Authority (CASA) regulates aviation activities in Australia. Applicable requirements include the Civil Aviation Regulations 1988 (CAR), Civil Aviation Safety Regulations 1998 (CASR) and associated Manual of Standards (MOS) and other guidance material. Relevant provisions are outlined in further detail in the following section.

Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

CASR 139.165 requires the owner of a structure (or proponents of a structure) that will be 100 m or more above ground level to inform CASA. This must be given in written notice and contain information on the proposal, the height and location(s) of the object(s) and the proposed timeframe for construction. This is to allow CASA to assess the effect of the structure on aircraft operations and determine whether the structure will be hazardous to aircraft operations.

Manual of Standards Part 139—Aerodromes

Chapter 9 sets out the standards applicable to Visual Aids Provided by Aerodrome Lighting.

Section 9.30 provides guidance on Types of Obstacle Lighting and Their Use:

1. *The following types of obstacle lights must be used, in accordance with this MOS, to light hazardous obstacles:*
    a. *low-intensity;*
    b. *medium-intensity;*
    c. *high-intensity;*
    d. *a combination of low, medium or high-intensity.*
2. *Low-intensity obstacle lights:*
    a. *are steady red lights; and*
    b. *must be used on non-extensive objects or structures whose height above the surrounding ground is less than 45 m.*
3. *Medium-intensity obstacle lights must be:*
    a. *flashing white lights; or*
    b. *flashing red lights; or*
    c. *steady red lights.*

    Note CASA recommends the use of flashing red medium-intensity obstacle lights.

4. *Medium-intensity obstacle lights must be used if:*
    a. *the object or structure is an extensive one; or*

  b. *the top of the object or structure is at least 45 m but not more than 150 m above the surrounding ground; or*

  c. *CASA determines in writing that early warning to pilots of the presence of the object or structure is desirable in the interests of aviation safety.*

Note For example, a group of trees or buildings is regarded as an extensive object.

5. *For subsection (4), low-intensity and medium-intensity obstacle lights may be used in combination.*
6. *High-intensity obstacle lights:*
   a. *must be used on objects or structures whose height exceeds 150 m; and*
   b. *must be flashing white lights.*
7. *Despite paragraph (6) (b), a medium-intensity flashing red light may be used if necessary, to avoid an adverse environmental impact on the local community.*

Sections 9.31 (8) and (9) provide guidance on obstacle lighting specific to wind farms:

8. *Subject to subsection (9), for wind turbines in a wind farm, medium-intensity obstacle lights must:*
   a. *mark the highest point reached by the rotating blades; and*
   b. *be provided on a sufficient number of individual wind turbines to indicate the general definition and extent of the wind farm, but such that intervals between lit turbines do not exceed 900 m; and*
   c. *all be synchronised to flash simultaneously; and*
   d. *be seen from every angle in azimuth.*

   Note: This is to prevent obstacle light shielding by the rotating blades of a wind turbine and may require more than 1 obstacle light to be fitted.
9. *If it is physically impossible to light the rotating blades of a wind turbine:*
   a. *the obstacle lights must be placed on top of the generator housing; and*
   b. *a note must be published in the AIP-ERSA indicating that the obstacle lights are not at the highest position on the wind turbines.*
10. *If the top of an object or structure is more than 45 m above:*
    a. *the surrounding ground (ground level); or*
    b. *the top of the tallest nearby building (building level); then the top lights must be medium-intensity lights, and additional low-intensity lights must be:*
    c. *provided at lower levels to indicate the full height of the structure; and*
    d. *spaced as equally as possible between the top lights and the ground level or building level, but not so as to exceed 45 m between lights.*

Advisory Circular 139.E-01 v1.0—Reporting of Tall Structures

In Advisory Circular (AC) 139.E-01 v1.0—Reporting of Tall Structures, CASA provides guidance to those authorities and persons involved in the planning, approval, erection, extension or dismantling of tall structures so that they may understand the vital nature of the information they provide.

Airservices Australia has been assigned the task of maintaining a database of tall structures. RAAF and Airservices Australia require information on structures which are:

a) 30 metres or more above ground level—within 30 kilometres of an aerodrome; or

b) 45 metres or more above ground level elsewhere for the RAAF, or

c) 30 m or more above ground level elsewhere for Airservices Australia.

The purpose of notifying Airservices Australia of these structures is to enable their details to be provided in aeronautical information databases and maps/charts etc used by pilots, so that the obstacles can be avoided.

The proposed WTGs must be reported to Airservices Australia. This action should occur once the final layout after micrositing is confirmed and prior to construction.

International Civil Aviation Organisation

Australia, as a contracting State to the International Civil Aviation Organisation (ICAO) and signatory to the Chicago Convention on International Civil Aviation (the Convention), has an obligation to implement ICAO's standards and recommended practices (SARPs) as published in the various annexes to the Convention.

Annex 14 to the Convention — *Aerodromes, Volume 1,* Section 6.2.4 provides SARPs for the obstacle lighting and marking of WTGs, which is copied below:

6.2.4 Wind turbines

6.2.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.

Note 1. — Additional lighting or markings may be provided where in the opinion of the State such lighting or markings are deemed necessary.

Note 2. — See 4.3.1 and 4.3.2

Markings

6.2.4.2 Recommendation. — The rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study.

Lighting

6.2.4.3 Recommendation. — When lighting is deemed necessary, in the case of a wind farm, i.e. a group of two or more wind turbines, the wind farm should be regarded as an extensive object and the lights should be installed:

a) to identify the perimeter of the wind farm;

b) respecting the maximum spacing, in accordance with 6.2.3.15, between the lights along the perimeter, unless a dedicated assessment shows that a greater spacing can be used;

c) so that, where flashing lights are used, they flash simultaneously throughout the wind farm;

d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located; and

e) at locations prescribed in a), b) and d), respecting the following criteria:

i) for wind turbines of less than 150 m in overall height (hub height plus vertical blade height), medium-intensity lighting on the nacelle should be provided;

ii) for wind turbines from 150 m to 315 m in overall height, in addition to the medium-intensity light installed on the nacelle, a second light serving as an alternate should be provided in case of failure of the operating light. The lights should be installed to assure that the output of either light is not blocked by the other; and

iii) in addition, for wind turbines from 150 m to 315 m in overall height, an intermediate level at half the nacelle height of at least three low-intensity Type E lights, as specified in 6.2.1.3, should be provided. If an aeronautical study shows that low-intensity Type E lights are not suitable, low-intensity Type A or B lights may be used.

Note. — The above 6.2.4.3 e) does not address wind turbines of more than 315 m of overall height. For such wind turbines, additional marking and lighting may be required as determined by an aeronautical study.

6.2.4.4 Recommendation. — The obstacle lights should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction.

6.2.4.5 Recommendation. — Where lighting is deemed necessary for a single wind turbine or short line of wind turbines, the installation should be in accordance with 6.2.4.3 e) or as determined by an aeronautical study.

As referenced in Section 6.2.4.3(e)(iii), Section 6.2.1.3 is copied below:

6.2.1.3 The number and arrangement of low-, medium- or high-intensity obstacle lights at each level to be marked shall be such that the object is indicated from every angle in azimuth. Where a light is shielded in any direction by another part of the object, or by an adjacent object, additional lights shall be provided on that adjacent object or the part of the object that is shielding the light, in such a way as to retain the general definition of the object to be lighted. If the shielded light does not contribute to the definition of the object to be lighted, it may be omitted.

As referenced in Section 6.2.4.3(b), Section 6.2.3.15 is copied below:

6.2.3.15 Where lights are applied to display the general definition of an extensive object or a group of closely spaced objects, and

a) low-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 45 m; and

b) medium-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 900 m.

Section 4.3 Objects outside the OLS states the following:

4.3.1 Recommendation.— Arrangements should be made to enable the appropriate authority to be consulted concerning proposed construction beyond the limits of the obstacle limitation surfaces that extend above a height established by that authority, in order to permit an aeronautical study of the effect of such construction on the operation of aeroplanes.

4.3.2 Recommendation. — In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation should be regarded *as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.*

Note. — This study may have regard to the nature of operations concerned and may distinguish between day and night operations.

ICAO Doc 9774 Manual on Certification *of Airports* defines an aeronautical study as:

An aeronautical study is a study of an aeronautical problem to identify potential solutions and select a solution that is acceptable without degrading safety.

Light characteristics

If obstacle lighting is required, installed lights should be designed according to the criteria set out in the applicable regulatory material and taking CASA's recommendations into consideration in the case that CASA has reviewed this risk assessment and provided recommendations.

The characteristics of the obstacle lights should be in accordance with the applicable standards in Part 139 MOS 2019.

The characteristics of low and medium intensity obstacle lights specified in Part 139 MOS 2019, Chapter 9, are provided below.

Part 139 MOS 2019 Chapter 9 Division 4 – Obstacle Lighting section 9.32 outlines Characteristics of Low Intensity Obstacle Lights.

1. *Low-intensity obstacle lights must have the following:*
    a. *fixed lights showing red;*
    b. *a horizontal beam spread that results in 360-degree coverage around the obstacle;*
    c. *a minimum intensity of 100 candela (cd);*
    d. *a vertical beam spread (to 50% of peak intensity) of 10 degrees;*
    e. *a vertical distribution with 50 cd minimum at +6 degrees and +10 degrees above the horizontal;*
    f. *not less than 10 cd at all elevation angles between –3 degrees and +90 degrees above the horizontal.*

    Note: The intensity requirement in paragraph (c) may be met using a double-bodied light fitting. CASA recommends that double-bodied light fittings, if used, should be orientated so that they show the maximum illuminated surface towards the predominant, or more critical, direction of aircraft approach.

2. *To indicate the following:*
    a. *taxiway obstacles;*
    b. *unserviceable areas of the movement area; low-intensity obstacle lights must have a peak intensity of at least 10 cd.*

Part 139 MOS 2019 Chapter 9 Division 4 – Obstacle Lighting section 9.33 outlines Characteristics of Medium Intensity Obstacle Lights.

1. *Medium-intensity obstacle lights must:*

   a. *be visible in all directions in azimuth; and*

   b. *if flashing — have a flash frequency of between 20 and 60 flashes per minute.*

2. *The peak effective intensity of medium-intensity obstacle lights must be 2 000 25% cd with a vertical distribution as follows:*

   a. *for vertical beam spread — a minimum of 3 degrees;*

   b. *at -1-degree elevation — a minimum of 50% of the lower tolerance value of the peak intensity;*

   c. *at 0 degrees elevation — a minimum of 100% of the lower tolerance value of the peak intensity.*

3. *For subsection (2), vertical beam spread means the angle between 2 directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity.*

4. *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m^2 or greater.*

Visual impact of night lighting

Annex 14 Section 6.2.4 and Part 139 MOS 2019 Chapter 9 are specifically intended for WTGs and recommends that medium intensity lighting is installed.

Generally accepted considerations regarding minimisation of visual impact are provided below for consideration in this aeronautical study:

- To minimise the visual impact on the environment, some shielding of the obstacle lights is permitted, provided it does not compromise their operational effectiveness;
- Shielding may be provided to restrict the downward component of light to either, or both, of the following:
  - such that no more than 5% of the nominal intensity is emitted at or below 5 degrees below horizontal; and
  - such that no light is emitted at or below 10 degrees below horizontal;
- If a light would be shielded in any direction by an adjacent object or structure, the light so shielded may be omitted, provided that such additional lights are used as are necessary to retain the general definition of the object or structure.
- If flashing obstacle lighting is required, all obstacle lights on a wind farm should be synchronised so that they flash simultaneously; and
- A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the rotor blades of light from the obstacle lights, without compromising the daytime visibility of the overall WTG.

Marking of WTGs

ICAO Annex 14 Vol 1 Section 6.2.4.2 recommends that the rotor blades, nacelle and upper 2/3 of the supporting mast of the WTGs should be painted a shade of white, unless otherwise indicated by an aeronautical study.

It is generally accepted that a shade of white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.

Wind monitoring towers

The details of the WMT were introduced in **Section 4** of this report.

Consideration could be given to marking any WMTs according to the requirements set out in Part 139 MOS 2019 Chapter 8 Division 10 Obstacle Markings; specifically:

> *8.110 Marking of Hazardous Obstacles*
>
> *(5) As illustrated in Figure 8.110 (5), long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that the darker colour is at the top; and the bands are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of: 1/7 of the height of the structure; or 30 m.*
>
> *(7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects.*
>
> *(8) The objects mentioned in subsection (7) must:*
> *(a) be approximately equivalent in size to a cube with 600 mm sides; and*
> *(b) be spaced 30 m apart along the length of the wire or cable.*

NASF Guideline D suggests consideration of the following measures specific to the marking and lighting of WMTs:

- the top 1/3 of wind monitoring towers to painted in alternating contrasting bands of colour. Examples of effective measures can be found in the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998. In areas where aerial application operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers
- marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires
- ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation **or**
- a flashing strobe light during daylight hours.

Temporary WMTs installed prior to WTG installation and WMTs not in close proximity to a WTG should be lit with medium-intensity steady red obstacle lighting at the top of the WMT mast. Characteristics of medium-intensity obstacle lighting is contained in MOS 139, Section 9.33

Overhead transmission lines

Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial application operators and marked in accordance with Part 139 MOS 2019 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8):

> *8.110 Marking of hazardous obstacles*
>
> *(7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects.*

(8) The objects mentioned in subsection (7) must:

(a) be approximately equivalent in size to a cube with 600 mm sides; and

(b) be spaced 30 m apart along the length of the wire or cable.

ANNEXURE 4 – RISK FRAMEWORK

A risk management framework is comprised of likelihood and consequence descriptors, a matrix used to derive a level of risk, and actions required of management according to the level of risk.

The risk assessment framework used by Aviation Projects has been developed in consideration of ISO 31000:2018 *Risk management—Guidelines* and the guidance provided by CASA in its Safety Management System (SMS) for Aviation guidance material, which is aligned with the guidance provided by the International Civil Aviation Organization (ICAO) in Doc 9589 *Safety Management Manual*, Third Edition, 2013. Doc 9589 is intended to provide States (including Australia) with guidance on the development and implementation of a State Safety Programme (SSP), in accordance with the International SARPs, and is therefore adopted as the primary reference for aviation safety risk management in the context of the subject assessment.

Section 2.1 of the ICAO Doc 9589 *The concept of safety* defines safety as follows [author's underlining]:

> *2.1.1 Within the context of aviation, safety is "the state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management."*

Likelihood

Likelihood is defined in ISO 31000:2018 as the chance of something happening. Likelihood descriptors used in this report are as indicated in Table 1.

Table 1 Likelihood Descriptors

No	Descriptor	Description
1	Rare	It is almost inconceivable that this event will occur
2	Unlikely	The event is very unlikely to occur (not known to have occurred)
3	Possible	The event is unlikely to occur, but possible (has occurred rarely)
4	Likely	The event is likely to occur sometimes (has occurred infrequently)
5	Almost certain	The event is likely to occur many times (has occurred frequently)

Consequence

Consequence is defined as the outcome of an event affecting objectives, which in this case is the safe and efficient operation of aircraft, and the visual amenity and enjoyment of local residents.

Consequence descriptors used in this report are as indicated in Table 2.

Table 2 Consequence Descriptors

No	Descriptor	People Safety	Property/Equipment	Effect on Crew	Environment
1	Insignificant	Minor injury – first aid treatment	Superficial damage	Nuisance	No effects or effects below level of perception
2	Minor	Significant injury – outpatient treatment	Moderate repairable damage – property still performs intended functions	Operations limitation imposed. Emergency procedures used.	Minimal site impact – easily controlled. Effects raised as local issues, unlikely to influence decision making. May enhance design and mitigation measures.
3	Moderate	Serious injury - hospitalisation	Major repairable damage – property performs intended functions with some short-term rectifications	Significant reduction in safety margins. Reduced capability of aircraft/crew to cope with conditions. High workload/stress on crew. Critical incident stress on crew.	Moderate site impact, minimal local impact, and important consideration at local or regional level, possible long-term cumulative effect. Not likely to be decision making issues. Design and mitigation measures may ameliorate some consequences.
4	Major	Permanent injury	Major damage rendering property ineffective in achieving design functions without major repairs	Large reduction in safety margins. Crew workload increased to point of performance decrement. Serious injury to small number of occupants. Intense critical incident stress.	High site impact, moderate local impact, important consideration at state level. Minor long-term cumulative effect. Design and mitigation measures unlikely to remove all effects.
5	Catastrophic	Multiple Fatalities	Damaged beyond repair	Conditions preventing continued safe flight and landing. Multiple deaths with loss of aircraft	Catastrophic site impact, high local impact, national importance. Serious long-term cumulative effect. Mitigation measures unlikely to remove effects.

Risk matrix

The risk matrix, which correlates likelihood and consequence to determine a level of risk, used in this report is shown in Table 3.

Table 3 Risk Matrix

		CONSEQUENCE				
		INSIGNIFICANT 1	MINOR 2	MODERATE 3	MAJOR 4	CATASTROPHIC 5
LIKELIHOOD	ALMOST CERTAIN 5	6	7	8	9	10
	LIKELY 4	5	6	7	8	9
	POSSIBLE 3	4	5	6	7	8
	UNLIKELY 2	3	4	5	6	7
	RARE 1	2	3	4	5	6

Actions required

Actions required according to the derived level of risk are shown in Table 4.

Table 4 Actions Required

8-10	**Unacceptable Risk**	Immediate action required by either treating or avoiding risk. Refer to executive management.
5-7	**Tolerable Risk**	Treatment action possibly required to achieve As Low As Reasonably Practicable (ALARP) - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.
0-4/5	**Broadly Acceptable Risk**	Managed by routine procedures, and can be accepted with no action.

ANNEXURE 5 – PROJECT TURBINE COORDINATES AND HEIGHTS

The following table is based on the highest proposed WTG model and configuration (V172 HH166) being considered for the project. The other WTG model (V162 HH150/166) has a lower maximum height.

Turbine Number	*Longitude*	*Latitude*	*Terrain Elevation (m AHD)*	*WTG Max Tip Elevation (m AGL)*	*WTG Max Tip Elevation (m AHD)*	*WTG Max Tip Elevation (ft AHD)*
T1	38°15'49.99"S	142°49'46.46"E	109	252	361	1184.4
T2	38°16'22.64"S	142°49'18.20"E	109	252	361	1184.4
T3	38°16'36.47"S	142°49'54.11"E	107	252	359	1177.8
T4	38°16'33.26"S	142°50'32.90"E	107	252	359	1177.8
T5	38°17'1.31"S	142°50'23.57"E	103	252	355	1164.7
WMT	38°16'34.13"S	142°49'37.11"E	109	140	249	816.9

AVIATION PROJECTS

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