July 2022

AVIATION IMPACT ASSESSMENT AND SOLAR GLARE REPORT

WATTA WELLA RENEWABLE ENERGY PROJECT

AVIATION PROJECTS

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ACRONYMS

AAAA	Aerial Application 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
ALA	aircraft landing area
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
AsA	Airservices Australia
ATSB	Australian Transport Safety Bureau
BESS	battery energy storage system
BoM	Bureau of Meteorology
CAAP	Civil Aviation Advisory Publications
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
CTAF	common traffic advisory frequency
DAH	Designated Airspace Handbook
DME	distance measuring equipment
ERC-H	en-route chart high
ERC-L	en-route chart low

ERSA	En Route Supplement Australia
GNSS	global navigation satellite system
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
RAAF	Royal Australian Air Force
RFDS	Royal Flying Doctor Service
RNAV	area navigation
RPT	regular public transport
RSR	route surveillance radar
SARPs	standards and recommended practices
VFR	visual flight rules
VFRG	visual flight rules guide
VHF	very high frequency
VOR	VHF omni-directional radio range
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**.

NOTES

A 5 m error budget has been applied for assessment of wind turbine generator (WTG) and wind monitoring tower (WMT) maximum height.

EXECUTIVE SUMMARY

Introduction

RES Australia Pty Limited (RES Australia) (the Proponent) is proposing to develop the Watta Wella Renewable Energy Project (the Project) in the Northern Grampians Shire Council local government area (LGA) in west Victoria, 16 km north-east of Stawell and 30 km north of Ararat to the central location of the Study Area. Aviation Projects Pty Ltd has been engaged by Umwelt (Australia) Pty Ltd to prepare an Aviation Impact Assessment for the proposed Project.

The Project is proposed to consist of up to 45 wind turbine generators (WTGs) with a maximum tip height of up to 255 m above ground level (AGL) with one temporary wind monitoring tower (WMT), a 85MW capacity solar farm made up of 1869 tables consisting of 27 solar modules per table and a 400MW/1200MWh battery energy storage system (BESS).

This Aviation Impact Assessment (AIA) has been prepared to support an application by the Proponent for a Planning Permit under the *Planning and Environment Act 1987* as well as an Environment Effects Statement (EES) referral written to the Minister of Planning.

This AIA assesses the potential aviation impacts associated with the Project, including any potential glare impacts to aviation receptors, and provides aviation safety advice in respect of relevant requirements of air safety regulations and procedures, and informs and documents consultation with relevant aviation agencies. A solar glare assessment for non-aviation receptors located in the vicinity of the Project is also conducted in consideration of Victorian State Government Solar Energy Guidelines.

This AIA report includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting and marking for client review and acceptance before submission to external aviation regulators.

Project description

The Project will comprise the following:

- up to 45 wind turbines with a maximum overall height (tip height) of up to 255 m AGL
- the highest wind turbine is WTG35 with a ground elevation of 269 m AHD (with 5 m buffer) and overall height of 524 m AHD (1719 ft AMSL)
- one proposed temporary wind monitoring tower (WMT) with a maximum height of 100 m (328.1 ft) AGL
- 85MW capacity solar farm made up of 1869 tables on a single axis tracking system consisting of 27 solar modules per table
- Associated power storage and transmission infrastructure including overhead transmission lines between the wind farm substation, switching station and terminal station. An existing overhead transmission line bisects the Project area and is higher than the proposed overhead transmission lines.

Conclusions

Based on a comprehensive analysis and assessment detailed in this report, the following conclusions were made:

Planning considerations

1. The Project as proposed satisfies the provisions of the Northern Grampians Planning Scheme regarding Stawell Airport and will not impact on the Airport Environs Overlay and Design and Development Overlay.

Certified airports

2. The Project Area is located within 30 nm (55.56 km) of three Certified Airports – Stawell Airport (YSWL), Ararat Airport (YARA) and St Arnaud Airport (YSTA)
3. The Project Area is located inside the 10 nm (+5 nm buffer) minimum sector altitude (MSA) of Stawell Airport
4. WTG35 is the highest wind turbine (overall height of 524 m AHD with 5 m buffer (1719 ft AMSL)) located within the horizontal extent of the 10 nm MSA buffer area of Stawell Airport and will be below the controlling altitude of the relevant sector by approximately 2281 ft AMSL (695 m AHD).
5. The Project Area is located beyond the horizontal extent of circling areas at Stawell Airport.

Aircraft Landing Areas (ALAs)

6. All validated ALAs are further than 3 nm from the Project Area and will not be adversely affected by any wind turbines of the Project.
7. An ALA identified at Wyndarra is located approximately 2.5 nm south-west of the nearest turbine (WTG42) and is beyond the likely limits of downwind turbulence from one to three turbines in north easterly winds.

Obstacle Limitation Surfaces

8. The obstacle limitation surfaces of Stawell Airport, Ararat Airport and St Arnaud Airport will not be impacted.

Air Routes and Lowest Safe Altitudes

9. The Project will not impact any air routes or grid lowest safe altitudes.

Airspace

10. The Project Area is located outside of controlled airspace (wholly within Class G airspace).

Aviation Facilities

11. The wind turbines of the Project will not penetrate any protection areas associated with aviation facilities.

Radar

12. The Project Area is located in Zone 4 (accepted zone) and outside the radar line of sight of Mt Macedon Route Surveillance Radar (RSR) and is not anticipated to interfere with the serviceability of this aviation facility.

Aviation Impact Statement

13. Based on the Project layout and overall turbine blade tip height limit of 255 m AGL, the blade tip elevation of the highest wind turbine, which is WTG35, will not exceed 524 m AHD (1719 ft AMSL).

14. This AIS concludes that the proposed Project:

    a) will not penetrate any obstacle limitation surface (OLS) surfaces

    b) will not penetrate Procedures for Air Navigation Services - Aircraft Operations PANS-OPS surfaces

    c) will not impact any nearby designated air routes

    d) will not have an impact on the grid lowest safe altitude (LSALT)

    e) will not have an impact on prescribed airspace

    f) is wholly contained within Class G airspace

    g) is unlikely to create downwind wake turbulence from the turbine blades in the circuit area of uncharted aerodromes or ALAs

    h) is outside the clearance zones associated with aviation navigation aids and communication facilities

    i) will not result in a glare hazard to aircraft.

Solar glare analysis

Based on the proposed layout and configuration of the solar farm and distance from any certified aerodromes, aircraft landing areas and air routes, no glare will result for aircraft operating to nearby aerodromes and flying the V223 air route in proximity to the Project. No glare is experienced for nearby dwellings and roads.

Obstacle lighting risk assessment

15. Aviation Projects has undertaken a safety risk assessment of the Project and concludes that WTGs and WMT will not require obstacle lighting to maintain an acceptable level of safety to aircraft.

Consultation

16. Refer to Section 5 for detailed responses from relevant aviation stakeholders.

Summary of key recommendations

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

The full list of recommendations and associated details is provided in Section 12 'Recommendations' at the end of this report.

1. Overhead transmission lines and/or supporting poles associated with the Project that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with Part 139 Manual of Standards (MOS) Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8) where applicable. The proposed overhead transmission lines are intended to be installed near the existing transmission line in the Project area, and at a lower height. Any changes to the planned configuration of the transmission lines should be reviewed for potential risk to aerial application operations.
2. To facilitate the flight planning of aerial application operators, the location and height of 'as constructed' wind turbines and the wind monitoring tower 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.
3. 'As constructed' details of WGT and WMT exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
4. 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations must be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
5. The Proponent should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project, noting that there is no statutory requirement to do so.
6. Details of the final wind farm layout should be provided to local and regional aircraft operators prior to construction in order for them to consider the wind farm for their operations.
7. The rotor blades, nacelles and towers of the wind turbines should be painted in white, providing sufficient contrast with the surrounding environment and to maintain an acceptable level of safety.
8. Consideration should be made to marking the temporary and permanent wind monitoring towers according to the requirements set out in Manual of Standards (MOS) Part 139 Chapter 8 Division 10 (as modified by the guidance in NASF Guideline D).

1. INTRODUCTION

1.1. Situation

RES Australia Pty Limited (RES Australia) (the Proponent) is proposing to develop Watta Wella Renewable Energy Project (the Project) in the Northern Grampians Shire Council local government area (LGA) in west Victoria, 16 km north-east of Stawell and 30 km north of Ararat to the central location of the Study Area.

The Project is proposed to consist of up to 45 WTGs, an 85MW capacity solar farm and a 400MW/1200MWh battery energy storage system (BESS).

The maximum tip height for the proposed WTGs will be up to 255 m AGL.

Umwelt has engaged Aviation Projects to prepare an AIA to assess the potential aviation safety impacts associated with the Project to support the proposed planning permit application and statutory approval from DELWP as well as an Environment Effects Statement referral to the Minister of Planning.

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. Solar glare analysis is performed on the PV installation in consideration of impacts to aviation receptors and to non-aviation receptors located near the Project. (Within 1 km)

This AIA report includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting and of applicable aspects for client review and acceptance before submission to external aviation regulators.

The AIA and supporting technical data will provide evidence and analysis for the planning application and EES referral to demonstrate that appropriate risk mitigation strategies have been identified.

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 an application for a planning permit under *the Planning and Environment Act 1987* as well as an EES referral written to the Minister of Planning.

The assessment specifically responds to the:

- Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria, dated November 2021
- Northern Grampians Planning Scheme
- NASF Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*
- Other specific requirements as advised by Airservices Australia.

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:

- Confirm the scope and deliverables with the Proponent
- Review client material
- Review relevant regulatory requirements and information sources
- 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
- Prepare a solar glare analysis using the ForgeSolar software
- Prepare an AIS and a qualitative risk assessment to determine need for obstacle lighting and marking
- 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*
- Consult with relevant Councils, Part 173 procedure designers (Airservices Australia) and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable)
- Consult/engage with stakeholders to negotiate acceptable outcomes (if required)
- Finalise the AIA report for client acceptance when responses received from stakeholders for client review and acceptance.

1.4. Aviation Impact Statement

The AIS includes the following specific requirements as advised by Airservices Australia:

Aerodromes:

- Specify all certified aerodromes that are located within 30 nm (55.56 km) of the Project Area
- Nominate all instrument approach and landing procedures at these aerodromes
- Review the potential effect of the Project operations on the operational airspace of the aerodrome(s).

Air Routes:

- Nominate air routes published in ERC-L & ERC-H which are located near/over the Project Area and review potential impacts of Project operations on aircraft using those air routes
- Specify two waypoint names located on the routes which are located before and after the obstacles.

Airspace:

- Nominate the airspace classification – A, B, C, D, E, G etc where the Project Area is located.

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

Material provided by the client for preparation of this assessment included:

- Location Coordinates, filename: WW_WTG_WMT_Ground_Elev_200521
- WTG and WMT data, GIS filename: 04372-RES-ERW-M2-PRE_IMINARY_LAYOUT_DRAFT02_Polylines.shp
- Solar Farm layout, GIS Filename: Infrastructure02_Table_20210420.shp
- Umwelt Solar Data Pack, Typical Drawings / Example Infrastructure \
- Wind turbine downwind wake turbulence studies
- Project Commissioning Report, 100 m Temp Mast Install, Report No. 20454, Rev 01

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AVIATION PROJECTS

2. BACKGROUND

2.1. Site overview

The closest townships to the wind energy facility and solar farm site include Stawell, 16 km south-west, Great Western 18 km south-west and Ararat 30 km south of the central part of the Project Area.

An overview of the Project Area relative to localities of Stawell, Great Western and Ararat provided in Figure 1 (source: Umwelt, Google Earth).

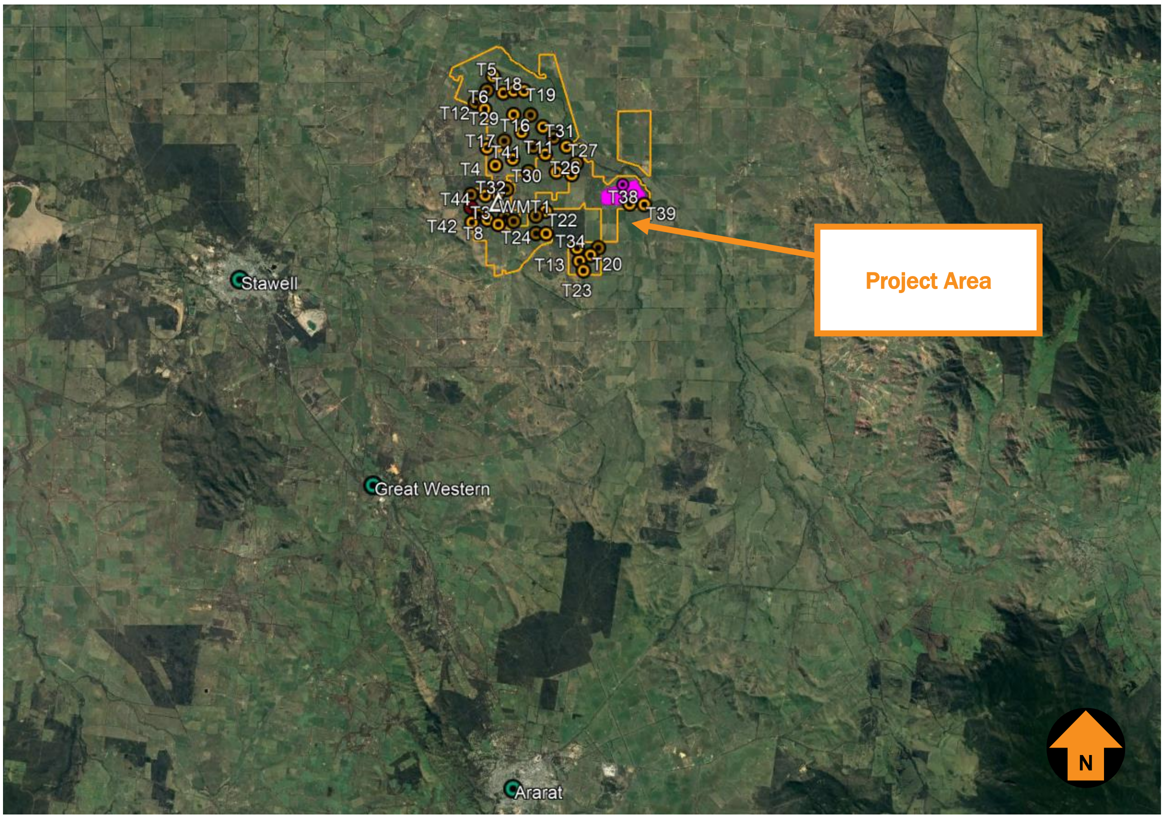

Figure 1 Project Area overview

2.2. Project description

The Watta Wella Renewable Energy Project is proposed to consist of up to 45 wind turbines and one temporary WMT. The solar farm is proposed to be made up of 1869 tables each containing 27 solar modules. Overhead transmission lines will be installed between the wind farm substation, switching station and terminal station. The overhead transmission lines are anticipated to be installed next to the existing transmission line, but at a lower height.

An indicative layout of the proposed wind farm and solar facility is provided in Figure 2 (source: RES), including the 45 indicative wind turbine locations and 1 indicative WMT location.

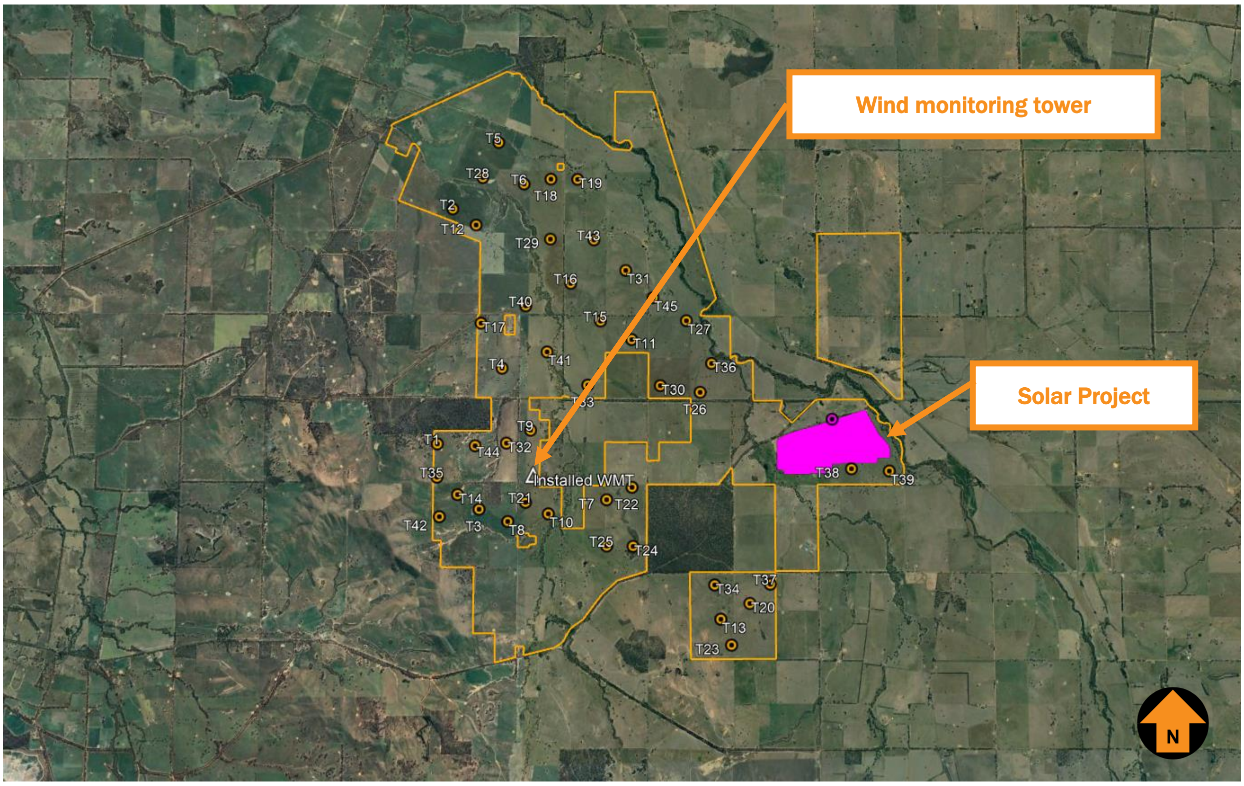

Figure 2 Project layout

3. EXTERNAL CONTEXT

This chapter explores the federal, state, and local planning context that may impact the Project. Each section will explore and respond to the planning context to identify any conflict between the Project and applicable planning requirements.

3.1. Victorian planning context

The Department on Environment, Land, Water and Planning (DELWP) has published *Development of Wind Energy Facilities in Victoria Policy and Planning Guidelines* (revised November 2021). These guidelines provide advice to inform planning decisions about a wind energy facility proposal.

The purpose of these guidelines is to set out:

- a framework to provide a consistent and balanced approach to the assessment of wind energy projects across the state
- a set of consistent operational performance standards to inform the assessment and operation of a wind energy facility project
- guidance as to how planning permit application requirements might be met.

The guidelines provide advice regarding locations in the state that are not appropriate for wind energy facilities. They also give a framework to ensure proposals for wind energy facilities are thoroughly assessed, including other considerations and approvals required in the process.

Section *4.3.6 Aircraft safety issues* and Section 5.1.5 *Aircraft safety* are relevant to this AIA and details are extracted below:

> *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 for a wind energy facility permit 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.*

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

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. Northern Grampians Planning Scheme

The Project is located within the Northern Grampians Shire LGA and therefore, subject to the Northern Grampians Planning Scheme (the Planning Scheme).

Clause 02.03-8 (Transport) of the Planning Scheme identifies the Stawell Aerodrome as a valuable economic and strategic asset within the region, including serving as a major emergency response base. It states '*the aerodrome caters for the general aviation needs of the region and is home to many aviation-related businesses, such as fire bombing, aircraft maintenance and restoration, crop-spraying, flying instruction, charter and recreational flight services. Planning must seek to protect the Stawell Aerodrome, as a key element in the local transport infrastructure of the region'*.

The strategic directions of Clause 02.03-8 (Transport) of relevance to the Project and this assessment includes:

> *Support the ongoing operation of the Stawell Aerodrome, including any future expansions.*

The Airport Environs Overlay (AEO) of the Planning Scheme applies the Stawell Airport. The purpose of the AEO is to:

> *To implement the Municipal Planning Strategy and the Planning Policy Framework.*
>
> *To identify areas which are or will be subject to high levels of aircraft noise, including areas where the use of land for uses sensitive to aircraft noise will need to be restricted.*
>
> *To ensure that land use and development are compatible with the operation of airports in accordance with the appropriate airport strategy or master plan and with safe air navigation for aircraft approaching and departing the airfield.*
>
> *To assist in shielding people from the impact of aircraft noise by requiring appropriate noise attenuation measures in new dwellings and other noise sensitive buildings.*
>
> *To limit the number of people residing in the area or likely to be subject to significant levels of aircraft noise.*

Schedule 4 to the Design and Development Overlay (DDO4) of the Planning Scheme relates to the Stawell Aerodrome Obstacle Limitation Surface Protection Area. The DDO4 includes the design objectives for the protection of the Stawell Airport's obstacle limitation surfaces (OLS) which are copied below:

> *To maintain the efficiency and safety of aircraft operations at the Stawell Aerodrome.*
>
> *To ensure development and landscaping does not present a hazard to aircraft take offs and landings at the Stawell Aerodrome.*
>
> *To ensure that development is appropriately sited and compatible with the operation of the Stawell Aerodrome.*
>
> *To ensure that all buildings and works minimise impacts on the safe operation of the Stawell Aerodrome.*
>
> *To recognise and implement any approved Obstacle Surface Limitation chart.*

Figure 3 below shows the extent of the DDO4.

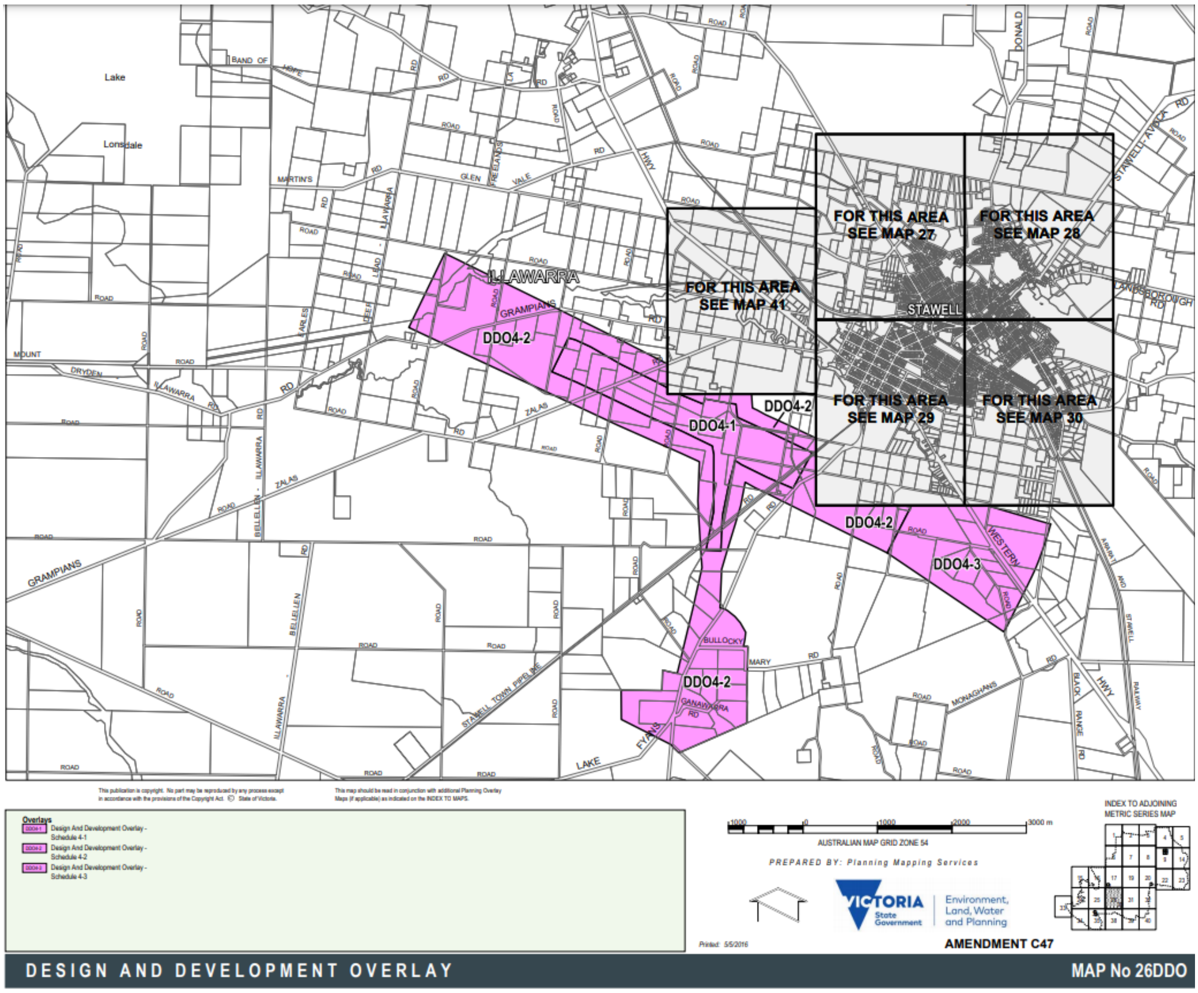

Figure 3 Northern Grampians Planning Scheme Design and Development Overlay – Schedule 4

The Project will not impact The Airport Environs Overlay or the Design and Development Overlay applied to Stawell Aerodrome established in the Planning Scheme.

3.3. Stawell Aerodrome Master Plan

The Draft *Stawell Aerodrome Master Plan Review* was prepared by Airports Plus Pty Ltd in November 2014. Airports Plus Pty Ltd undertook the Master Plan in 2008 which was adopted by the Northern Grampians Shire Council in January 2009. The review of the Master Plan was initiated to bring the master plan document up to date and consider any future development. The Council adopted the review in 2015.

The Master Plan provides guidance and strategies for the current and future uses of Stawell Aerodrome. There is reference in the 2014 review about potentially lengthening the main runway 11/29 to accommodate large aircraft associated with aerial fire-fighting operations. The runway extension is constrained by land ownership issues.

There is no reference in the master plan review of upgrading the aerodrome to a Code 4 and therefore expanding the applicable Obstacle Limitation Surface (OLS) dimensions.

The maximum distance an OLS extends from an aerodrome is 15,000 m. The Project is located more than 15,000 m from Stawell aerodrome and outside of the OLS associated with current and future aerodrome operations.

3.4. National Airports Safeguarding Framework

The National Airports Safeguarding Advisory Group (NASAG) was established by the Commonwealth Department of Infrastructure and Transport to develop a national land use planning framework called the National Airports Safeguarding Framework (NASF). The purpose of this framework 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 wind monitoring towers.

The methodology for preparing the risk assessment is contained in the NASF Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*.

The risk assessment will have regard to all potential aviation activities within the vicinity of the Project Area 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.

3.5. 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 in Figure 4 and Figure 5

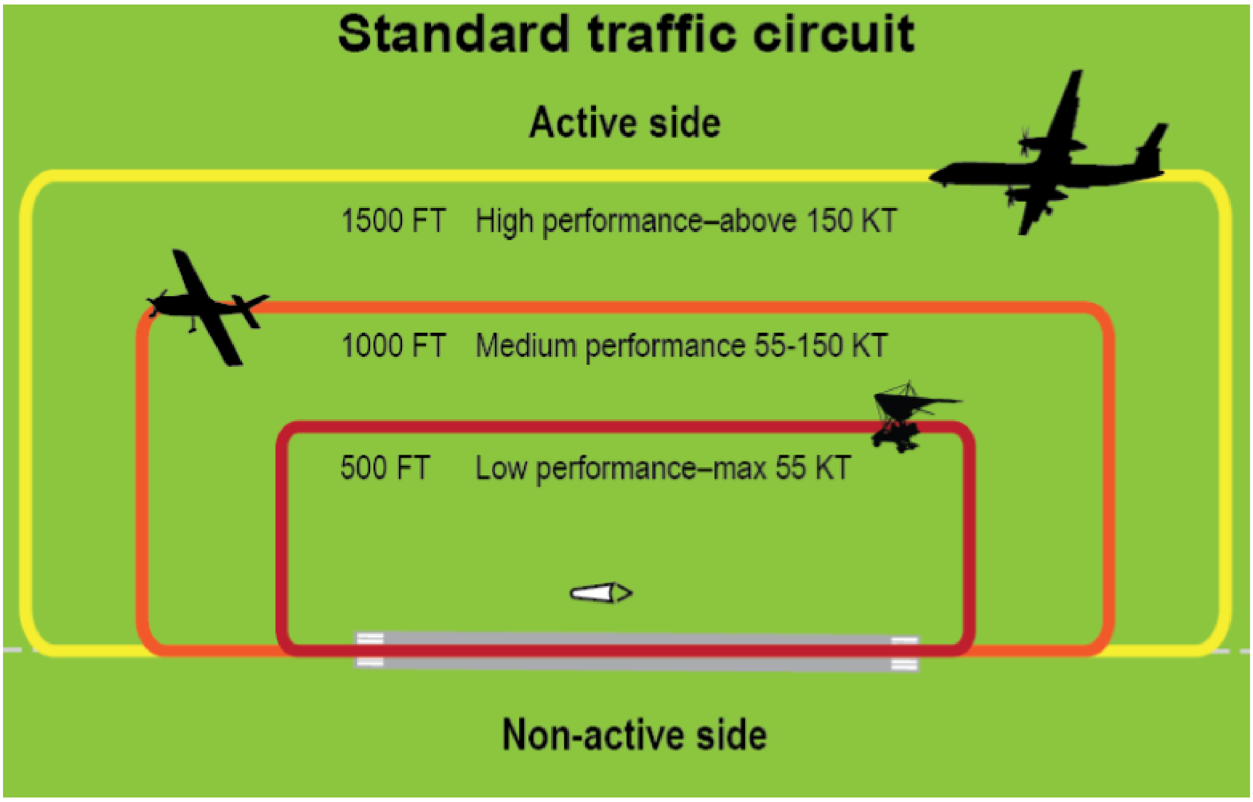

Figure 4 Lateral and vertical separation in the standard aerodrome traffic circuit

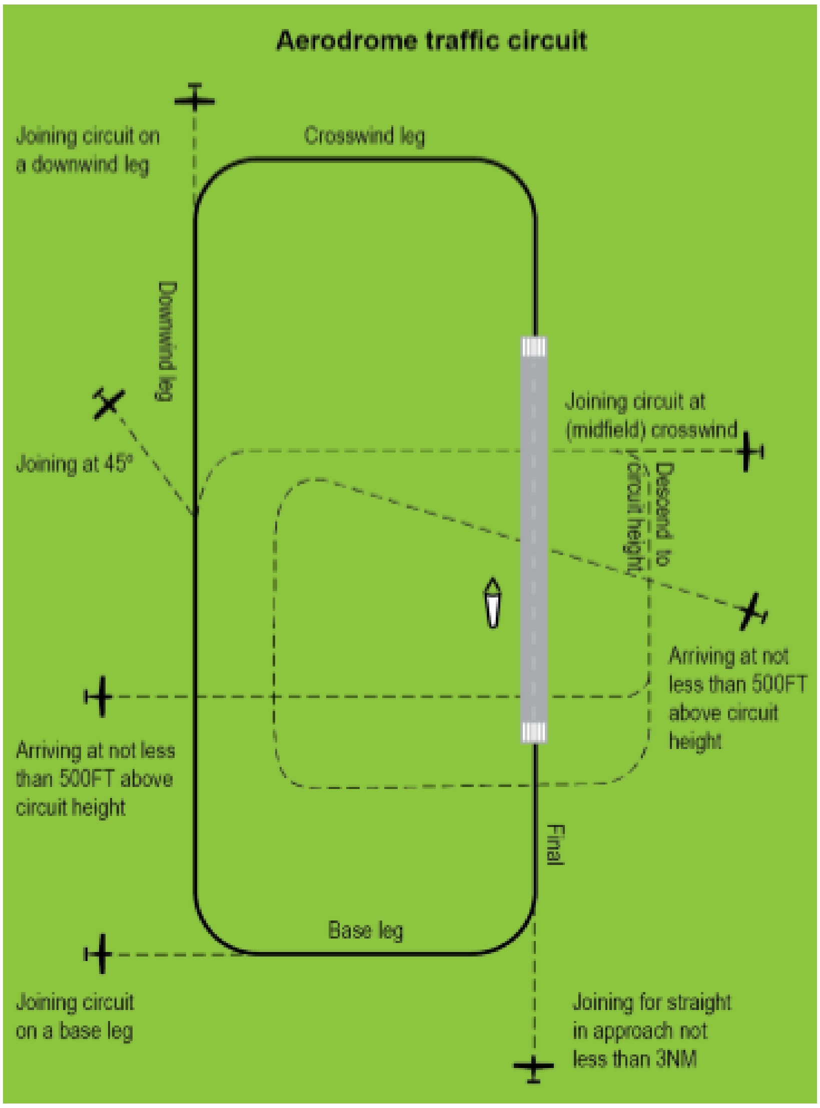

Figure 5 Aerodrome standard traffic circuit, showing arrival and joining procedures

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.*

3.6. Rules of flight

3.6.1. 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 Regulations (1998) 91.267 (Minimum height rules—other areas) prescribes the minimum height for flights in areas other than populous areas or public gatherings. Aircraft are required to maintain 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.

These rules do not apply during normal take-off and landing operations in accordance with procedures for operations at non-controlled aerodromes.

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

3.6.2. 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.*

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

According to CASR 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.

3.7. 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 wind turbines) and clear of the highest point of the terrain by 500 ft vertical distance and 300 m horizontal distance in areas outside populous areas. In VMC, the wind turbines 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 wind turbines 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 above the highest point of the terrain.

It is expected that the wind turbines will be sufficiently visually conspicuous to pilots conducting VFR operations within the vicinity of the Project to enable appropriate obstacle avoidance maneuvering.

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

3.8. Passenger transport operations

Regular public transport (RPT) and passenger carrying charter operations are generally operated under the IFR.

3.9. 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 and outside 300 m from known or observed obstacles and/or terrain.

3.10. Military operations

There may be occasional high-speed low-level military jet aircraft and helicopter operations conducted in the area. The Project is not located near to any Defence aviation establishment that would regularly conduct such operations.

3.11. Aerial agricultural operations

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

There is a medium rate of aerial application operations in the area.

Due to the nature of the operations conducted, aerial agriculture pilots are subject to rigorous training and assessment requirements in order 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.

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

Refer to Section 5 for detailed responses from aerial agricultural operator stakeholders.

3.12. Aerial Application Association of Australia

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

> *As a result of the overwhelming safety and economic impact of wind farms and supporting infrastructure on the sector, AAAA opposes all wind farm developments in areas of agricultural production or elevated bushfire risk.*
>
> *In other areas, AAAA is also opposed to wind farm developments unless the developer is able to clearly demonstrate they have:*
>
> > *1. consulted honestly and in detail with local aerial application operators;*
> >
> > *2. sought and received an independent aerial application expert opinion on the safety and economic impacts of the proposed development;*
> >
> > *3. clearly and fairly identified that there will be no short or long term impact on the aerial application industry from either safety or economic perspectives;*
> >
> > *4. if there is an identified impact on local aerial application operators, provided a legally binding agreement for compensation over a fair period of years for loss of income to the aerial operators affected; and*
> >
> > *5. adequately marked any wind farm infrastructure and advised pilots of its presence.*

AAAA had developed National Windfarm Operating Protocols (adopted May 2014). These protocols note the following comments:

> *At the development stage, AAAA remains strongly opposed to all windfarms that are proposed to be built on agricultural land or land that is likely to be affected by bushfire. These areas are of critical safety importance to legitimate and legal low-level operations, such as those encountered during crop protection, pasture fertilisation or firebombing operations.*
>
> *However, AAAA realises that some wind farm proposals may be approved in areas where aerial application takes place. In those circumstances, AAAA has developed the following national operational protocols to support a consistent approach to aerial application where windfarms are in the operational vicinity.*

The protocols list considerations for developers during the design/build stage and the operational stage, for pilots/aircraft operators during aircraft operations and discusses economic compensation. NASF Guideline D is included in the Protocols document as Appendix 1, and AAAA Aerial Application Pilots Manual – excerpts on planning are provided as Appendix II.

This Aviation Impact Assessment has been prepared in consideration of the National Windfarm Operating Protocols.

3.13. Local aerial application operators

Local aerial application operators consulted in previous studies undertaken by Aviation Projects have stated that a wind farm would, in all likelihood, prevent aerial agricultural operations in that particular area, but that properties adjacent to the wind farm would have to be assessed on an individual basis.

Aerial application operators generally align their positions with the AAAA policies.

Based on previous studies undertaken by Aviation Projects, and subject to the results of consultation with AAAA and any further consultation with local aerial application operators, it is reasonable to conclude that safe aerial application operations would still be possible on properties within and neighbouring the Project area by implementing recommendations provided in this report.

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.

To facilitate the flight planning of aerial application operators, details of the Project, including 'as constructed' location and height information of wind turbines, wind monitoring towers 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.

3.14. Aerial firefighting

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

Most 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 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.*

Refer to Section 5 for detailed responses from aerial firefighting stakeholders including CFA.

3.15. Emergency services - Royal Flying Doctor Service/Air Ambulance

Royal Flying Doctor Service (RFDS)/Air Ambulance 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.

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.

4. INTERNAL CONTEXT

4.1. Wind farm location

The wind farm is situated in an area comprised mainly of farming properties on a landscape with rolling terrain.

4.2. Wind turbine description

The maximum blade tip height of the proposed wind turbines will be up to 255 m AGL.

The highest ground elevation of any of the proposed wind turbines (WTG35) is 264 m AHD, which, with a 5 m error budget, results in a maximum overall height of 524 m AHD (1719 ft AMSL).

Figure 6 demonstrates the Project layout identifying the highest wind turbine WTG35 (source: RES, Google Earth).

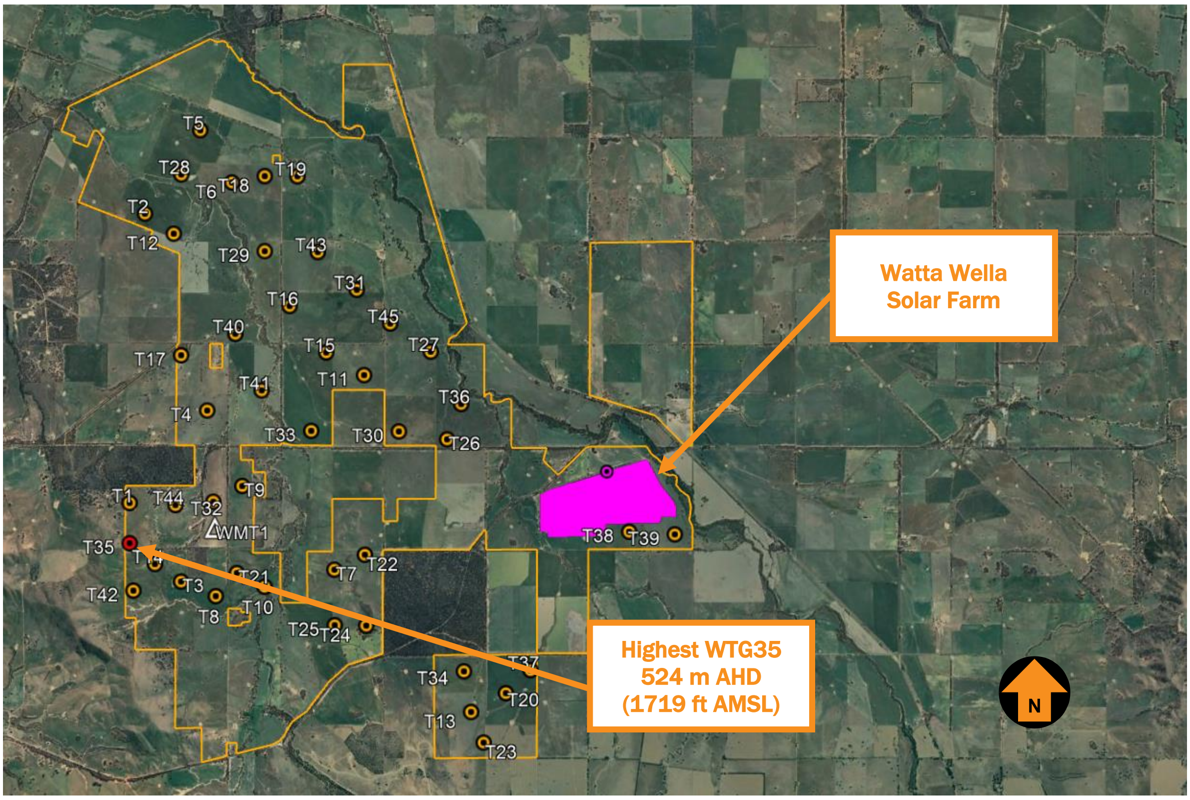

Figure 6 Project layout and highest wind turbine

The coordinates and ground elevations of the Project wind turbines analysed are listed in Annexure 3.

4.3. Wind monitoring tower description

A WMT with a maximum height of 100 m (328.1 ft) AGL in height was installed in February 2022. The details of the WMT were reported to Airservices Australia. The WMT location is provided in Figure 7. (Source: RES, Google Earth)

A separate AIA was undertaken for the temporary WMT and is provided as an Annexure to this report. (Reference: 10220302_Watta_Wella_WF_WMT_AIA_v1.0_220624)

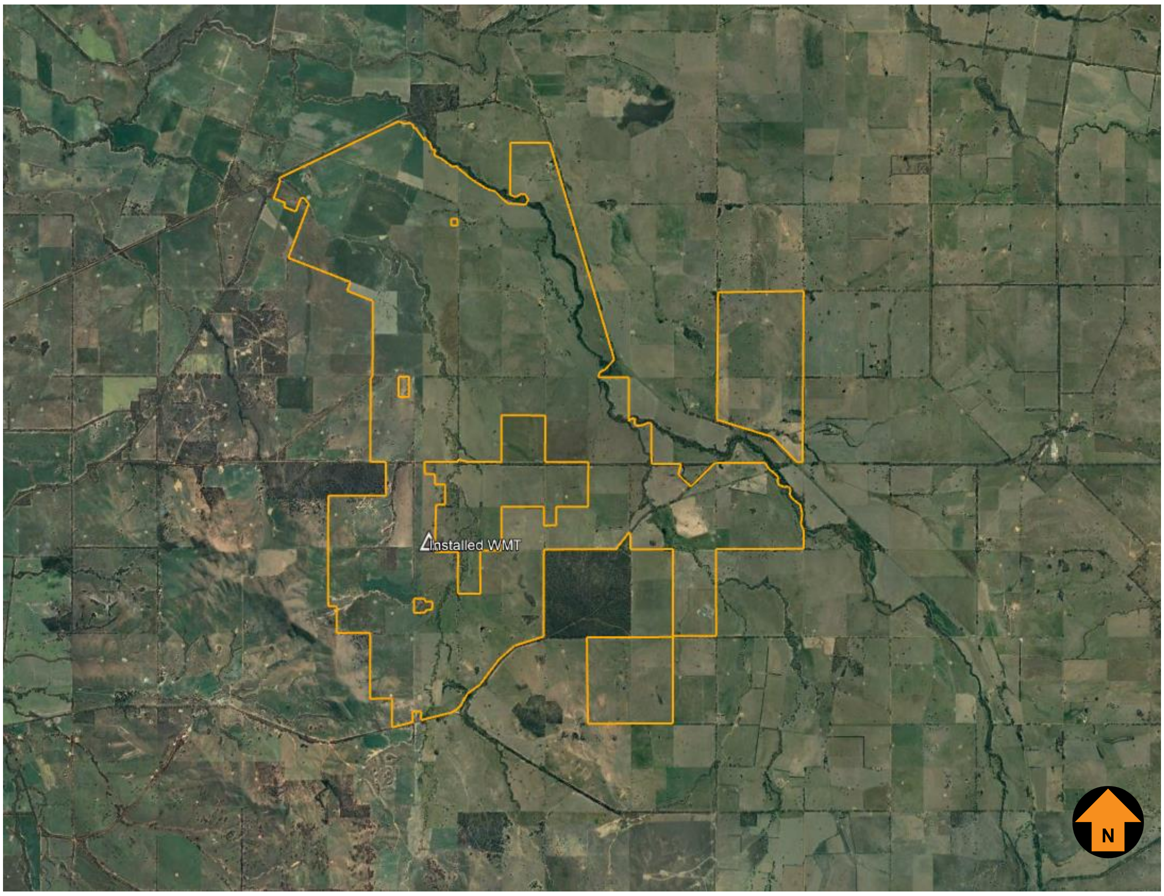

Figure 7 Installed temporary WMT location within Project Area

Table 1 provides the details of the temporary WMT provided by RES.

Table 1 Temporary WMT details

Parameter	**Details**
WMT ID	WMT1
Location	37.023927°S 142.919895°E
Error budget (m)	5 m
Ground elevation at site (approximate)	239 m (784 ft AMSL)
Height of tower AGL	100 m (328.1 ft)
WMT tip height AHD	344 m AHD (1,129 ft AMSL)
Lighting	Nil – assessed as not required
Marking	Marker balls at 2/3 of mast height, top 1/3 painted in red/white/red bands, Marking at guy bases
Design	Steel lattice
Commissioning date	6/02/2022
Reported to Airservices Australia	10/02/2022

5. CONSULTATION

The stakeholders consulted include:

- Airservices Australia
- Ararat Rural City Council
- Northern Grampians Shire Council
- Department of Defence
- Royal Flying Doctor Service
- Country Fire Authority VIC
- AgAir (VIC)
- Wyndarra ALA Owner

Details and results of the consultation activities are provided in Table 2.

Table 2 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices Australia	Consultation email sent 02 September 2021	Response received 14 October 2021 from William Zhao (Advisor Customer Engagement)	*…Summary* *Based on the above assessment, our view is that the proposed wind farm would not have an impact on any Airservices designed instrument procedures, CNS facilities or ATC operations at Melbourne Airport.* *Vertical Obstacle Notification* *We request that the proponent completes the Vertical Obstacle Notification Form for tall structures and submits it to VOD@airservicesaustralia.com as soon as the development reaches the maximum height.*	Report tall structures to VOD@airservicesaustralia.com Vertical Obstacle Notification Form: https://www.airservicesaustralia.com/wp-content/uploads/Tall-Structure-Vertical-Obstacle-Form.pdf
Northern Grampians Shire Council	Consultation email sent 02 September 2021	Response received 01 October 2021 from Klaas Meekel (Statutory Planner)	*…All permits for wind farms in Victoria are now processed by DELWP (on behalf of the Minister).* *Council does not have the internal expertise to be able to give any meaningful comments / feedback on your attached report. Your report, together with all other required specialist reports for the planning permit, should therefore be sent to DELWP.*	No further action required.

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Ararat Rural City Council	Consultation email sent 02 September 2021	Response received 22 October 2021 from Veronica Schilling (Manager Planning, Community and Compliance)	*We have reviewed the materials and also liaised with the Ararat Airport Manager. We have no issue with the proposal at all.*	No further action required.
CASA	CASA has advised that it will only review assessments referred to it by a planning authority or agency.			
CFA VIC	Consultation email sent 02 September 2021	Response received 03 September 2021 Email from Luke Patterson (Commander Aviation)	Luke Patterson replied…*As you would be aware it's the pilot's responsibility to maintain separation alike any other vertical hazard eg communications tower, masts, terrain etc. A wind turbine tower is no different.* *Each aircraft and pilot have varying levels of experience, ability and other external factors ie weather to determine what separation they need to maintain – a wind turbine by itself or together as a facility isn't a major impediment to aerial firefighting operations as they're easily seen and reasonably known. However, the risk of metrological weather masts and associated guy wires under 150 feet in researching sites are a known*	It was recommended by CFA to consult with Agair (admin@agair.com.au). Agair added to consultation list. Action – consult with Agair.

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			hazard to fire aviation activities which are unmarked on navigational charts and unlit/unidentified. Copies of AFAC doctrine and Guidelines for Wind Energy Facilities were also attached to the response email and have been previously referenced in this AIA.	
Department of Defence	Consultation email sent 02 September 2021 Reminder email sent 18 October 2021 and again 09 February 2021	Response received 03 March 2022 by Charles Mangion, Director of Land Planning and Regulation	*Thank you for referring the abovementioned wind farm proposal to the Department of Defence (Defence) for comment. Defence understands that this is a proposal for the construction and operation of a wind farm 16km northeast of Stawell Township Victoria with 45 turbines and maximum height of 255 metres AGL (to blade tip)* *As tall structures, wind farms can have the potential to pose a number of concerns for Defence, particularly with regard to aircraft safety, military low flying and radar interference. Defence has conducted an assessment of the amended proposal for potential impacts on the safety of Defence flying operations.* *There is an ongoing need to obtain and maintain accurate information about tall structures so that this information can be marked on aeronautical charts. Marking tall structures on aeronautical charts assists pilot navigation and enhances flight safety. Airservices Australia (ASA) is responsible for recording the location and height of tall structures. The information is held in a*	Report construction of structures as per recommendations in this assessment.

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			central database managed by ASA and relates to the erection, extension, or dismantling of tall structures, the top of which is above: *a. 30 metres AGL, that are within 30 kilometres of an aerodrome; and* *b. 45 metres AGL elsewhere.* *The proposed 250 metres AGL turbines meet the requirements for reporting of tall structures. Defence therefore requests that the applicant provide ASA with "as constructed" details. The details can be emailed to ASA at vod@airservicesaustralia.com.* *Defence notes that the National Airports Safeguarding Framework Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers recommends that where a wind turbine 150 metres or taller in height is proposed away from aerodromes, the proponent should conduct an aeronautical risk assessment and submit that assessment to the Civil Aviation Safety Authority (CASA) to determine whether the proposal is a hazard to aircraft safety and requires approved lighting or marking.* *If CASA determines that obstacle lighting is to be provided, it should be compatible with persons using*	

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			night vision devices. If LED lighting is proposed, the frequency range of the *2* *Defending Australia and its National Interests* *LED light emitted should be within the range of wavelengths 665 to 930 nanometres. Defence also requests that the colour used for the wind turbines ensure that they are conspicuous to aircraft during daylight hours.* *Defence has no objection to the proposed wind farm provided that the project complies with the above conditions.* *Should you wish to discuss the content of this advice further, my point of contact is Tim Hogan at land.planning@defence.gov.au or telephone on (02) 5109 7933.*	
RFDS	Consultation email sent 02 September 2021 Reminder email sent 18 October 2021	Nil response	N/A	No further action required
AgAir	Consultation email sent 06 September 2021	Response received 07 September 2021	Response from Rob Boschen (CEO Agair) *...Being the primary tenant at Stawell airport and a major contractor to the State Government of Victoria for*	Consider implementing marking in accordance with recommendations specified in NASF and per the

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			firebombing aircraft, as well as providing an aerial application service to the agriculture sector in the region, any constructions such as this do impact on our business. Any impact that adversely affects the safety of our aircraft operations is of great concern. *We align ourselves with the AAAA Windfarm policy and communicate with our customers and suppliers the risks that windfarm developments create to our business. Apart from the obvious risk to safe flight that exists with wind towers, our clients are reminded that the quality of workmanship either in aerial application or firebombing will be compromised should application aircraft be required to manoeuvre around obstacles such as these. This lower degree of quality will come at a financial cost to our client. Of most concern to our business with wind farm developments are the construction of the 'met towers'. These towers seem to 'spring' up anywhere very quickly and without notice. They are hard to see and are generally located in an area well away from any other vertical structures.* *Although your research shows no incidents of aircraft colliding with met towers it is not due to good management. Businesses operating aircraft at low level train their flight crew to look for, and be very vigilant when operating around these structures. Because they*	specifications of Part 139 MOS 2019. Refer WMT assessment 102203-02 (Annexure report)

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			are so hard to see it is equally hard for a pilot to remember where they are at all times and determine accurate distance reference from the tower or guy wires once in the pilots field of view. *This is an area that wind farm proponents would do well to focus on so as to share the management of risk more equitably with flight crews of aircraft operating at low level.*	
ALA Operator (Rick & Diane Holden) – initial consultation	Consultation email sent 06 September 2021	Response received 06 September 2021	Response from Rick Holden - *After looking closely at the proposed turbine site it is quite obvious that my ALA will be affected by the positioning of some of the most South Westerly turbines.* *Please take on board that the aircraft affected by those turbines are high performance light weight aircraft that cruise at the same TAS as the Cessna 210 and the Beech bonanza A36/F33A (165 TAS). However they are much lighter weight and more susceptible to Wake turbulence emanating from these extra-large wind turbines……. That is fact!!!* *The 2 aircraft presently operating on a regular basis out of our ALA are Vans Aircraft RV9 & RV3B, they are* ***not*** *LSA aircraft. They need the same circuit area as your C210 or Bonanza.*	Action taken – Aviation Projects were engaged specifically to liaise directly with the Holden family (engagement reference 102303-03) and attend the ALA site for further investigation. The engagement concluded that '*the wind farm is far enough away from Mr Holden's ALA that wind shear from the nearest WTGs is unlikely to have an adverse impact upon his take-off and landing activities, as opposed to the trees and nearby terrain which he recognises as a hazard that he addresses each time he goes flying.'*

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			I strongly recommend you play by the rules and remove the offending turbines from the proposed present wind farm plan. *This paramount safety issue will be closely watched.*	
ALA Operator (Rick and Dianne Holden) Onsite consultation with RES and Aviation Projects representatives 2022	8 February 2022	17 February 2022, by Rick Holden.	*There is no doubt Wind turbines do create significant Wake Turbulence. What is unclear is how potentially dangerous it can be. After carefully reading your Aviation Impact Assessment pages 32 to 35 I was impressed with your analysis and agree we do have a real problem of safety that needs to be addressed. From the practical standpoint, yes we do come well within the 2.8 Kms (16 x 178M) during a normal legally executed take off on our runway 07 with standard LH circuit. As you correctly point out on page 34, turbines WTG1, WTG14 & WTG35 and may I suggest from the plan WGT42 do pose an unacceptable risk to the safety of our operations during North Easterly wind conditions. As Dan made clear, they are able to move turbines around as necessary to mitigate risk to everyone's satisfaction.* *For us (Myself, Jason & Jon) this is a very serious situation we find ourselves in.* *Sincerely,* *Rick Holden*	Mr Holden's main concern is the additional turbulence that he believes will cause him a hazard when operating at his Wyandra airstrip (ALA) Further investigations into studies for the extent of wind farm generated turbulence have been obtained from RES Head Office in England. Assessment of the extent of this turbulence is referred to later in this report.

AVIATION PROJECTS

6. AVIATION IMPACT STATEMENT

6.1. Nearby certified aerodromes

The Project area is located within 30 nm (55.56 km) of three certified airports – Stawell Airport (YSWL), Ararat Airport (YARA) and St Arnaud Airport. (YSTA)

The location of the Project Area relative to Stawell, Ararat and St Arnaud Airports is shown in Figure 8 (source: Umwelt, OzRunways, Open Street Map).

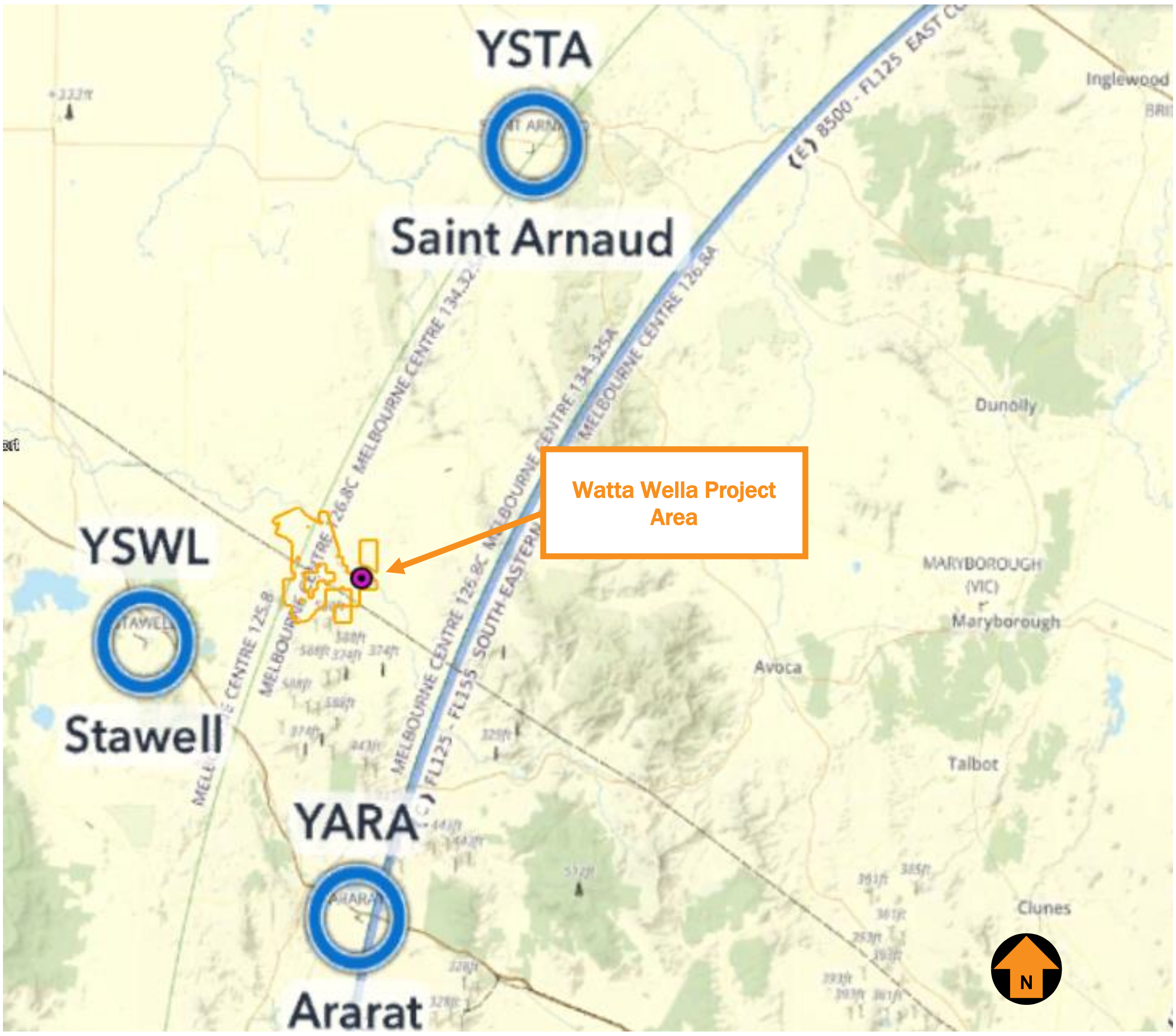

Figure 8 Location of Certified Airports within 30 nm of Watta Wella Renewable Energy Project

Figure 9 shows a 30 nm arc for Stawell Airport which is associated with a 25 nm minimum sector altitude (MSA) of this airport plus 5 nm buffer areas (source: Umwelt, Google Earth).

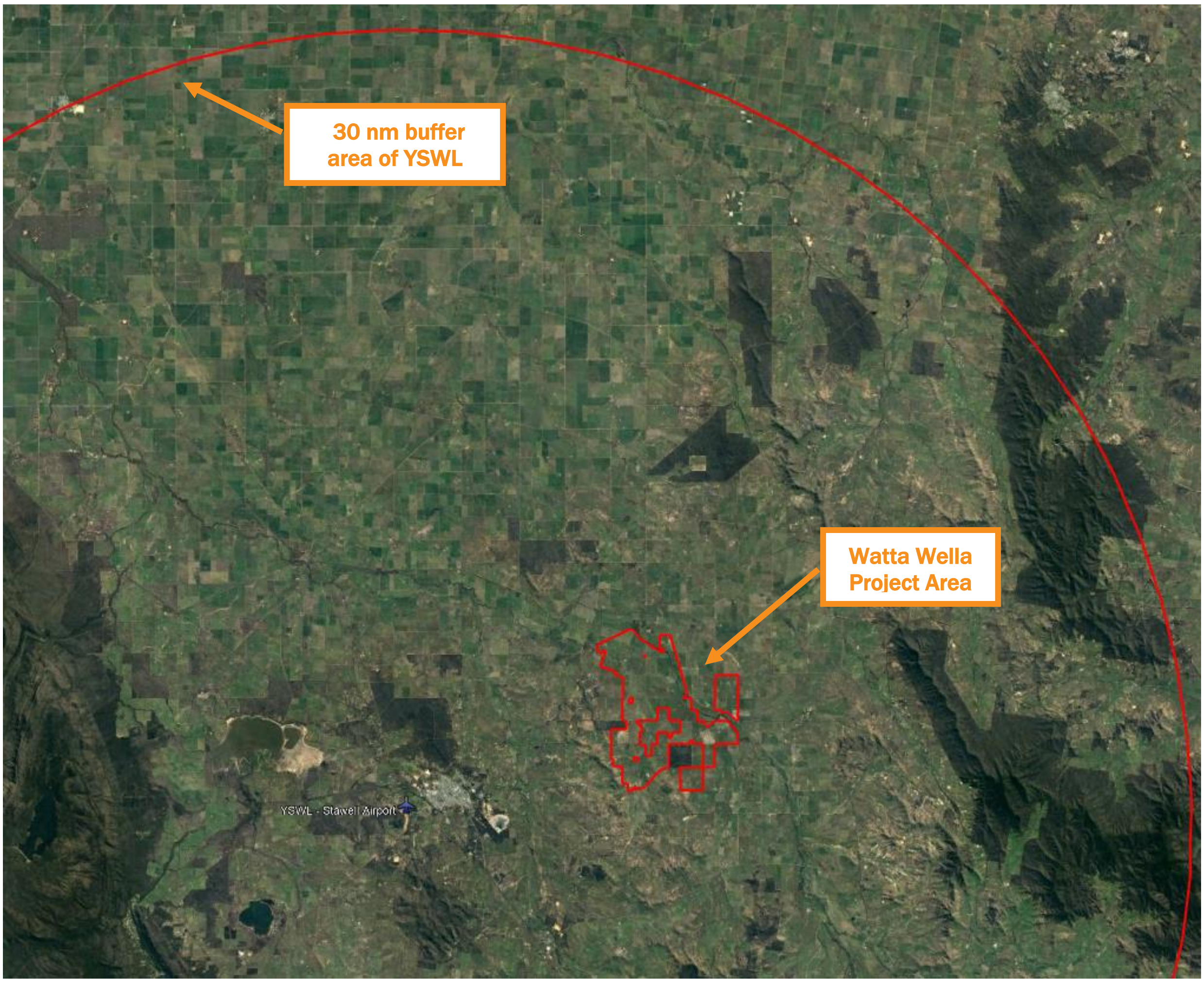

Figure 9 Stawell Airport 30 nm buffer areas

6.2. Stawell Airport

Stawell Airport (YSWL) is a certified aerodrome operated by Northern Grampians Shire Council, with a published aerodrome elevation of 246 m AHD (807 ft AMSL) (source: Airservices Australia, Aerodrome Chart SWLAD01-166, 25 March 2021).

Stawell Airport has two runways:

- Runway 11/29 sealed runway with a length of 1403 m, width 30 m and runway strip 90 m
- Runway 18/36 sealed runway with a length of 854 m, width 18 m and runway strip 90 m.

Figure 10 shows the Stawell Airport (YSWL) runway layout (source: AsA, Aerodrome Chart, dated 21 March 2021).

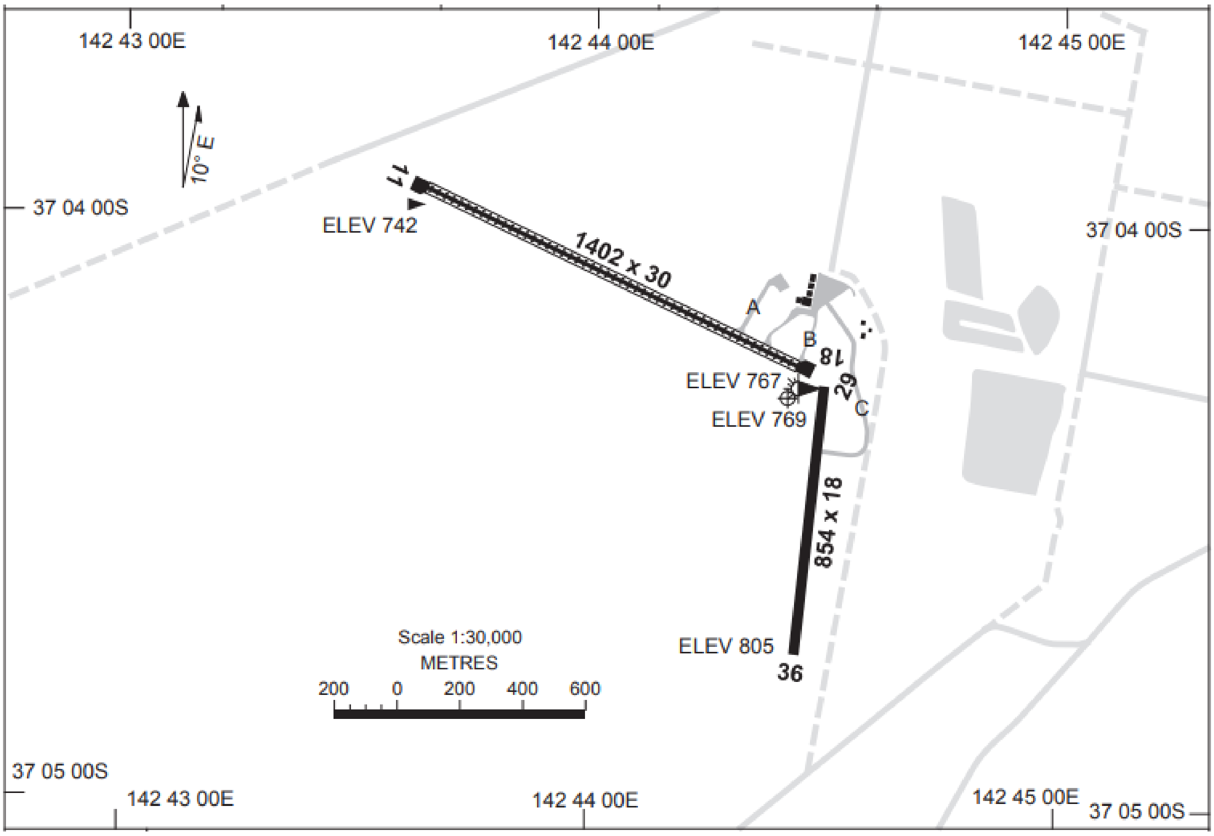

Figure 10 Stawell Airport runway layout

Stawell Airport's Aerodrome Reference Point (ARP) coordinates published in Airservices Australia's ERSA are Latitude 37°04'18"S and Longitude 142°44'25"E.

6.3. Instrument procedures – Stawell Airport

A check of the AIP via the Airservices Australia website showed that Stawell Airport is served by non-precision terminal instrument flight procedures, as per Table 3 (source: Airservices Australia June 2022).

Procedure charts for Stawell Airport are designed by Airservices Australia and are noted accordingly.

Table 3 Stawell Airport (YSWL) aerodrome and procedure charts

Chart name	*Effective date*
AERODROME CHART (AsA)	25-Mar-2021 (SWLAD01-171)
RNAV-Z (GNSS) RWY 11 (AsA)	23-May 2019 (SWLGN01-171)
RNAV-Z (GNSS) RWY 29 (AsA)	23-May-2019 (SWLGN02-171)

6.4. PANS-OPS surfaces – Stawell Airport

An image of the MSA published for Stawell Airport is shown in Figure 11 (Source Airservices Australia).

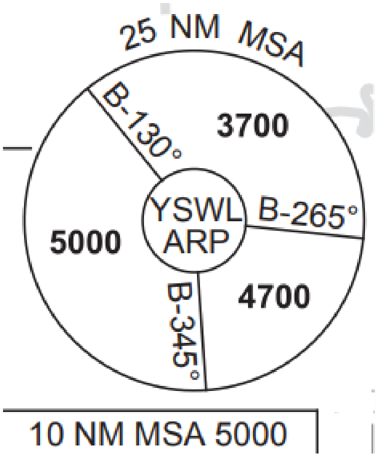

Figure 11 MSA established for Stawell Airport

Obstacles within 15 nm (10 nm MSA + 5 nm buffer) and within 30 nm (25 nm MSA + 5 nm buffer) of Stawell Airport's ARP define the height at which an aircraft can fly when within 10 nm and 25 nm.

The Manual of Standards 173 *Standards Applicable to Instrument Flight Procedure Design* (MOS 173), requires that a minimum obstacle clearance (MOC) of 1000 ft below the published MSA is maintained.

The Project Area is located within the 10 nm (+ 5nm buffer) MSA of Stawell Airport, and the north-eastern sector of the 25 nm MSA. The 10 nm MSA is not sectorised. AIP ENR 1.5-18 specifies that when a sectorised 25nm MSA is provided with a lower MSA than the 10 nm MSA, the lower 25nm sector MSA may be used. Therefore, the 25 nm MSA sector B130° - B265° MSA of 3700 ft is the controlling surface.

Figure 12 shows the 10 nm (+ 5 nm buffer) and 25 nm (+ 5 nm buffer) MSAs of Stawell Airport relative to the Project (source: Umwelt, Google Earth).

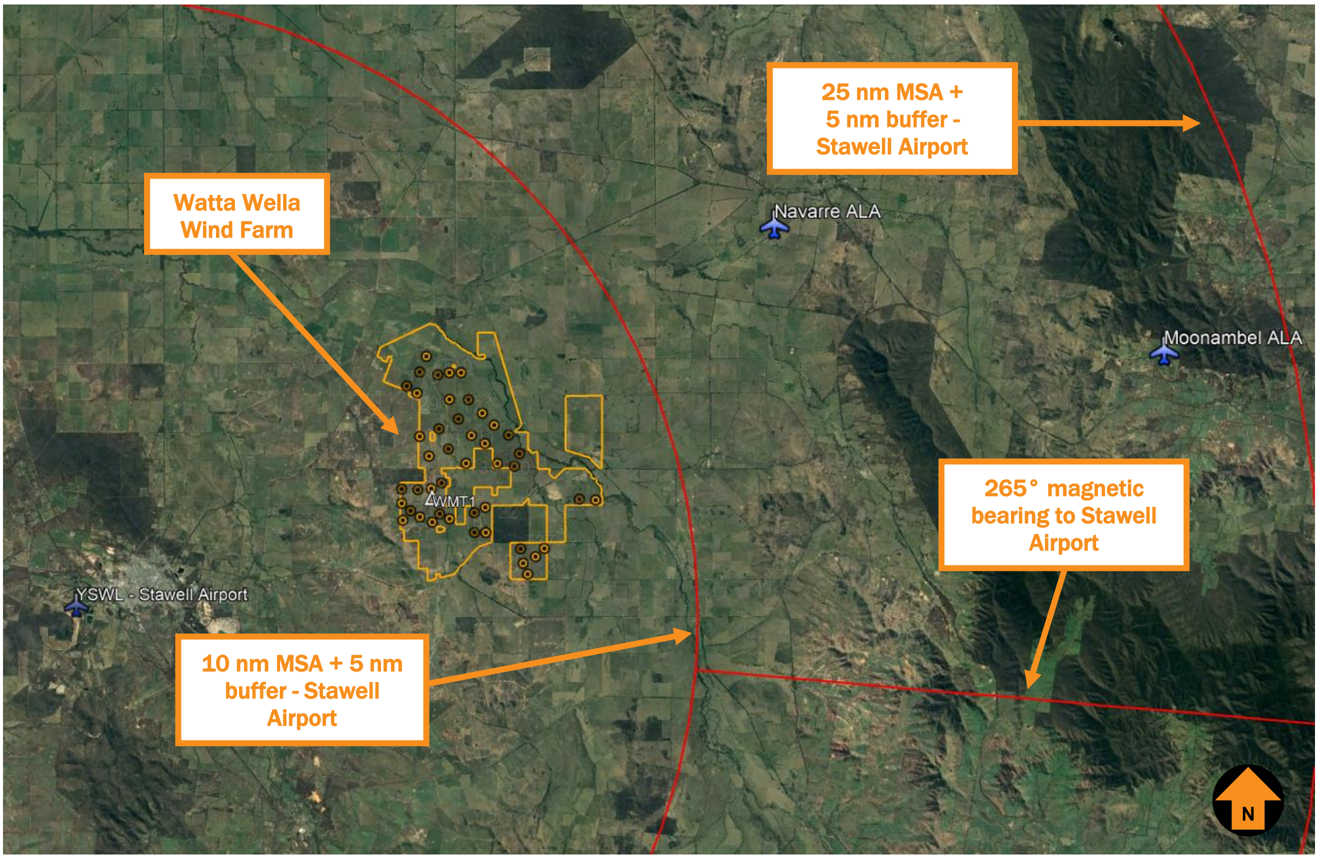

Figure 12 Stawell Airport (YSWL) 10nm (+ 5 nm buffer) and 25nm (+ 5 nm buffer) MSA with sectors

WTG35 is the highest wind turbine located inside of the horizontal extent of the 10 nm MSA (+ 5 nm buffer) of Stawell Airport with a tip height of 1719ft AMSL (with 5 m buffer).

An impact analysis of Stawell Airport's MSA is provided in Table 4.

Table 4 Stawell Airport MSA impact analysis

MSA	Minimum altitude	MOC (300m/984.3 ft)	Impact on airspace design	Potential solution	Impact on aircraft ops
10 nm	5000ft AMSL	4000 ft AMSL	Nil – below the controlling altitude by approximately 2281 ft	N/A	N/A
25 nm (Sector B130° and B265°)	3700 ft AMSL	2700 ft AMSL	Nil – below controlling surface by approximately 981 ft	N/A	N/A
25 nm (Sector B265° and B345°)	4700 ft AMSL	3700 ft AMSL	Nil – below controlling surface	N/A	N/A
25 nm (Sector B345° and B130°)	5000 ft AMSL	4000ft AMSL	Nil – below controlling surface	N/A	N/A

The Project will not impact instrument flight procedures at Stawell Airport.

6.5. Circling areas – Stawell Airport

The maximum horizontal distance that category C circling area may extend for an aerodrome in Australia is 4.2 nm (7.7778 km) from the threshold of each usable runway.

The Project Area is located beyond the horizontal extent of category A, category B and category C circling areas at Stawell Airport.

6.6. Obstacle limitation surfaces – Stawell Airport

The maximum horizontal distance that an obstacle limitation surface (OLS) may extend for an aerodrome in Australia is 15 km (8.1 nm) from the edge of a runway strip.

The Project Area is located well beyond the horizontal extent of the obstacle limitation surfaces of Stawell Airport.

6.7. Ararat Airport (YARA)

Ararat Airport is a certified aerodrome operated by Ararat Rural City Council, with a published aerodrome elevation of 307 m AHD (1008 ft AMSL) (source: Airservices Australia, ERSA-FAC, 16 June 2022). The aerodrome is located approximately 28 km south of the nearest wind turbine.

Ararat Airport has two runways:

- Runway 12/30 Code 1 sealed runway with a length of 1240 m, width 30 m and runway strip 90 m
- Runway 04/22 Code 1 grass runway with a length of 660 m, width 18 m and runway strip 90 m.

Figure 13 shows the Ararat Airport (YARA) runway layout (source: AsA, ERSA-FAC, dated 16 June 2022).

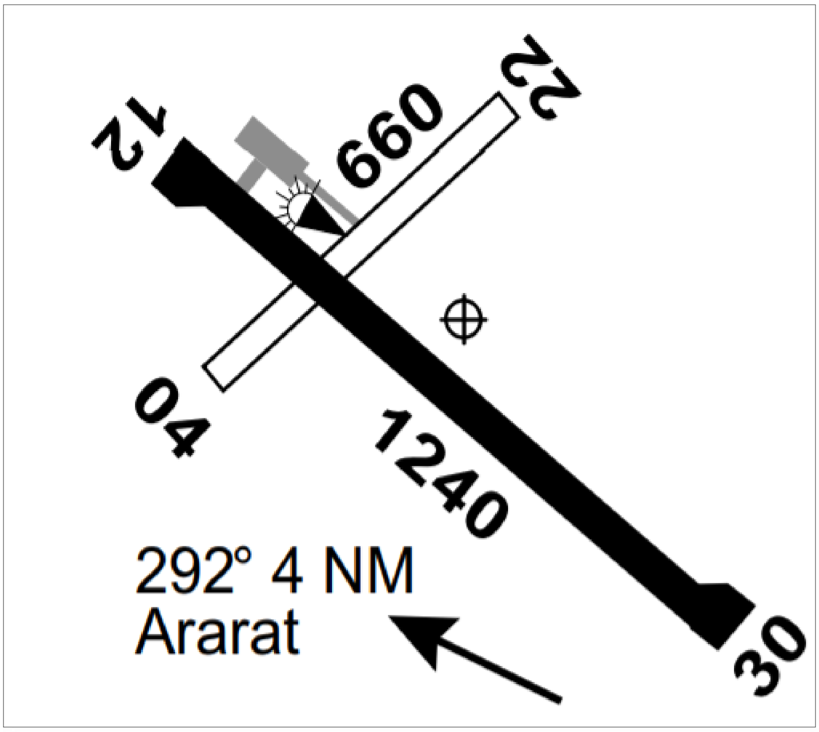

Figure 13 Ararat Airport runway layout

There are no instrument approach procedures published for Ararat Airport. The Project is located beyond the horizontal distances specified for a Code 1 Non-instrument OLS in Part 139 MOS 2019 Chapter 7, and will not affect Ararat Airport's OLS.

6.8. St Arnaud Airport (YSTA)

St Arnaud Airport is a certified aerodrome operated by Northern Grampians Shire Council, with a published aerodrome elevation of 195 m AHD (639 ft AMSL) (source: Airservices Australia, ERSA-FAC, 16 June 2022). The aerodrome is located approximately 42 km north-east of the nearest wind turbine.

St Arnaud Airport has two runways:

- Runway 18/36 Code 1 sealed runway with a length of 999 m, width 18 m and runway strip 90 m
- Runway 09/27 Code 1 gravel runway with a length of 535 m, width 18 m and runway strip 90 m.

Figure 14 shows the St Arnaud Airport runway layout (source: AsA, ERSA-FAC, dated 16 June 2022).

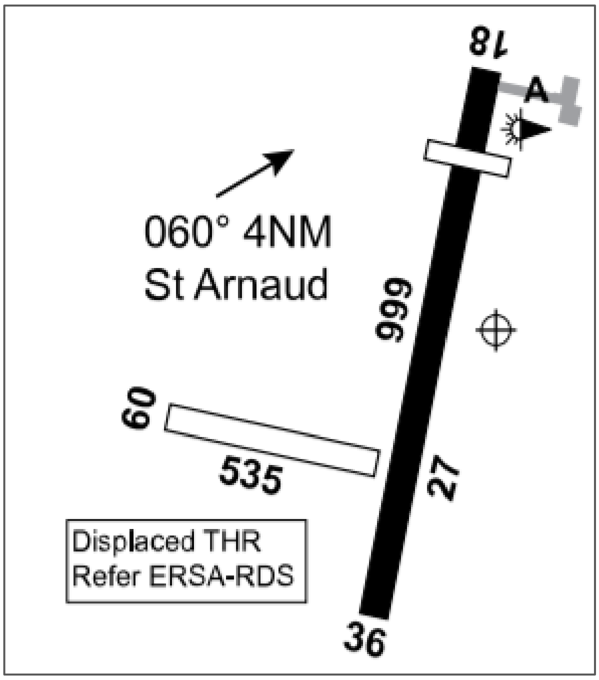

Figure 14 St Arnaud Runway layout

There are no instrument approach procedures published for St Arnaud Airport. The Project is located beyond the horizontal distances established for a Code 1 Non-instrument OLS in accordance with Part 139 MOS Chapter 7 and will not affect St Arnaud's OLS.

6.9. Nearby aeroplane landing areas

As a guide, an area of interest within a 3 nm radius of an aeroplane landing area (ALA) is used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA.

A search on OzRunways, which sources its data from Airservices Australia (AIP), did not identify any unregulated aerodromes in close proximity to the Project Area. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

A review of NationalMap (an online map-based tool allowing access to spatial data from Australian government agencies) was also undertaken.

The two closest ALAs observed in relation to the Project Area (identified on OzRunways and NationalMaps) were Navarre and Ozmon (Moonambel). Figure 15 shows the location of these two ALAs (and 3 nm radius) in relation to the Project Area. (Source Umwelt, Google Earth) All ALAs identified via OzRunways are further than 3 nm from, and will not be adversely affected by, any wind turbines of the Project.

An additional non-regulated aerodrome was identified near the Project during the site visit conducted by Aviation Projects on 17 March 2021. It is located on a property named Wyandra. Figure 16 shows the ALA site (source Google Earth), and Figure 17 is a photo taken from Landsborough Road during the site visit, looking north towards the ALA. Figure 18 shows the ALA location (and 3 nm radius) in relation to the Project.

The Wyandra ALA is within 3 nm of wind turbines and may therefore be affected by the Project.

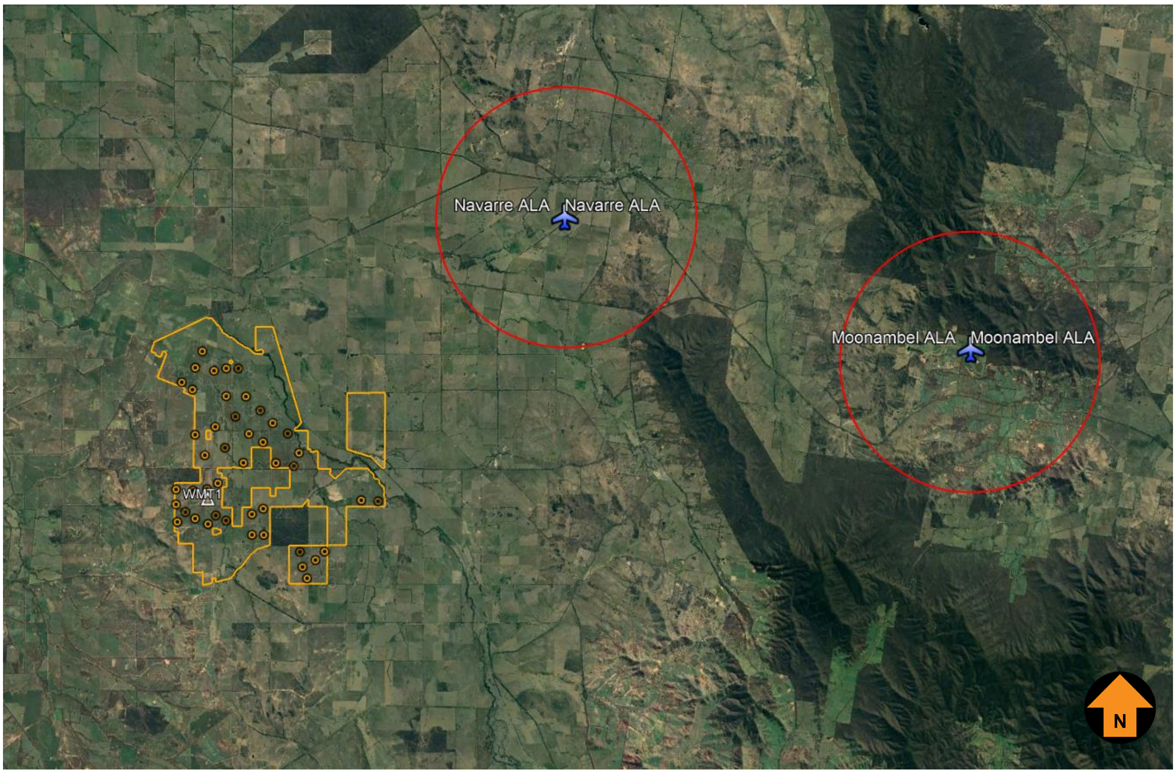

Figure 15 Project relative to closest ALAs identified on OzRunways and NationalMaps

Figure 16 Wyandra ALA runway layout south-west of Project

Figure 17 photo of Wyandra ALA from Landsborough Road

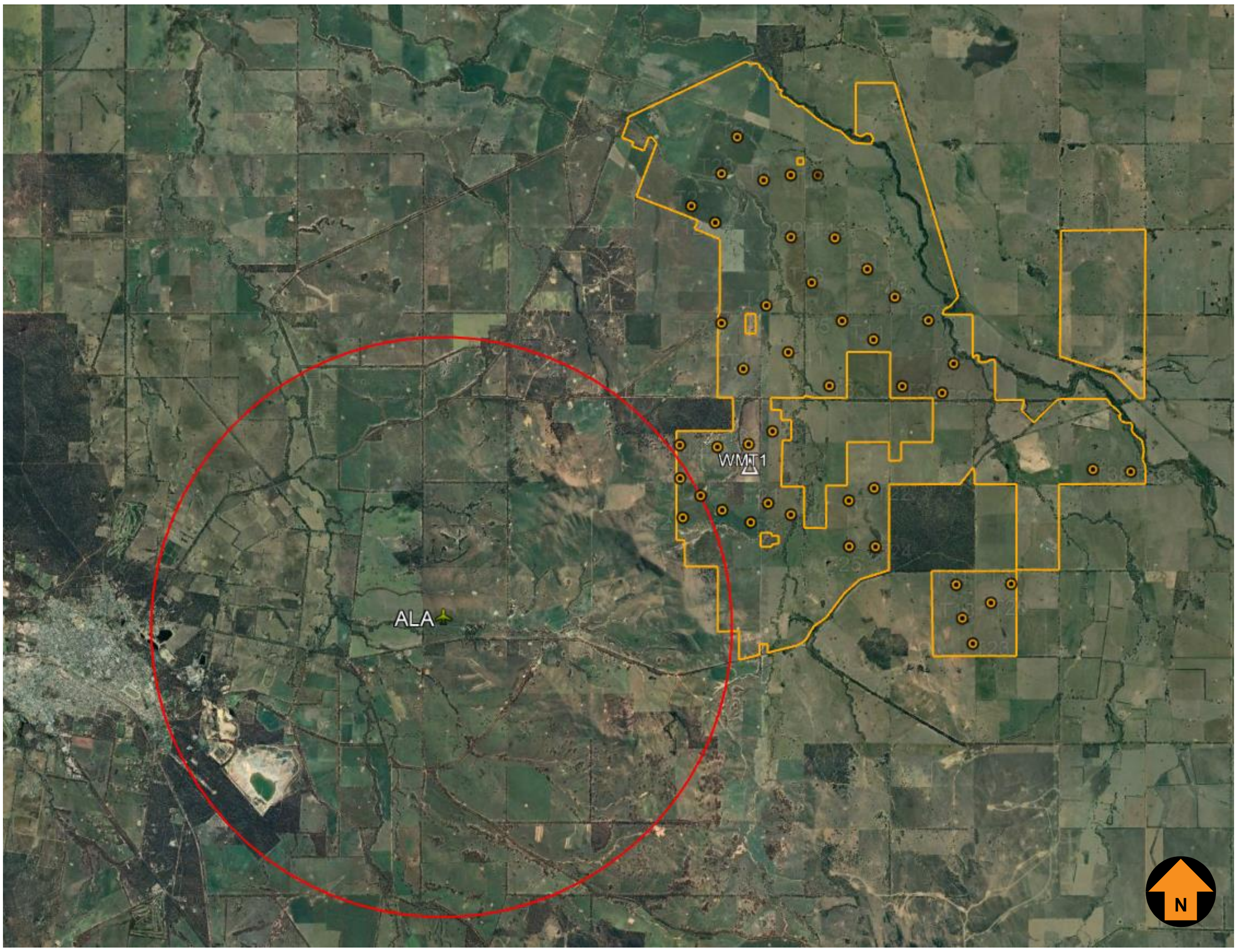

Figure 18 Location of Wyandra ALA (and 3 nm radius) in relation to Project

6.10. Impact on Wyandra ALA South-west of Project

WTG42, located in the south-western quadrant of the Project Area, is the closest turbine to the Wyandra ALA displayed in Figure 16 and lies within a 3nm radius of the approximate centroid of the ALA.

A typical circuit pattern (comprised of 1 nm upwind and crosswind legs) is displayed at Figure 19 for both runways and both circuit directions in relation to a 16 x rotor diameter (178 m) radius of 2848 m, an area described in National Airports Safeguarding Framework (NASF) Guideline D – *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers*.

NASF Guideline D details that *"wind turbines may create turbulence which is noticeable up to 16 rotor diameters from the turbine".*

In accordance with NASF Guideline D, downwind turbulence from the nearest turbines may still exist in the area described as the normal circuit area of the ALA in a north-easterly wind.

The NASF Guideline D turbulence figure is based on United Kingdom (UK) Civil Aviation Authority (CAA) Civil Aviation Publication (CAP) 764 – *CAA Policy and Guidelines on Wind Turbines*, which in turn is based on *"research activity or modelling and studying the wake characteristics.....using computational fluid dynamics techniques, wind tunnel tests and on site LIDAR measurements."*

This CAP recognises that the extent of the turbulence diminishes to less than 10% of what exists immediately behind the turbine within 5 rotor diameters (RD). This study was based on a 30 m diameter turbine.

Section 4.2 of the CAP specifies anticipated distances from a wind turbine development which might have an impact on 'civil aerodromes,' depending on the nature of the aerodrome and length of runway(s). Relevant to the Wyandra ALA, with a runway distance less than 800 m, the following distance is identified for potential impacts by wind turbine development:

> *6. Within 3 km of a non-radar equipped unlicensed aerodrome with a runway of less than 800 m.*

A study by the European Academy of Wind Energy, - *Do Wind Turbines Pose Roll Hazards to Light Aircraft*, 2018, used a large-eddy simulations (LES) to assess wind-generated roll hazards to small aircraft from the wake of a utility-scale wind turbine – a GE 1.5 MW turbine with three bladed rotor of 77 m in diameter and a hub height of 80 m. A typical aircraft was used in the study, a Cessna 172.

This study is considered a simple method for quantifying turbine-wake-induced roll hazards on general aviation aircraft.

The "*assessment criteria are based on the maximum rolling moment that the aileron on a typical aircraft can generate to counteract a moment induced by the wake field*."

This study determined:

- Turbine wakes tend to diffuse more rapidly in convective conditions as the mechanical mixing of the air erodes the wake (Baker and Walker 1984, Magnusson and Smedman 1994, Mirocha et al., 2015)
- The worst case for longer-persisting wakes exist in stable atmospheric conditions (Bodini et al., 2018)
- 99.99% of all calculations exist within the low hazard threshold
- No moments reached the high hazard threshold
- In stable conditions the largest roll hazards occur most frequently about 5 D downwind of the turbine
- All of the peak hazards are located in the high-shear zone at the edge of the wake between 3 and 7 D downwind from the turbine
- Normal control inputs by pilots when first noticing the roll movement will alleviate the wake impact.

The advice provided by the NASF Guideline D and the data and conclusions contained in the above study is clear that any turbulence downwind of a turbine is significantly decreased beyond approximately 7 rotor diameters. After consideration of available reports provided by both independent research and by RES UK Head Office, Aviation Projects and RES Australia Pty Ltd have agreed that a conservative distance of 10 rotor diameters is an appropriate distance to consider that the turbulence is dissipated to an extent less than the effect of the turbulence generated by the wind flow over hills, trees and other natural objects. Figure 19 depicts the two distances in relation to the nominal circuit area of 1 nm around the ALA.

The ALA consists of two runways , one with a length of approximately 600 m and the other approximately 300 m. This indicates that the ALA is used by light aircraft only potentially including aerial agriculture operators.

Aircraft typically associated with operations at an ALA with this length of runway are unlikely to require a circuit pattern as large as the indicative one used for this analysis. Wake turbulence would only affect the ALA with a wind from the north-east in which case aircraft would generally be taking off toward the north-east and could make a turn at 500 ft AGL and avoid the potential extent of wake turbulence impact.

Stands of trees immediately adjacent to the ALA plus hills to the north and east of the ALA also generate wind shear type turbulence to aircraft operating at Wyandra, as recognised by the ALA operator during on site discussions with him on 8 February 2022. His main concern was that there would be increased turbulence from the wind farm, within his nominal circuit area.

Using the results of the study above that show that the turbine turbulence is dissipated within approximately 7 rotor diameters, it is apparent that there will be no additional turbulence occurring within the nominal circuit area or beyond 10 rotor diameters.

The ALA operator indicated that he flies a CASA compliant circuit in his aircraft and therefore in doing so, would be outside of the area of likely wind turbine generated turbulence. There is also sufficient distance from/to the runway to enable normal maneuvering outside the area where turbine created turbulence is likely to exist in the north easterly winds.

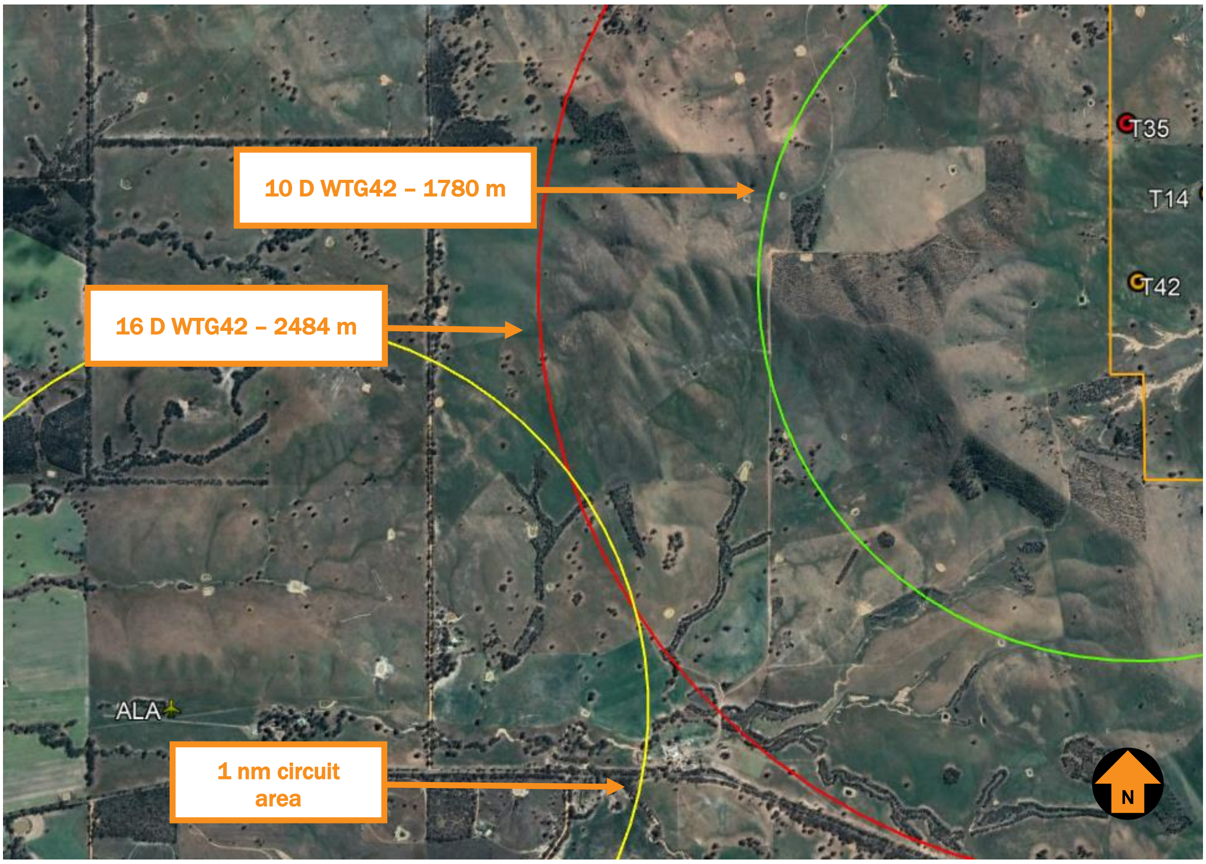

Figure 19 16 D and 10 D for WTG42 in relation to circuit area for both runways

The Bulgana Green Energy Hub (wind farm) is located approximately 11 km east of Stawell and south of the Watta Wella Project. It consists of 114 m AGL wind turbines. The cumulative effect of the Project and the existing wind farm in proximity to the ALA could limit accessibility further for aircraft arriving from and departing to an easterly direction to avoid overfly turbines on approach and departure.

Figure 20 demonstrates the representative project boundary for the Bulgana Green Energy Hub in relation to the Project and the Wyandra ALA in proximity to the Project Area (Source: RES, Bulgana Green Power Hub, Google Earth).

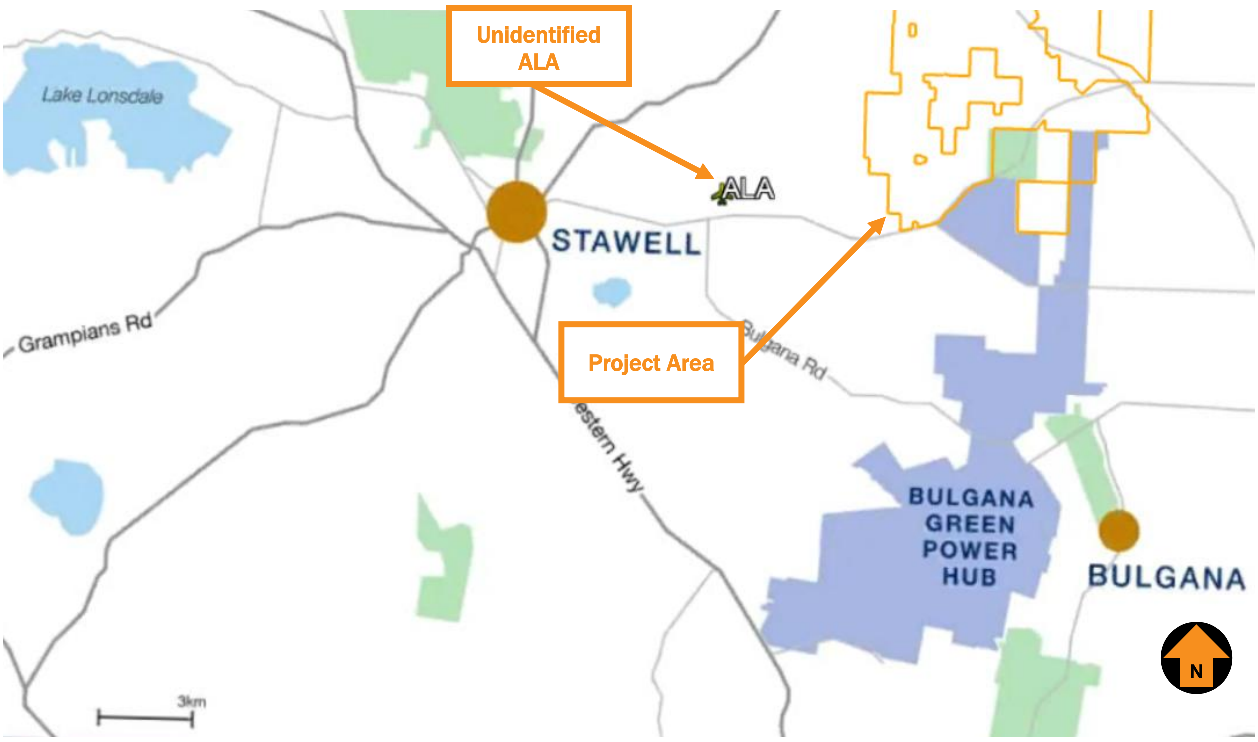

Figure 20 ALA in relation to the Project Area and representative location of Bulgana Green Energy Hub

6.11. Air routes and LSALT

MOS 173 requires that a minimum obstacle clearance of 1000 ft below the published lowest safe altitude (LSALT) is maintained along each air route.

The Project is located in the vicinity of 3 air routes. It is also located in 3 separate grids identified in the EnRoute Chart – Low (ERCL 2). The most limiting grid LSALT applicable to the wind farm location is 3900 ft AMSL (MOC 2900 ft AMS) in the north-western quadrant of the wind farm.

The highest wind turbine is WTG35, with a maximum overall height of 524 m AHD (1719 ft AMSL) with 5 m buffer applied and is below the grid LSALT MOC of 3900 ft AMSL by 665 m (2181 ft AMSL). Therefore, the proposed Project will not affect the grid LSALT.

Figure 21 provides the grid LSALT and air routes in proximity to the proposed Project (source: Umwelt, OzRunways, Airservices ERC Low 2 Chart, 5 November 2020).

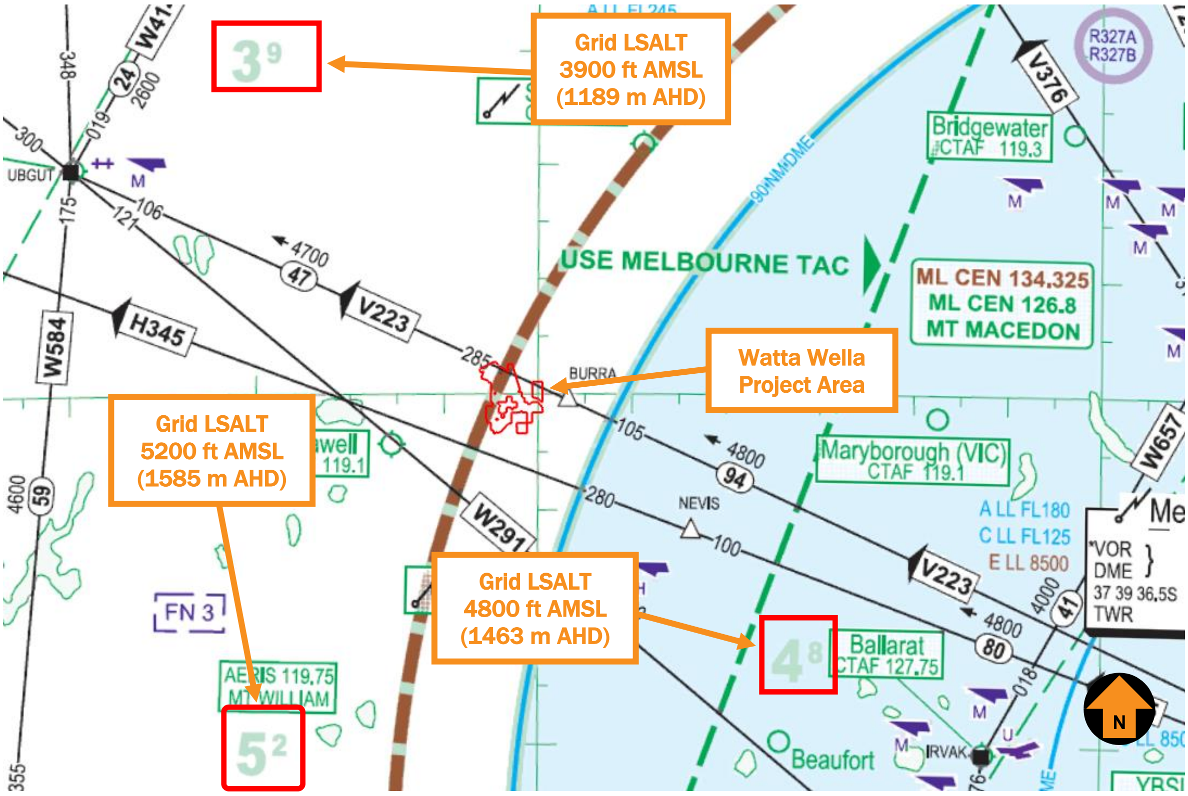

Figure 21 Grid LSALT and air routes in proximity to the proposed Project

An impact analysis of the surrounding air routes is provided in Table 5.

Table 5 Air route impact analysis

Air route	*Waypoint pair*	*Route LSALT*	*MOC*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
H345 (ERC-L & ERC-H)	Nevis – Borto	5200 ft AMSL	1280 m AHD 4200 ft AMSL	Nil	N/A	N/A
W291 (ERC-L)	Ubgut – Esdig	4800 ft AMSL	1158 m AHD 3800 ft AMSL	Nil	N/A	N/A

Air route	*Waypoint pair*	*Route LSALT*	*MOC*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
V223 (ERC-L)	Burra – Ubgut	4700 ft AMSL	1128 m AHD 3700 ft AMSL	Nil	N/A	N/A

Note: MOC is the height above which obstacles would impact on LSALTs or air routes.

The Project will not an impact on any route LSALT.

6.12. Airspace

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

Therefore, the Project will not impact controlled airspace.

6.13. Aviation facilities

NASF Guideline G *Protecting Aviation Facilities – Communication, Navigation and Surveillance (CNS)* provides guidance regarding the assessment and potential impact on aviation facilities. Part 139 MOS 2019 Chapter 19 prescribes the requirements for impact assessment for development within a certified aerodrome boundary or near an existing CNS facility.

The following aviation facilities were identified in proximity to the Project Area:

- Mt William Repeater Station located approximately 21 nm (39 km) southwest of the Project
- BEN NEVIS Airservices Tower approximately 15 nm (28 km) southeast of the Project.

Figure 22 shows the location of the Project Area relative to nearby aviation facilities (source: Airservices Australia, Google Earth).

Figure 22 Project Area relative to nearby aviation facilities

The Project will not penetrate any protection areas associated with aviation facilities specified in NASF Guideline G and Part 139 MOS 2019 Chapter 19.

6.14. Radar

Airservices Australia currently requires an assessment of the potential for wind turbines to affect radar line of sight.

With respect to aviation radar facilities, the closest radar is the Mt Macedon Route Surveillance Radar (RSR) which is located approximately 78 nm (145 km) east southeast of the Project Area.

The proposed Project Area is located in Zone 4 and outside the radar line of sight of the Secondary Surveillance Radar (SSR). The EUROCONTROL guidelines state:

> *When further than 16 km from an SSR the impact of a wind turbine (3-blades, 30-200 m height, and horizontal rotation axis) is considered to be tolerable.*

Due to the distance and terrain profile of the Project Area from the facility, it is anticipated that the Project will not impact the Mt Macedon Route Surveillance Radar (RSR).

Note: Route Surveillance Radar (RSR) and Secondary Surveillance Radar (SSR) is the same radar system.

6.15. Consultation

An appropriate and justified level of consultation was undertaken with relevant parties.

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

6.16. AIS summary

Based on the Project layout and overall turbine blade tip height limit of 255 m AGL, the blade tip elevation of the highest wind turbine, which is WTG35, will not exceed 524 m AHD (1719 ft AMSL) and:

- will not penetrate any OLS surfaces
- will not penetrate PANS-OPS surfaces
- will not impact any nearby designated air routes
- will not have an impact on the grid LSALT
- will not have an impact on prescribed airspace
- is wholly contained within Class G airspace
- is unlikely to produce any hazardous turbulence to aircraft operating at Wyandra ALA
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

6.17. ALA analysis summary

All validated ALAs are further than 3 nm from, and will not be adversely affected by, any wind turbines of the Project.

The list of wind turbines (obstacles), showing coordinates and elevation data that are applicable to this AIS, is provided in Annexure 3.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 10 it has been concluded that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the WTGs or WMT, without obstacle lighting on the WTGs and WMT of the Project.

For completeness, lighting standards and guidelines are summarized in Annexure 5.

7.1. Wind monitoring tower

In terms of obstacle marking and lighting requirements, relevant requirements set out in Part 139 MOS 2019 and NASF are provided below.

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:

> *8.109 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.*

Refer to Section 4.3 for additional information regarding the temporary WMT. An aviation impact assessment has also been conducted on the WMT and is referenced as an annexure in this report.

8. SOLAR GLARE ANALYSIS – WATTA WELLA SOLAR FARM

8.1. Solar farm project overview

The Watta Wella Solar Farm will be located in the eastern part of the Project boundary and comprise of 1869 tables with 27 solar modules per table with an indicative capacity of 85MW. A horizontal single axis tracking system will be used with an anti-reflecting coating on the solar panels.

A preliminary design was provided (ref RES Drawing 03707D2206-01) with the PV Module orientation, row length and elevations yet to be confirmed.

8.2. Site overview

The Project Area is not located in close proximity to any certified aerodromes or aeroplane landing areas. It is located approximately:

- 22 km north-east from Stawell Aerodrome
- 11 km north-east from the unidentified ALA to the south-west of the Project
- 13 km south-west from Navarre ALA
- 2.8 km horizontally from the closest point of ATS air route V223 between waypoints Burra and Ubgut.

The preliminary layout of the Watta Wella Solar Farm is provided in an excerpt from the Solar Infrastructure Plan in Figure 23 showing the project boundary and nominal configuration. (Source: RES, Drawing No. 04372-RES-SOL-DR-TE-002 Rev 2.1)

Figure 24 provides the location of the solar farm in relation to the nearest certified aerodrome (Stawell Airport YSWL) and the nearest Air route V223. (Source RES, Airservices, Google Earth)

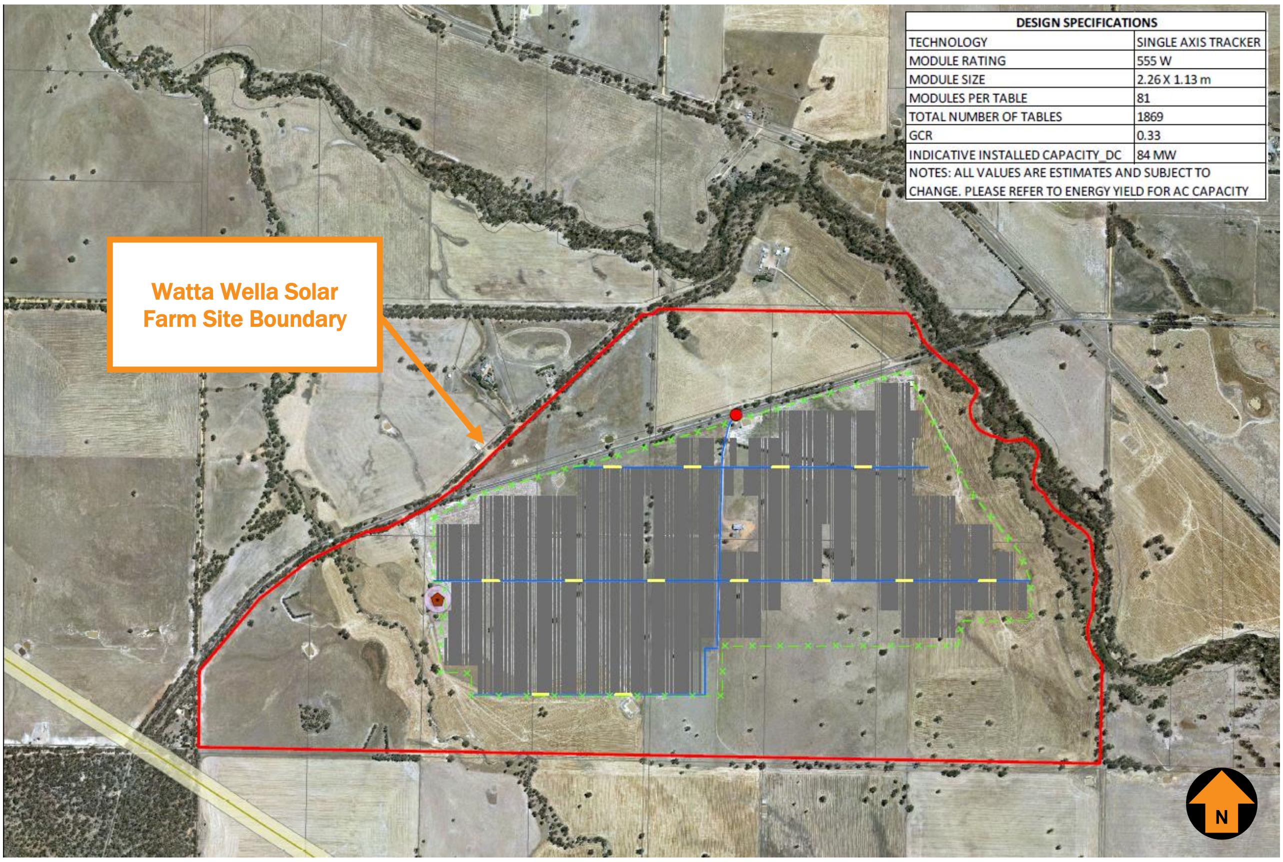

Figure 23 Watta Wella Solar farm layout

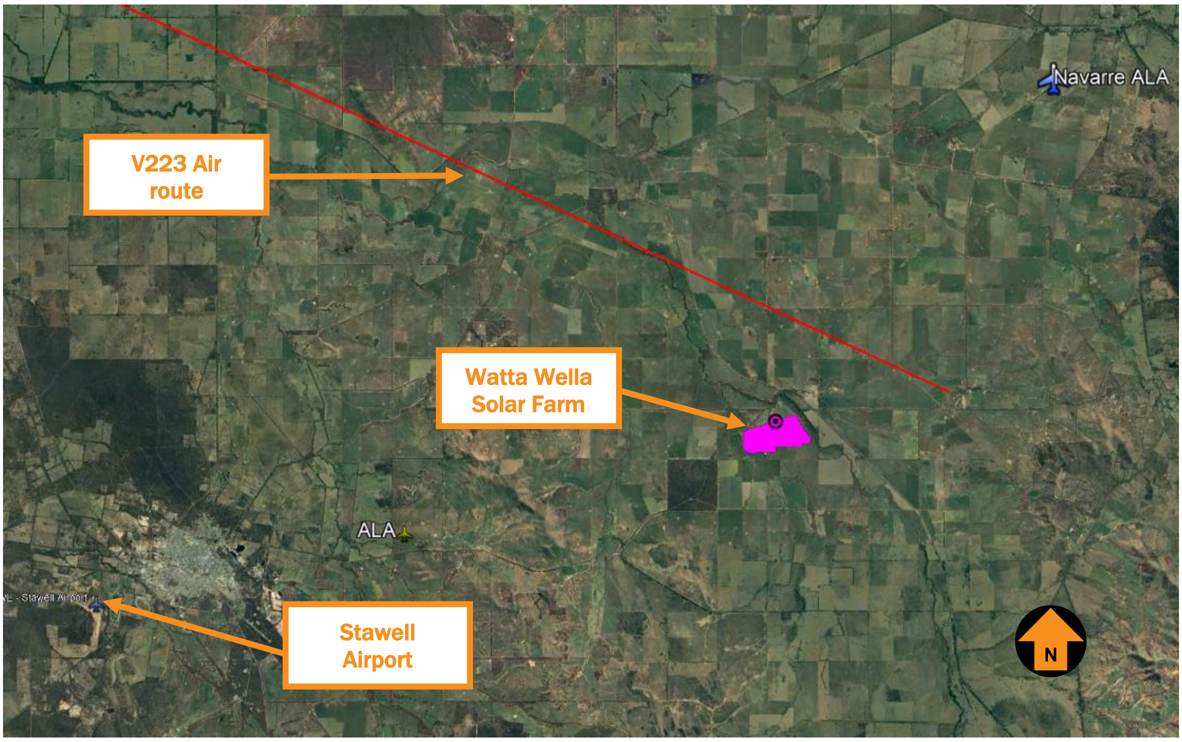

Figure 24 Watta Wella Solar Farm in relation to Stawell Airport and V223 Air route

8.3. Planning context – Aviation impacts

Solar photovoltaic (PV) panels can produce glint (a momentary flash of bright light) and glare (a continuous source of bright light), which could result in an ocular impact to pilots or air traffic controllers.

The Civil Aviation Safety Authority (CASA) regulates aviation activities in Australia. Standards for certified aerodromes are established in Part 139 MOS 2019. Chapter 9.143 of Part 139 MOS (Other lighting on the aerodrome) states in section (8) and (9):

> *(8) An aerodrome operator must immediately notify CASA in writing of any proposals for equipment or lighting installation within the aerodrome boundary which would reflect sunlight, including solar panels, mirrors or reflective building cladding, and*
>
> *(9) An aerodrome operator must not proceed with any proposal mentioned in subsection (8) unless CASA has determined, in writing, that it will not cause a hazard to aircraft operations.*

The contents in this report and the results of the analysis conducted on the proposed installation can be referenced by CASA as part of its determination if required.

The National Airport Safeguarding Framework Guideline E Managing the Risk of Distractions to Pilots from Lighting in the Vicinity of Airports provides guidance on the potential risk of distractions to pilots of aircraft from lighting and light fixtures near airports but does not specifically address solar glare.

The Federal Aviation Administration (FAA) provided a free tool called S*olar Glare Hazard Analysis Tool* (SGHAT) and supporting Interim Policy 78 FR 63276 for the assessment of solar glare.

The FAA policy requires the following standard:

> *No potential for glare or "low potential for after-image" along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds). The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath.*

SGHAT was withdrawn from public access in 2017. The ForgeSolar glare analysis tool is recommended instead for non-military/government users. ForgeSolar analysis evaluates the occurrence of glare on a minute by minute basis and categorises the ocular impact of solar glare into 3 categories:

- Green - low potential to cause after-image (flash blindness)
- Yellow - potential to cause temporary after-image
- Red - potential to cause retinal burn (permanent eye damage)

The analysis should determine the level of adherence to the FAA policy for these components:

1. Analysis time interval and eye characteristics used are acceptable
2. No glare of any kind for Air Traffic Control Tower(s) (ATCT) at cab height
3. Flight path receptor(s) do not receive yellow glare.

The Watta Wella Solar Farm is not within the boundary of any Certified aerodrome and is not located along the final flight path for any existing landing thresholds. (2 statute miles from landing threshold) Aircraft flying near the solar farm would likely be in the enroute phase of the flight (not approaching to land) and most likely at an altitude of at least 4,700ft AMSL which is the LSALT of the nearest air route, V223.

8.4. ForgeSolar analysis – Aviation and nearby dwellings/roads

A glare analysis was prepared using the ForgeSolar application for the proposed Project layout with settings as per details provided in Table 6. An orientation of 0° was used on the basis that the tracking axis is orientated north south. (Source RES Drawing: 03707D2206-01) The overall site layout was separated into 5 sections (PV arrays) for the analysis. The analysis was conducted for aviation receptors in accordance with the established FAA policy, and for non-aviation receptors (dwellings and roads within 1 km of the installation) in response to the Victorian State Government Solar Facility Guidelines.

Flight path receptors were established for runway approaches for all directions at Stawell Airport, runway approaches for all directions at the ALA to the south-west of the Project, and for a 4 nm section of the V223 air route that is nearest to the solar farm.

8 discrete observation receptors (dwellings) were included in the analysis configuration, all within 1 km of the closest section of the solar installation footprint. A 1.8 m height above ground was used for all dwellings to represent a nominal eye height.

Nearby sections of Joel Joel, Landsborough, and Perry roads within 1 km of the PV installation were included, using a 1.5 m height representing nominal driver eye height. 50° view angle was applied based on FAA research which determined impact of glare beyond 50° is mitigated.

The FAA Policy is not considered to apply to non-aviation related receptors. The FAA policy objective is specified to prevent occurrence of glare affecting pilots in a critical phase of flight (during final approach to land) and prevent glare from distracting air traffic controllers who are visually scanning the airport movement surfaces and reviewing display screens inside the control tower.

Table 6 Solar farm configuration used in glare analysis

Parameter	*Setting*
Axis tracking	Single axis
Backtracking	Nil
Module surface material	anti-reflective coating
Tracking axis orientation	0°
Maximum Tracking angle	60°
Panel material	Smooth glass with AR coating
Reflectivity	Vary with sun
Slope error	Correlate with material

A non-backtracking algorithm has been adopted as the preferred configuration for the backtracking functionality of the single axis tracking system. A system with no backtracking functionality means the PV modules rotate to track the sun through the range of rotation (determined by the proposed maximum tracking angle 60°) and will not backtrack to avoid shading. A system with backtracking functionality would normally result in glare to nearby receptors when the PV panels are parallel with the ground when the sun is close to ground to avoid shading, theoretically causing the light to be reflected off the panels on to receptors directly behind the array

Figure 25 provides a description of the effect of the backtracking configuration for a single-axis system. (Source, ForgeSolar).

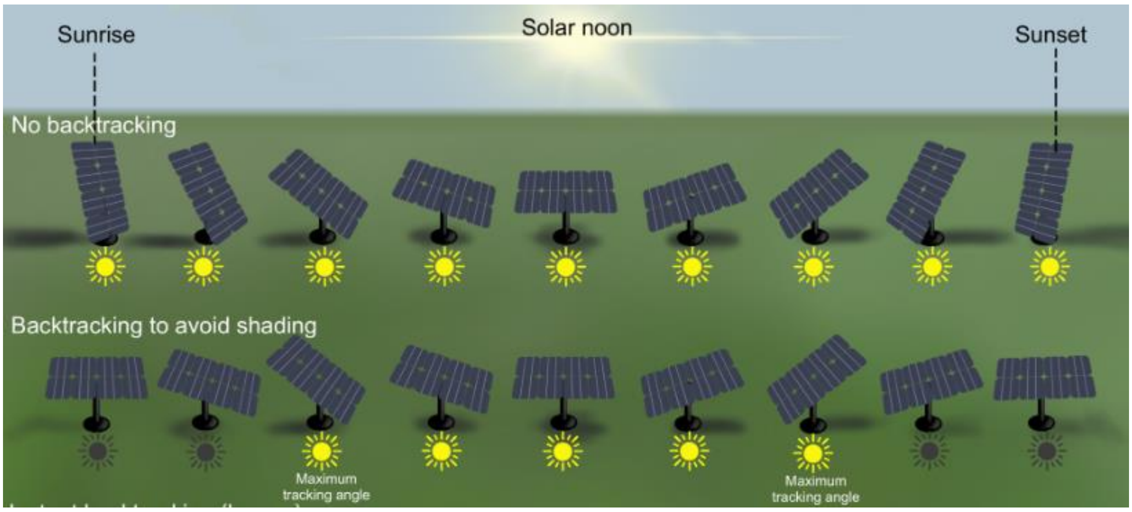

Figure 25 backtracking description

The following assumptions and limitations apply to the ForgeSolar analysis methodology:

- The algorithm does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
- The system output calculation assumes clear, sunny skies year-round.

The analysis determined that, for aviation impacts:

- No glare experienced for any aviation receptor

For nearby dwellings and roads:

- No glare experienced

The site configuration established for the solar glare analysis is provided at Figure 26 and Figure 27. The red markers represent discrete observation receptors (dwellings) and the blue lines are nearby routes (roads).

8.5. Victoria State Government – Guidelines for Solar Energy Facilities

Victoria State Government (Department of Environment, Land, Water and Planning) has developed Solar Energy Facilities – Design and Development Guidelines. (August 2019) Impacts of solar reflection are categorised in four ways in the guidelines:

- *No impact: a solar reflection is not geometrically possible, or it will not be visible from the assessed receptor. No mitigation is required.*
- *Low impact: a solar reflection is geometrically possible, but the intensity and duration of an impact is considered to be small and can be mitigated with screening or other measure.*

- *Moderate impact: a solar reflection is geometrically possible and visible, but the intensity and duration of an impact varies according to conditions. Mitigation measures (such as through design, orientation, landscaping or other screening method) to reduce impacts to an acceptable level will be required.*
- *Major impact: a solar reflection is geometrically possible and visible under a range of conditions that will produce impacts with significant intensity and duration. Significant mitigation measures are required if the proposed development is to proceed.*

The guidelines also recommend measures to reduce impact of glare, including:

• use anti-reflective solar panel coatings and non-reflective frames and avoid using reflective materials and paints on buildings and infrastructure

• adjust the orientation of panels relative to glare risks such as oncoming traffic coming down a road from an elevated area

• locate landscape screening of a sufficient height, width and foliage density at maturity to reduce glint and glare impacts.

The guidelines recommend an assessment of glare using an '*accepted methodology based on best practise'* and consider impacts on dwellings and roads with 1 km of the proposed facility.

Dwellings within 1 km of the Project Area were assessed in this report. No glare was experienced for any non-aviation receptor in the analysis.

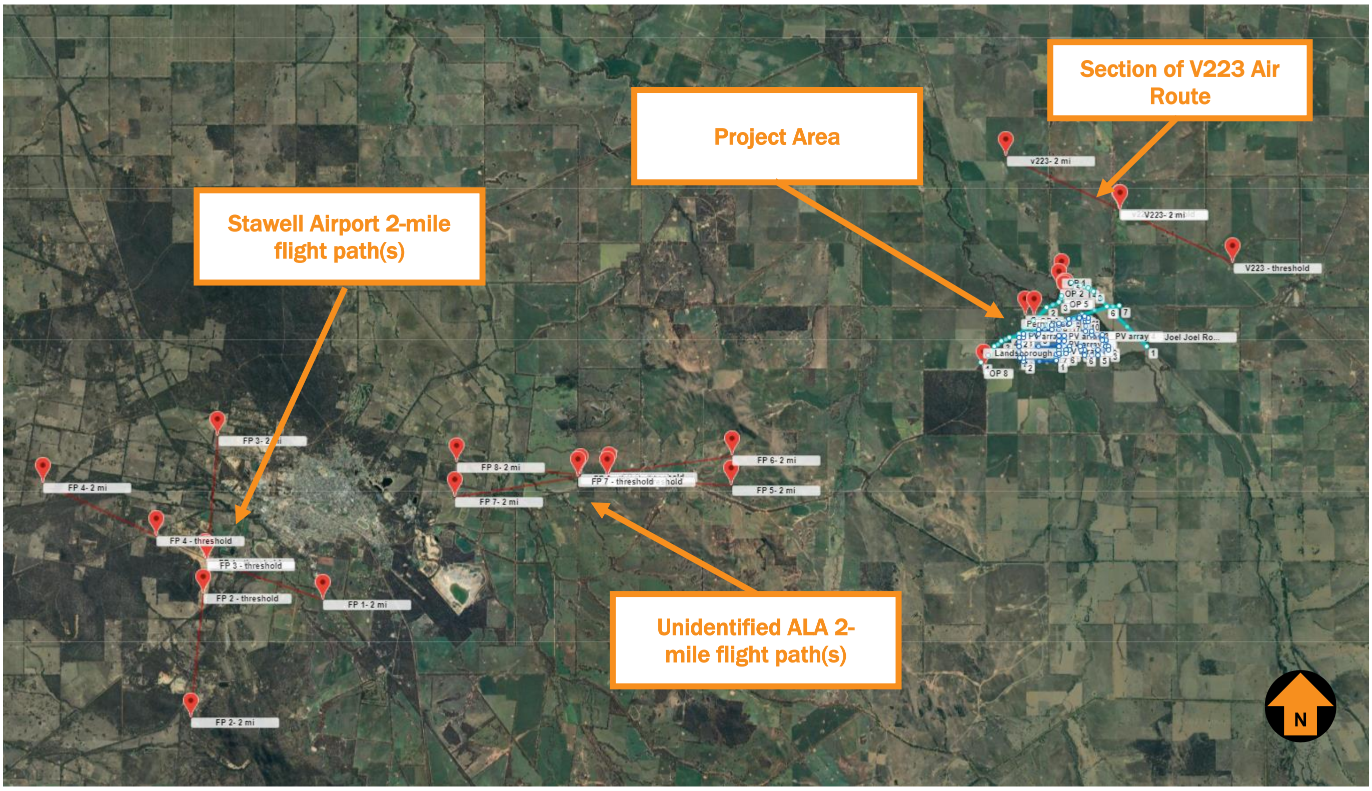

Figure 26 Solar farm glare analysis site configuration (aviation receptors)

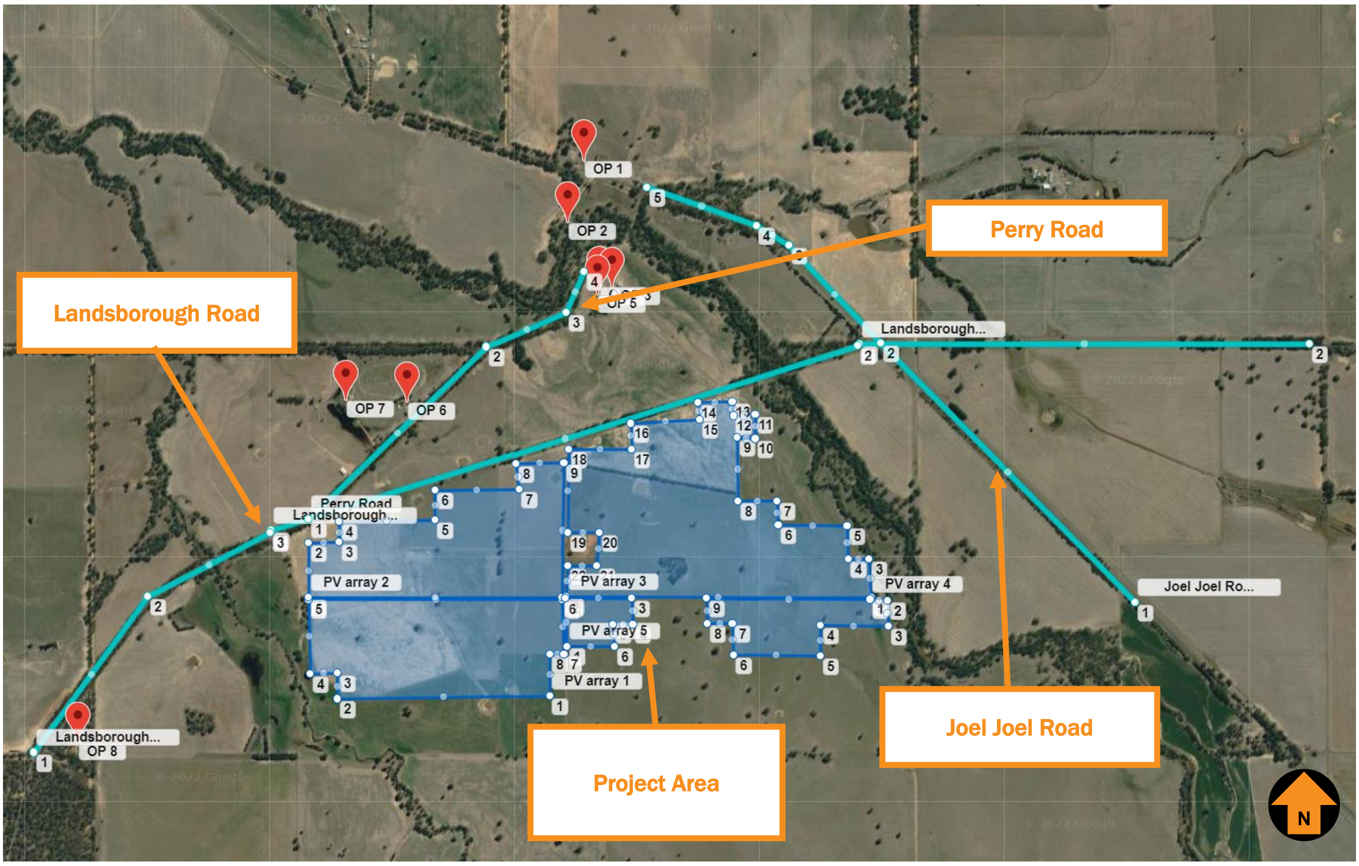

Figure 27 Solar farm glare analysis site configuration (non-aviation receptors)

A copy of the glare analysis report is provided at Annexure 1.

The Solar Glare Analysis conducted in this report concludes:

- The solar facility does not impact aviation receptors and is acceptable in relation to the FAA Policy for solar glare, and other relevant Australian planning context for aviation.
- There is no glare experienced for non-aviation receptors

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 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, with 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, over 50% (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 1.09:1 to 1.77:1. 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 7 (source: ATSB).

Table 7 Number of fatalities by GA 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 28 refers to Fatal Accident Rate by operation type per million departures over the 6-year period 2014-2019 (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 2014-2019. According to the ATSB report, the number of fatal accidents per million departures for GA aircraft over the 6-year reporting period 2014-2019 ranged between 6.6 in 2014 and 4.9 in 2019.

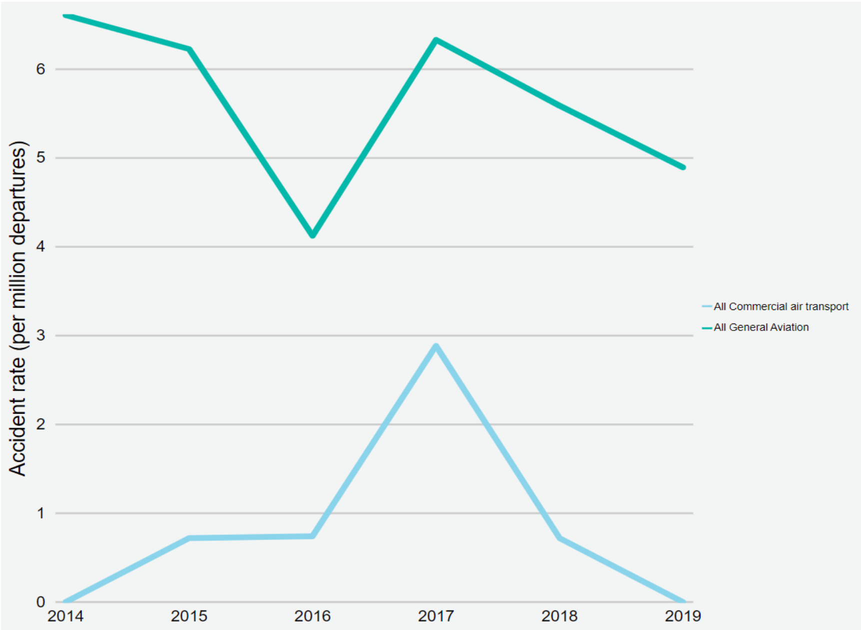

Figure 28 Fatal Accident Rate (per million departures) by Operation Type

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 8 (source: ATSB).

Table 8 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

Sub-category	Fatal accidents	Fatalities
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, no aircraft collided with a wind turbine or a wind monitoring tower.

Of the 20,529 incidents, serious incidents, and accidents in GA operations in the 10-year period, 1404 (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

To provide some perspective on the likelihood of a VFR aircraft colliding with a wind turbine, a summary of the four accidents that involved an aircraft colliding with a wind turbine, and the relevant factors applicable to this assessment, is incorporated in this section.

Based on the statistic of the Global Wind Energy Council (GWEC) report 2019, there were 341,320 wind turbines operating around the world at the end of 2016. In 2019, approximately 60.4 GW of wind power had been installed worldwide.

According to the Australian Renewable Energy Agency (ARENA), at the end of 2018 there were 94 wind farms operating in Australia. Clean Energy Council data indicates another 8 projects were commissioned in 2019 and there were 30 were under construction or financially committed, making a total of 132 wind farms nationally.

Aviation Projects has researched public sources of information, accessible via the internet, 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.

Of the four known accidents, one was caused by 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 overhead a wind farm, and the aircraft struck a wind turbine on its descent. This accident is not applicable to the circumstances under consideration.

There have been two accidents involving collision with a wind turbine during the day.

Only one of these (Melle, Germany 2017) resulted in a single fatality, as the result of a collision with a wind turbine steel lattice mast at a very low altitude during the day with good visibility and no cloud. If the mast was solid and painted white, then it more than likely would have been more visible than if it was equipped with an obstacle light.

In the other case (Plouguin, France, 2008), the pilot decided to descend below cloud in an attempt to find the destination aerodrome. The aircraft was in conditions of significantly reduced horizontal visibility in fog where the top of the turbine was obscured by cloud. The turbines became visible too late for avoidance manoeuvring and the aircraft made contact with two turbines. The aircraft was damaged but landed safely.

In both cases, it is difficult to conclude that obstacle lighting would have prevented the accident.

The other fatal accident occurred at night in instrument meteorological conditions (IMC) and is not applicable to the circumstances under consideration.

There is one other accident mentioned in a database compiled by an anti-wind farm lobby group, which suggests a Cessna 182 collided with a wind turbine 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, but suggests that the accident was caused by IFR 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 is made of wind turbines or a wind farm.

A summary of the four accidents is provided in Table 9.

Table 9 Summary of accidents involving collision with a wind turbine

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
1	Diamond DA320-A1 D-EJAR Collided with a wind turbine approximately 20 m above the ground, during the day in good visibility. The mast was grey steel lattice, rather than white, although the blades were painted in white and red bands.	02 Feb 2017	Melle, Germany	1	Day VFR No cloud and good visibility	Not specified	Not specified	Not specified	Not applicable

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
2	The Piper PA-32R-300, N8700E, was destroyed during an impact with the blades of a wind turbine tower, at night in IMC. The wind farm was not marked on either sectional chart covering the accident location; however, the pilot was reportedly aware of the presence of the wind farm.	27 Apr 2014	10 miles south of Highmore, South Dakota	4	Night IMC Low cloud and rain	420 ft AGL overall	Fitted but reportedly not operational on the wind turbine that was struck	The NTSB determined the probable cause(s) of this accident to be the pilot's decision to continue the flight into known deteriorating weather conditions at a low altitude and his subsequent failure to remain clear of an unlit wind turbine. Contributing to the accident was the inoperative obstruction light on the wind turbine, which prevented the pilot from visually identifying the wind turbine.	An operational obstacle light may have prevented the accident

3	Beechcraft B55 The pilot was attempting to remain in VMC by descending the aircraft through a break in the clouds. The pilot, distracted by trying to visually locate the aerodrome, flew into an area of known wind turbines. After sighting the turbines, he was unable to avoid them. The tip of the left wing struck the first turbine blade, followed by the tip of the right wing striking the second turbine. The pilot was able to maintain control of the aircraft and landed safely.	04 Apr 2008	Plougin, France	0	Day VFR The weather in the area of the wind turbines had deteriorated to an overcast of stratus cloud, with a base between 100 ft to 350 ft and tops of 500 ft.	328 ft AGL hub height, 393 ft AGL overall	Not specified	This pilot reported having been distracted by a troubling personal matter which he had learned of before departing for the flight. The wind farm was annotated on aeronautical charts.	Not applicable

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
4	VariEze N25063 The aircraft collided with a wind turbine following in-flight separation of the majority of the right canard and all of the right elevator	20 July 2001	Palm Springs, USA	2	Day VFR	N/A	N/A	The failure of the builder to balance the elevators per the kit manufacturer's instructions	Not applicable

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 WTGs and WMTs of the Project.

Based on an extensive review of accident statistics data (see summary in Section 9) and input from stakeholders, five (5) identified risk events associated with wind turbines and WMTs relate to aviation safety, and are listed as follows:

1. potential for an aircraft to collide with a wind turbine, controlled flight into terrain (CFIT);
2. potential for an aircraft to collide with a wind monitoring tower (CFIT);
3. potential for a pilot to initiate manoeuvring to avoid colliding with a wind turbine or monitoring tower resulting in collision with terrain;
4. potential for the hazards associated with the Project to invoke operational limitations or procedures on operating crew; and
5. effect of obstacle lighting on neighbours.

It should be noted that according to guidance provided by the Commonwealth Department of Infrastructure and Regional Development, and in line with generally accepted practice, the risk to be assessed should primarily be associated with passenger transport services. 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.

A fifth identified risk event associated with WTGs and WMTs is the potential visual impact associated with obstacle lighting (if fitted) on surrounding residents.

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 level of risk to an acceptable level.

A summary of the level of risk associated with the proposed Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table 10 to Table 14 below.

Table 10 Aircraft collision with wind turbine

Risk ID:	**1. Aircraft collision with wind turbine (CFIT)**

Discussion

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

There have been four reported occurrences worldwide of aircraft collisions with a component of a wind turbine structure since the year 2000 as discussed in Section 0. 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 wind turbine:

- GA VFR aircraft operators generally do not 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; and
- If the aircraft was flown through the wind farm, there is still a very small chance that it would hit a wind turbine.

Refer to the discussion of worldwide accidents at Section 9.4.

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

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 is clear of the OLS of any aerodrome.

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

There have been four reports of aircraft collisions with wind turbines worldwide, which have resulted in a range of consequences, where aircraft occupants sustained minor injury in some cases and fatal injuries in others. Similarly, aircraft damage sustained ranged from minor to catastrophic. One of these accidents resulted from structural failure of the aircraft before the collision. Only two relevant accidents occurred during the day, and only one resulted in a single fatality. It is assessed that collision with a wind turbine resulting in multiple fatalities and damage beyond repair 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 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 turbines will be a maximum of 255 m (836 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 103 m (337 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, 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 wind turbines.
- If cloud descends below the turbine 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 AGL (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The wind turbines are typically coloured white so they should be visible during the day.
- The 'as constructed' details of wind turbines 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.
- Because the turbines are above 100 m AGL, there is a statutory requirement to report the towers 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:

- Details of the Project should be communicated to local and regional aircraft operators prior to, during and following 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 wind turbine rotor blades prior to the commencement of the subject aircraft operations within the Project Area.
  - Arrangements should encourage applicable aerodrome operators to publish details of the wind farm in ERSA for surrounding aerodromes.

Residual Risk With the additional recommended treatments, the likelihood of an aircraft collision with a wind turbine 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 **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 wind turbine, without obstacle lighting on the turbines of the Project.**

Residual Risk	7 - Tolerable

Table 11 Aircraft collision with wind monitoring tower

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

Discussion

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

It is proposed to install one temporary WMT with a maximum height of 100 m (328.1 ft) AGL in height.

The final location of the WMT will be determined as part of the final construction design and the details will be reported to Airservices Australia.

There are only a few instances of aircraft colliding with a WMT, but they were all during the day with good visibility, and no instance was in Australia.

There is a relatively low rate of aircraft activity in the vicinity of the wind farm.

There are no known aerial agriculture 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 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.

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 wind monitoring tower 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 location of the WMT will be determined as part of the final construction design and the details will be reported to Airservices Australia.
- 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 WMT will be at a maximum height of 100 m (328.1 ft) AGL, which will be approximately 52.4 m (171.9 ft) below the minimum height of 500 ft AGL for an aircraft flying at this height.

- In the event that descending cloud forces an aircraft lower than 152.4 m AGL (500 ft), 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 the tower. - 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) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. - The WMT will be constructed from grey steel. - Although the WMT is proposed to be lower than the 100 m AGL height which initiates reporting requirements to CASA per CASR 139.165(1), the WMT may be reported 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: - The location of the WMT will be determined as part of the final construction design and the details should be reported to Airservices Australia, local and regional aerodrome and aircraft operators before, during and following construction. - The WMT should be marked with aviation marker balls and consideration should be made to Part 139 MOS 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.*	

Residual Risk	
With the additional recommended treatments, the likelihood of an aircraft colliding with a WMT resulting in multiple fatalities and damage beyond repair will be **Unlikely**. 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. Only if a WMT exceeds 150 m AGL in height and is not in relatively close proximity to a wind turbine. In the circumstances, the level of risk under the proposed treatment plan 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 the WMTs, without obstacle lighting on the WMTs of the Project.**	
Residual Risk	7 - Tolerable

Table 12 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 as a result of manoeuvring to avoid colliding with a wind turbine 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 turbines will be a maximum of 255 m (837 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 103 m (337 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 wind turbines.

If cloud descends below the turbine 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 wind turbines are typically coloured white so they should be visible during the day
- The 'as constructed' details of wind turbines 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 turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines 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 wind farms, but none in Australia, and all were during the day. It is assessed that a ground collision accident following manoeuvring to avoid a wind turbine 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. • Wind turbines will be a maximum of 255 m (837 ft at the top of the blade tip, so the rotor blade at its maximum height will be approximately 103 m (337 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 wind turbines. • If cloud descends below the turbine 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 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 wind turbines are typically coloured white, typical of most wind turbines operational in Australia, so they should be visible during the day. • The 'as constructed' details of wind turbines 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 turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines 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 have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following 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 Area.	
Residual Risk With the additional recommended treatments, the likelihood of ground collision resulting from manoeuvring to avoid a wind turbine 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 our assessment that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a wind turbine, without obstacle lighting on the turbines of the Project.**	
Residual Risk	7 - Tolerable

Table 13 Effect of 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 agriculture operations conducted at night in the vicinity of the Project.	
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 (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. • Wind turbines will be a maximum of 255 m (837 ft) at the top of the blade tip, so the rotor blade at its maximum height will be approximately 103 m (337 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, 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 wind turbines. • 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 wind turbines. • If cloud descends below the turbine 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 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 wind turbines are coloured white so they should be visible during the day. • The 'as constructed' details of wind turbines 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 turbines will be higher than 110 m AGL, there is a statutory requirement to report the turbines 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
Proposed Treatments Given the current treatments and the limited scale and scope of flying operations conducted within the vicinity of the Project, there is likely to be little additional safety benefit to be gained by installing obstacle lighting, other than if a WMT exceeds 150 m AGL in height and is not in relatively close proximity to a wind turbine. However, the following treatments, which can be implemented at little cost, will provide an additional margin of safety: • Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following 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.	
Residual Risk Notwithstanding the current level of risk is considered **Tolerable**, the additional recommended treatments will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **as low as reasonably practicable 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 WTGs and WMTs of the Project.**	
Residual Risk	5 - Tolerable

Table 14 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 wind turbines or WMT 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 wind turbines or WMTs are higher than 150 m (492 ft) AGL, they must be regarded as obstacles unless CASA assess otherwise. For objects outside an OLS and above 110 m obstacle lighting is required, 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. If 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 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 or shielding. There are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours. These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to those on the ground. 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 results of this study are summarised as follows:

11.1. Project description

The Project will comprise the following:

- up to 45 wind turbines with a maximum overall height (tip height) of up to 255 m AGL
- the highest wind turbine is WTG35 with a ground elevation of 269 m AHD (with 5 m buffer) and overall height of 524 m AHD (1719 ft AMSL)
- One temporary WMT proposed with a height of 100 m (328.1 ft) AGL located in the south-west of the Project Area
- 85MWdc capacity solar farm
- Associated high voltage equipment and transmission infrastructure.

11.2. Regulatory requirements

The following regulatory requirements apply:

- Objects exceeding 100 m AGL must be reported to CASA as soon as practicable after forming the intention to construct or erect the proposed object or structure, in accordance with CASR Part 139.165(1)(2)
- Wind turbines and wind monitoring towers must be marked in accordance with respect to Part 139 MOS 2019 Chapter 8 Division 10 8.110
- Wind turbines must be lit in accordance with Part 139 MOS 2019 Chapter 9 Division 4 9.30 and 9.31, unless an aeronautical study assesses they are of no operational significance.

11.3. Planning considerations

The Project as proposed satisfies the provisions of the Planning Scheme regarding Stawell Airport, and will not impact on the Airport Environs Overlay and the Design and Development Overlay.

11.4. Consultation

An appropriate and justified level of consultation was undertaken with relevant parties, refer to Section 5 for a detailed summary of the consultation.

11.5. Aviation Impact Statement

Based on the Project layout and overall turbine blade tip height limit of 255 m AGL, the blade tip elevation of the highest wind turbine, which is WTG35, will not exceed 524 m AHD (1719 ft AMSL) and:

- will not penetrate any OLS surfaces

- will not penetrate PANS-OPS surfaces
- will not impact any nearby designated air routes
- will not have an impact on the grid LSALT
- will not have an impact on prescribed airspace
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities
- is unlikely to produce any hazardous turbulence to aircraft operating at Wyandra ALA.

Airservices Australia has advised that the proposed wind farm would not have an impact on any Airservices designed instrument procedures, CNS facilities or ATC operations at Melbourne Airport. Refer to Section 5

11.6. Solar Glare analysis summary

Based on the Project layout and configuration, the PV Installation:

- will not result in Yellow Glare to aviation receptors and is acceptable to the FAA Policy
- Will not result in any glare to nearby dwellings or roads located within 1km of the Project.

11.7. ALA analysis summary

ALAs further than 3 nm from will not be adversely affected by, any wind turbines of the Project.

Wyandra ALA is unlikely to be affected by downwind wake turbulence from the nearest turbines.

11.8. Aircraft operator characteristics

Aircraft will be required to navigate around the Project Area in low cloud conditions where aircraft need to fly at 500 ft AGL.

The Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the wind turbine rotor blades prior to the commencement of the subject aircraft operations within the Project Area.

Wind turbines 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.

11.9. Hazard lighting and marking

The following conclusions apply to hazard marking and lighting:

- Wind turbines and wind monitoring towers must be marked in accordance with Part 139 MOS 2019 Chapter 8 Division 10 section 8.110.

- Wind turbines must be lit in accordance with Part 139 MOS 2019 Chapter 9 Division 4 9.30 and 9.31, unless an aeronautical study assesses they are of no operational significance.
- Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.
- CASA has advised that it will only review assessments referred to it by a planning authority or agency.
- With respect to marking of turbines, 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.

11.10. Summary of risks

A summary of the level of residual risk associated with the proposed Project with the Recommended Treatments implemented, is provided in Table 15.

Table 15 Summary of Risks

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Communicate details of the Project to local and regional operators and encourage applicable aerodrome operators to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with wind monitoring tower	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Although there is no obligation to do so, consideration should be made for marking the wind monitoring tower according to the requirements set out in Part 139 MOS 2019 Chapter 8 Division 10 Obstacle Markings, specifically 8.110 (5), (7) and (8). Details of wind monitoring towers should be communicated to local and regional operators and to CASA and Airservices Australia following construction.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Communicate details of the Project to local and regional operators and encourage applicable aerodrome operators 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 to local and regional operators and encourage applicable aerodrome operators 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. 'As constructed' details of WGT and WMT exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. 'As constructed' details of wind turbine and WMT coordinates and elevation should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office 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 wind turbines, wind monitoring tower 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 local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project.

Marking of turbines

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

Lighting of turbines

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

Marking of wind monitoring towers

9. Aviation Projects is undertaking a separate Aviation Impact Assessment for the temporary wind monitoring tower.

Micrositing

10. The potential micrositing of the turbines and wind monitoring tower have been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level is within 100 m of the nominal turbine and wind monitoring tower positions. Providing the micrositing is within 100 m of the turbines and wind monitoring towers 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 aviation impact assessment 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 agriculture 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

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.

APPENDICES

1. References
2. Definitions
3. Turbine coordinates and heights
4. Risk Assessment Framework
5. CASA Regulatory Requirements – Lighting and Marking

APPENDIX 1 – REFERENCES

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

- Airports Plus Pty Ltd, *Stawell Aerodrome Master Plan Review 2014*
- Airservices Australia, Aeronautical Information Package dated 16 June 2022
- Bureau of Meteorology, VIC Radar Sites Table and Information, http://www.bom.gov.au/australia/radar/vic_radar_sites_table.shtml
- Civil Aviation Safety Authority, Civil Aviation Regulations 1998 (CAR)
- Civil Aviation Safety Authority, Civil Aviation Safety Regulations 1998 (CASR)
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 92-1(1): Guidelines for aeroplane landing areas, dated July 1992 (no longer promulgated by CASA)
- Civil Aviation Safety Authority, Advisory Circular (AC) 91-10 v1.1: *Operations in the vicinity of non-controlled aerodromes*, dated November 2021
- Civil Aviation Safety Authority, Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design, version 1.5, dated March 2016
- Civil Aviation Safety Authority, *Part 139 (Aerodromes) Manual of Standards 2019*, dated 5 September 2019
- Civil Aviation Safety Authority, Advisory Circular 139.E-01 v1.0—Reporting of Tall Structures, dated December 2021
- Civil Aviation Safety Authority, Advisory Circular (AC) 139.E-05 v1.0 Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome
- Department of Infrastructure and Regional Development, Australian Government, National Airport Safeguarding Framework, Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*, dated June 2013
- European Academy of Wind Energy, Do wind turbines pose roll hazards to light aircraft - 2018
- 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 22 December 2020
- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*
- Victorian Government, Department of Environment, Land, Water & Planning, *Development of Wind Energy Facilities in Victoria Policy and Planning Guidelines,* revised November 2021
- Victoria State Government, the Department on Environment, Land, Water and Planning (DELWP), VicPlan – Interactive Planning Information.

APPENDIX 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)	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.

Term	Definition
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.
Runway	A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.
Runway strip	A defined area including the runway and stopway, if provided, intended: a. to reduce the risk of damage to aircraft running off a runway; and b. to protect aircraft flying over it during take-off or landing operations.
Safety Management System	A systematic approach to managing safety, including organisational structures, accountabilities, policies and procedures.

APPENDIX 3 – TURBINE COORDINATES AND HEIGHTS

Source: Umwelt, WW_WTG_WMT_Ground_Elev_200521

Note: the heights include a 5 m allowance for variation in site elevation. WTG details will be updated once the final layout is confirmed

WTG ID	*Easting*	*Northing*	*Base Elevation (m AHD)*	*Height (m AGL)*	*Error budget + 5 m*	*Overall height (m AHD)*	*Overall height (ft AMSL)*
1	669456	5901184	253.17	255	260	513.17	1683.711
2	669771	5905747	202.43	255	260	462.43	1517.233
3	670243	5899928	259.93	255	260	519.93	1705.89
4	670703	5902617	224.67	255	260	484.67	1590.202
5	670676	5907048	202.5	255	260	462.5	1517.463
6	671165	5906212	211.02	255	260	471.02	1545.417
7	672673	5900064	232.9	255	260	492.9	1617.205
8	670785	5899686	243.15	255	260	503.15	1650.835
9	671239	5901414	237.41	255	260	497.41	1632.002
10	671558	5899817	222.08	255	260	482.08	1581.704
11	673206	5903124	228.66	255	260	488.66	1603.293
12	670222	5905422	203.14	255	260	463.14	1519.562
13	674797	5897777	240.82	255	260	500.82	1643.19

WTG ID	Easting	Northing	Base Elevation (m AHD)	Height (m AGL)	Error budget + 5 m	Overall height (m AHD)	Overall height (ft AMSL)
14	669836	5900213	252.36	255	260	512.36	1681.053
15	672612	5903494	226.96	255	260	486.96	1597.716
16	672046	5904239	225.82	255	260	485.82	1593.975
17	670304	5903498	213.55	255	260	473.55	1553.718
18	671687	5906301	204.23	255	260	464.23	1523.139
19	672207	5906287	204.97	255	260	464.97	1525.567
20	675354	5898061	236.09	255	260	496.09	1627.671
21	671126	5900043	237.4	255	260	497.4	1631.969
22	673162	5900290	233.02	255	260	493.02	1617.599
23	674987	5897292	250.8	255	260	510.8	1675.935
24	673163	5899173	245.03	255	260	505.03	1657.003
25	672661	5899189	236.86	255	260	496.86	1630.198
26	674502	5902083	220.18	255	260	480.18	1575.471
27	674268	5903473	210.54	255	260	470.54	1543.842
28	670360	5906355	201.32	255	260	461.32	1513.591
29	671664	5905115	211.63	255	260	471.63	1547.418

WTG ID	Easting	Northing	Base Elevation (m AHD)	Height (m AGL)	Error budget + 5 m	Overall height (m AHD)	Overall height (ft AMSL)
30	673740	5902224	227.99	255	260	487.99	1601.095
31	673115	5904473	216.36	255	260	476.36	1562.937
32	670775	5901176	234.45	255	260	494.45	1622.29
33	672346	5902262	216.86	255	260	476.86	1564.578
34	674696	5898420	237.81	255	260	497.81	1633.315
35	669448	5900550	263.85	255	260	523.85	1718.752
36	674735	5902637	212.15	255	260	472.15	1549.124
37	675751	5898414	224.51	255	260	484.51	1589.677
38	677361	5900566	227.22	255	260	487.22	1598.569
39	678084	5900510	217.96	255	260	477.96	1568.187
40	671170	5903819	207.98	255	260	467.98	1535.442
41	671571	5902917	210.75	255	260	470.75	1544.531
42	669486	5899801	261.8	255	260	521.8	1712.026
43	672508	5905083	213.77	255	260	473.77	1554.439
44	670175	5901136	244.54	255	260	504.54	1655.396
45	673634	5903931	208.73	255	260	468.73	1537.903

APPENDIX 4 - RISK ASSESSMENT 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
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.

APPENDIX 5 – 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 time-frame 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.

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 139-08 v2—Reporting of Tall Structures

In Advisory Circular (AC) 139-08 v2—*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, the top measurement of which is:

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

b) 45 metres or more above ground level elsewhere.

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 wind turbines 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 wind turbines, 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/m² or greater.*

Visual impact of night lighting

Annex 14 Section 6.2.4 and Part 139 MOS 2019 Chapter 9 are specifically intended for wind turbines 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 turbine.

Marking of turbines

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 wind turbines 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 0 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 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.

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 agriculture 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.*

ANNEXURES

1. Solar glare analysis (aviation and non-aviation receptors) – *ForgeSolar-analysis-report-Watta Wella_Solar_Farm_ (Nil backtrack) _v1.0_220623*
2. Wind Monitoring tower aviation impact assessment - *102203-02_Watta_Wella_WF_WMT_AIA_v1.0_220624*

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