AVIATION PROJECTS

July 2025

AVIATION IMPACT ASSESSMENT

TATHRA WIND FARM

Prepared for SynergyRED

DOCUMENT CONTROL

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ACRONYMS

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

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

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

Nil

EXECUTIVE SUMMARY

Introduction

Synergy Renewable Energy Developments (referred to as SynergyRED or the Proponent) proposes to develop a renewable energy project in the mid‐west of Western Australia, referred to as the Tathra Wind Farm. The site is located within the Shire of Carnamah, approximately 15km east of Eneabba town site and approximately 300km north of Perth, Western Australia.

The project is proposed to include up to 140 wind turbine generators (WTGs) (total capacity of up to 1,000MW across the site), 500MW in solar and 500MW in battery storage, with supporting infrastructure (the Proposal). The Proposal, located on predominantly cleared land currently used for agriculture will connect into the South‐West Interconnected System (SWIS) via the existing 330kV transmission lines which are situated within the development envelope.

The associated infrastructure for the Proposal comprises of the following:

- Up to 140 wind turbine generators (WTGs) with a total capacity of up to 1,000MW across the site.
- Up to 500MW capacity in solar and 500MW in Battery Energy Storage Systems (BESS), including associated roads, foundations and drainage.
- Associated turbine foundations and hard stand areas.
- A turbine design comprising:
  - Blade length up to 90 m.
  - Tower/hub height between 110m and 160m; and
  - Turbine tip height up to 250m.
- Site entrances from public roads and internal access roads between wind turbines and supporting infrastructure.
- Overhead transmission poles or towers and power lines, and underground electrical cables.
- Electrical substations and switchyards, including ancillary electrical equipment (e.g. STATCOM).
- Operations and maintenance buildings, workshops, and associated car parking.
- Temporary construction facilities, including site offices, construction compounds, laydown areas, gravel borrow pits and concrete batching plant.
- Water abstraction bore(s) for construction activities and associated infrastructure (dams/turkey’s nests).
- Fire water tanks.
- Communication towers and monitoring masts (meteorological masts) up to 150m tall.

Synergy has requested Aviation Projects to prepare an Aviation Impact Assessment (AIA) for the proposed Project development. The AIA will include reviewing potential impacts of the development, providing safety advice in relation to the relevant air safety regulations and procedures and providing a technical report to support the planning application process.

This assessment should:

- Be completed to a suitable standard to support planning approvals, including identifying and demonstrating appropriate risk management strategies.
- Be undertaken in accordance with the relevant air safety regulations, and procedures, including:
    - CASA, Civil Aviation Safety Regulations 1998 (CASR)
    - National Airports Safeguarding Framework (NASF) Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers.*
    - Western Australia Government, Department of Planning, Lands and Heritage, Position Statement: Renewable energy facilities, March 2020.
    - Specific requirements as advised by Airservices Australia.
- Consider and address the Shire of Carnamah Local Planning Policy Wind Farms/Turbines.
- Include all engagement and ongoing consultation with relevant aviation agencies to complete the assessment, including negotiating acceptable mitigation to identified impacts.
- Allow for flexibility in the assessment for changes to turbine technology and layout.

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

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

Project description

Tathra Wind Farm includes the following:

- Up to 140 WTGs with a maximum tip height of 250 m above ground level (AGL).
- The ground elevation for the highest WTG location is 314 m Australian Height Datum (AHD), which, with a 250 m WTG height, results in a maximum overall height of 564 m AHD (1850.4 ft above mean sea level (AMSL)).

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 planning provisions of Shire of Carnamah's Local Planning Policy – Wind Farms/Turbines and would not create incompatible intrusions or compromise the safety of existing airports and associated navigation and communication facilities.

Certified airports

2. There is no certified airport located within 30 nm (56 km) from the Project Site.

Obstacle Limitation Surfaces (OLS)

3. The Project is located outside the horizontal extent of OLS of any certified aerodrome.

Uncertified Aerodromes

4. There is one (1) uncertified aerodrome identified within 3 nm of the project site – Judeen Aerodrome:
    - The proposed wind farm would be considered potentially hazardous obstacles
    - When the wind blows from the north, northwest or northeast, downstream wake turbulence from the closer WTGs would extend into the circuit area.
    - Further consultation with the owner/operator of this aerodrome would be beneficial in understanding the potential extent of these impacts.

Air Routes and Lowest Safe Altitude (LSALT)

5. The WTGs would impact the Grid LSALT, which would need to be raised by 100 ft to 2900 ft AMSL.
6. The WTGs would impact the air route LSALT—Z41, which would need to be raised by 100 ft to 2900 ft AMSL

Airspace

7. The project area is located within Class G airspace and outside all controlled airspace, Prohibited, Restricted and Danger areas.

Aviation Facilities

8. The WTGs would not penetrate any protection areas associated with aviation facilities.

ATC Surveillance Radar

9. The project site is located outside the area of interest to assess the potential impact of the development on surveillance radar. The Project would not impact the Perth Preliminary Surveillance Radar (PSR)/ Secondary Surveillance Radar (SSR) and Kalamunda Air Route Surveillance Radar (RSR).

Aviation Impact Statement (AIS)

10. Based on the proposed WTG layout and maximum blade tip height of 250 m AGL, the blade tip elevation of the highest wind turbine would not exceed 564 m (1850.4 ft AMSL).
    a. There are no certified airports located within 30 nm (56 km) of the Project Site.
    b. The WTGs would impact the Grid LSALT, which would need to be raised by 100 ft to 2900 ft AMSL.
    c. The WTGs would impact the air route LSALT—Z41, which would need to be raised by 100 ft to 2900 ft AMSL.
    d. The project area is located within Class G airspace and outside all controlled airspace, Prohibited, Restricted and Danger areas.
    e. The WTGs would not impact the aviation facilities of nearby certified airports.
    f. The WTGs would not impact the closest radar installations.
    g. The WTGs must be reported to CASA, and construction details must be provided to Airservices.

Obstacle lighting risk assessment

11. Aviation Projects has undertaken a safety risk assessment of the Project and concludes that the proposed WTGs would not require obstacle lighting to maintain an acceptable level of safety to aircraft.
12. Over the 15-year period between 2010-2025, no aircraft collided with a WTG or a WMT in Australia.
13. There is no regulatory requirement to mark or light power poles or overhead transmission lines.
14. WA Department of Fire and Emergency Services normally recommends aviation obstacle lighting and markings be placed on the wind farms to protect emergency services aviation aircraft.

Consultation

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

The consultation process will commence after approval of the Final Draft AIA and authorisation to proceed from the client. It will continue throughout the review of the Development Application.

The risk assessment will be updated, and this report will be finalised based on the feedback received during the consultation process. Feedback will be documented in this report.

Summary of key recommendations

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

Notification and reporting

1. Details of WTGs 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. Final details of WTG coordinates and elevation should be provided to Airservices Australia two weeks prior, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com
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 final location and height information of WTGs 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.

6. Consultation with Western Australia Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service would be required regarding the buffer area of the boundary.

Marking of WTGs

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

Lighting of WTGs

8. CASA will determine whether obstacle lighting is recommended for the WTGs. Lighting the WTGs is not a formal requirement.
9. WA Department of Fire and Emergency Services normally recommends aviation obstacle lighting and markings be placed on the wind farms to protect emergency services aviation aircraft.

Micrositing

10. Providing the micrositing of the WTGs, it would not likely result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Aerial firefighting

11. The developer or operator should consider the guidance contained in the National Council for Fire and Emergency Services, Wind Farms and Bushfire Operations to ensure:

    a. Liaison with the relevant fire and land management agencies is ongoing and effective

    b. Access is available to the wind farm site by emergency services for on-ground firefighting operations.

    c. Wind turbines are shut down immediately during emergency operations.

    d. 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. This may not always be possible due to the risk to equipment and personnel as a fire approaches or exists in or near to the WTGs.

Aviation Projects considers that it may be impractical to stop and lock the turbine blades in a Y configuration due to the time needed to stop and lock the turbine and the risk to personnel having to climb into the WTG tower as a bush fire approaches. WTG blades can be feathered to effectively stop or reduce the rotation rate of the turbine to a very slow speed.

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

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

1. INTRODUCTION

1.1. Situation

Synergy Renewable Energy Developments (referred to as SynergyRED or the Proponent) proposes to develop a renewable energy project in the mid - west of Western Australia, referred to as the Tathra Wind Farm. The site is located within the Shire of Carnamah, approximately 15km east of Eneabba town site and approximately 300km north of Perth, Western Australia.

The project is proposed to include up to 140 wind turbine generators (WTGs) (total capacity of up to 1,000MW across the site), 500MW in solar and 500MW in battery storage, with supporting infrastructure (the Proposal). The Proposal, located on predominantly cleared land currently used for agriculture will connect into the South - West Interconnected System (SWIS) via the existing 330kV transmission lines which are situated within the development envelope.

The associated infrastructure for the Proposal comprises of the following:

- Up to 140 wind turbine generators (WTGs) with a total capacity of up to 1,000MW across the site.
- Up to 500MW capacity in solar and 500MW in Battery Energy Storage Systems (BESS), including associated roads, foundations and drainage.
- Associated turbine foundations and hard stand areas.
- A turbine design comprising:
    - Blade length up to 90 m.
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    - Turbine tip height up to 250m.
- Site entrances from public roads and internal access roads between wind turbines and supporting infrastructure.
- Overhead transmission poles or towers and power lines, and underground electrical cables.
- Electrical substations and switchyards, including ancillary electrical equipment (e.g. STATCOM).
- Operations and maintenance buildings, workshops, and associated car parking.
- Temporary construction facilities, including site offices, construction compounds, laydown areas, gravel borrow pits and concrete batching plant.
- Water abstraction bore(s) for construction activities and associated infrastructure (dams/turkey's nests).
- Fire water tanks.
- Communication towers and monitoring masts (meteorological masts) up to 150m tall.

SynergyRED has engaged Aviation Projects to prepare an AIA to support the proposed application and formally consult with aviation agencies.

1.2. Purpose and Scope

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

The AIA responds explicitly to the following key legislation, approvals, and guidance material:

- Civil Aviation Safety Regulations 1998 (CASR).
- Shire of Carnamah Local Planning Policy Wind Farms/Turbines.
- National Airports Safeguarding Framework (NASF) Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers.*
- Western Australia Government, Department of Planning, Lands and Heritage, Position Statement: Renewable energy facilities, March 2020.
- Specific requirements as advised by Airservices Australia.

1.3. Methodology

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

- Review relevant regulatory requirements and information sources
- Conduct a site visit to properly investigate aviation safety aspects of the proposed Project Site for the overall wind farm site once determined
- Prepared a draft wind farm AIA with supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified. The draft AIA report included an Aviation Impact Statement (AIS) for Airservices Australia and a qualitative risk assessment to determine the need for obstacle lighting and applicable aspects for client review and acceptance before submission to external aviation regulators
- Identified risk mitigation strategies that may provide an acceptable alternative to night lighting for the wind farm. The risk assessment will be completed following the guidelines in *ISO 31000:2018 Risk Management –Guidelines*
- Consulted with aviation regulators, consisting of Airservices Australia and the Department of Defence
- Consulted with relevant Council (s) and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable)
- Consulted/engaged with stakeholders to negotiate acceptable outcomes (if required)
- Finalise the AIA report for client acceptance.

1.4. Aviation Impact Statement (AIS)

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

Aerodromes:

- Specify all certified aerodromes that are located within 30 nm (55.6 km) of the Project Site
- Nominate all instrument approach and landing procedures at these aerodromes

- Review the potential effect of 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 Site and review potential impacts of project operations on aircraft using those air routes.

Airspace:

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

Navigation/Radar:

- Nominate aviation navigation systems in proximity to the Project Site.

1.5. Material reviewed

The material provided by the Proponent for the preparation of this assessment includes:

- GIS Data of Tathra Wind Farm (received 22 April 2025)
  - TTWF_Infrastructure_Polygon_All.shp
  - TTWF_Lot_Boundaries.shp
  - TTWF_Neighbour_Lot_Boundaries.shp
  - TTWF_Project_TX_Lines.shp
  - TTWF_Proposed_Solar.shp
  - TTWF_Wind_Turbine_Location_All.shp
  - TTWF_Study_Area.shp
- WTG coordinates and ground elevation data (received 22 April 2025)
  - TTWF_Wind_Turbine_Data_R1.xlsx

2. BACKGROUND

2.1. Site Overview

The Project Site is located approximately 300 km north of Perth and 15km east of Eneabba townsite, within the Shire of Carnamah Local Government Area (LGA).

An overview of the Project Site relative to Eneabba is provided in Figure 1 (source: SynergyRED, Google Earth).

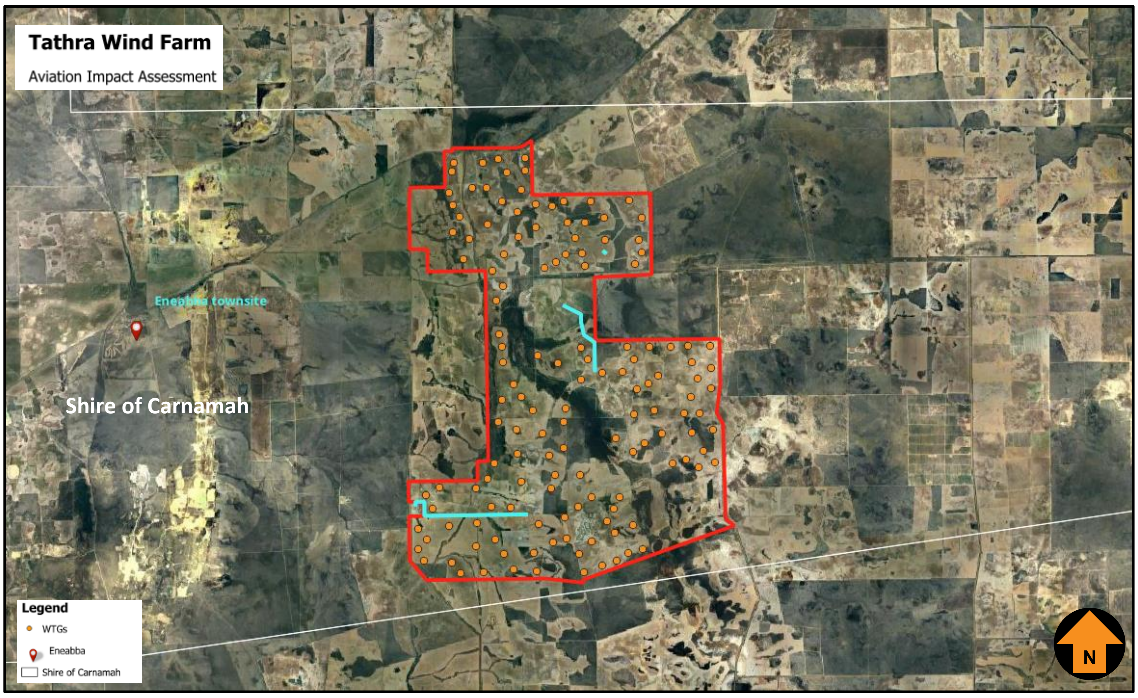

Figure 1 Project Site overview

2.2. Project Description

The Project Site involves constructing, operating, maintaining and decommissioning the Tathra Wind Farm, including a final layout of up to 140 WTGs.

The WTGs would have a rotor diameter of 180 m, with a maximum tip height of 250 m AGL.

The ground elevation for the highest WTG location is 314 m AHD, which, with a 250 m WTG height, results in a maximum overall height of 564 m AHD (1850.4 ft AMSL).

3. EXTERNAL CONTEXT

3.1. National Airports Safeguarding Framework

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

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

NASF Guideline D provides guidance to State/Territory and local government decision makers, airport operators and developers of wind farms to jointly address the risk to civil aviation arising from the development, presence and use of wind farms and WMTs.

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

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

NASF Guideline D strongly encourages consultation with aviation stakeholders in the early stages of wind farm development planning, including with aerodrome owners and operators, regional aircraft operators and CASA and Airservices.

3.2. Western Australia Government, Department of Planning, Lands and Heritage

The Western Australian Planning Commission administers responsibility for approving renewable energy facilities through local councils. The Department of Planning, Lands and Heritage has published *Position Statement: Renewable energy facilities* (March 2020) on behalf the Western Australia Planning Commission. These guidelines provide advice to inform planning decisions about a wind energy facility proposal.

The intent of this position statement is to:

- Outline the Western Australian Planning Commission (WAPC) requirements to support the consistent consideration and provision of renewable energy facilities within Western Australia
- Identify assessment measures to facilitate appropriate development of renewable energy facilities.

The position statement applies to the preparation and assessment of planning instruments including regional and local planning schemes and strategies.

The position statement supersedes Planning Bulletin 67 Guidelines for Wind Farm Development (2004).

Section 5.3.1 *Community Consultation* and Section 5.3.5 *Public and Aviation safety* are relevant to this assessment and are extracted below:

> *Section 5.3.1 Community Consultation*
>
> *Early consultation with the community and stakeholders by the proponents is encouraged to ensure that the proposal is compatible with existing land uses on and near the site. The local government should be consulted with respect to the community consultation program. Relevant stakeholders may include:*
>
> - *Air Services Australia*
> - *Australian Wind Alliance*
> - *Civil Aviation Safety Authority*
>
> *5.3.5 Public and aviation safety*
>
> *Proponents of wind turbine proposals should refer to the National Airports Safeguarding Framework (NASF) Guideline D: Managing the Risk to Aviation Safety of Wind Turbine Installation (Wind Farms) / Wind Monitoring Towers to determine any potential aviation safety risks and possible mitigation measures.*
>
> *Any potential aviation safety risks identified require consultation with Civil Aviation Safety Authority (CASA), Air Services Australia and/or the Commonwealth Department of Defence.*

The position paper defines Renewable energy facility as premises used to generate energy from a renewable energy source and includes any building or other structure used in, or relating to, the generation of energy by a renewable resource. It does not include renewable energy electricity generation where the energy produced principally supplies a domestic and/or business premises and any on selling to the grid is secondary.

An aviation impact assessment would include consultation with relevant aviation stakeholders and address aviation-related matters included in the Position Statement

3.3. Shire of Carnamah – Local Planning Policy – Wind Farms/Turbines

The Project Site will be subject to Shire of Carnamah's *local planning policy – wind farms/turbines*, including:

> *8. POLICY PROVISIONS*
>
> *Other Potential Impacts*
>
> *Developers are required to take into consideration the of airfields when developing wind farm/turbines within close proximity to the area, so as not to impact the operation and activities of the Airport users including any aeronautical, gliding and flying associations operating within the Shire. Consultation with relevant government authorities and airport operators will be required.*
>
> *Developers of wind turbine proposals should refer to the National Aviation Safeguarding Framework (NASF) Guideline D: Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms) / Wind Monitoring Towers to determine any potential aviation safety risks and possible mitigation measures. Any potential aviation safety risks identified require consultation with the Civil Aviation Safety Authority (CASA), Air Services Australia and/or the Commonwealth Department of Defence.*
>
> *The NSAF guideline identifies consultation with unlicensed aerodrome owners and CASA/Air Services. CASA has released an advisory circular AC 139.E-05v1.1 Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome.*

All wind farm and turbine developments must adhere to and comply with the regulations, specifications, and requirements outlined by the Civil Aviation Safety Authority (CASA), as though airstrips were registered. This ensures that the development does not impede the potential future upgrade of the airstrips from its current unregistered CASA uncertified status to that of a Registered CASA certified Airport.

Consultation with relevant government authorities and airport operators will be required. Wind farm proposals should not have negatively impact through interference with normal agricultural or farming activities of nearby rural properties, such as aerial spraying. An aviation assessment by a suitable qualified aviation consultant may be required to demonstrate turbines will not impact on aerial spraying activities of surrounding farms or unlicenced airstrips.

10. GUIDELINES

The following information must be submitted where development approval is sought for large renewable energy systems:

e) Aviation Impact Assessment (noting that Wind Farms are unlikely to be supported within the vicinity of Carnamah or Eneabba Airfields).

3.4. Civil Aviation Safety Authority (CASA)

CASA provides the following guidance to inform pilots of their obligations at non-certified aerodromes.

3.4.1. AC 91-02 V1.2, Guidelines for aeroplanes with MTOW not exceeding 5700 kg – suitable places to take off and land, dated November 2022

This AC provides guidance for pilots of:

- Aeroplanes with maximum take-off weight (MTOW) not exceeding 5700 kg that are operated under Part 91 of CASR, including experimental aircraft, and
- Light sport aircraft (LSA) under Part 103 of CASR.

Purpose

This AC provides guidance to assist aeroplane pilots when determining the suitability of a place to safely take off and land. It provides an overview of pilot responsibilities, discusses the relevant circumstances recommended to be considered and includes general information and advice to enhance the safety of taking off and landing at any place.

2 Introduction

2.2 Use of Aerodromes

2.2.1 Regulation 91.410 authorises a place for use as an aerodrome if: (i) it is suitable for the landing and taking-off of aircraft; and (ii) an aircraft can land at or take off from the place safely, having regard to all the circumstances of the proposed landing or take-off (including the prevailing weather conditions).

4.2.4 The examples below are two of many possible considerations:

- the obstacles surrounding the aerodrome have been accurately described and are still current (e.g. have the trees on final grown taller since last reported), and

– the information provided enables the pilot to judge whether or not a landing approach can be made from both runway directions.

3.4.2. AC 91-10 v1.4, Operations in the vicinity of non-controlled aerodromes, dated May 2025

This AC provides guidance on procedures that, when followed, will improve situational awareness and safety for all pilots when flying at, or in the vicinity of, non-controlled aerodromes.

> *7.2 Traffic circuit direction*
>
> *7.2.1 The standard aerodrome traffic circuit facilitates the orderly flow. Unless an alternative requirement for an aerodrome is stated in the ERSA or NOTAMs, all turns must be made to the left (regulation 91.385).*
>
> *7.2.2 When arriving at an aerodrome to land, the pilot will normally join the circuit on upwind, crosswind (midfield), or at or before mid-downwind. Landings and take-offs should be made on the active runway or the runway most closely aligned into wind.*
>
> *7.3.2 During initial climb-out, the turn onto crosswind should be appropriate to the performance of the aircraft but, in any case, not less than 500 ft above terrain so as to be at circuit height when turning downwind (regulation 91.390). Pilots may vary the size of the circuit depending on:*
>
> *– the performance of the aircraft*
>
> *– AFM/Pilot's Operating Handbook requirements*
>
> *– company standard operating procedures*
>
> *– other safety reasons.*
>
> *7.8 Final approach*
>
> *7.8.1 The turn onto final approach should be:*
>
> *– completed by a distance and height that is common to all operations at the aerodrome*
>
> *– commensurate with the speed flown in the circuit for all aircraft of the same type.*

Illustrations of the standard aerodrome traffic circuit procedures provided in AC 91-10 v1.4. are shown in Figure 2 and Figure 3.

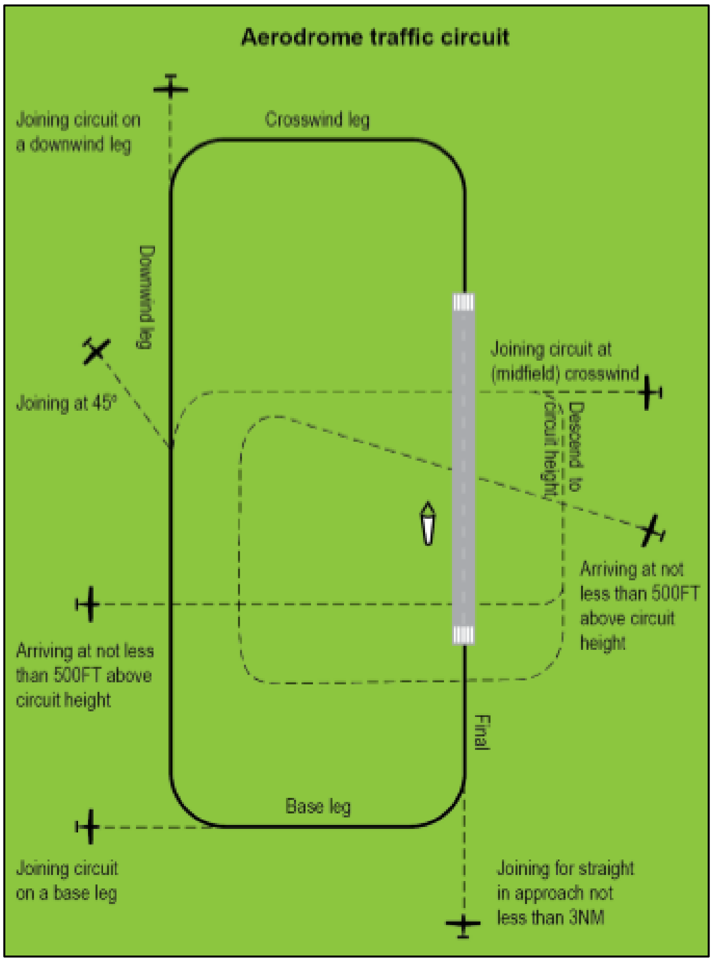

Figure 2 Aerodrome standard traffic circuit, showing arrival and joining procedures.

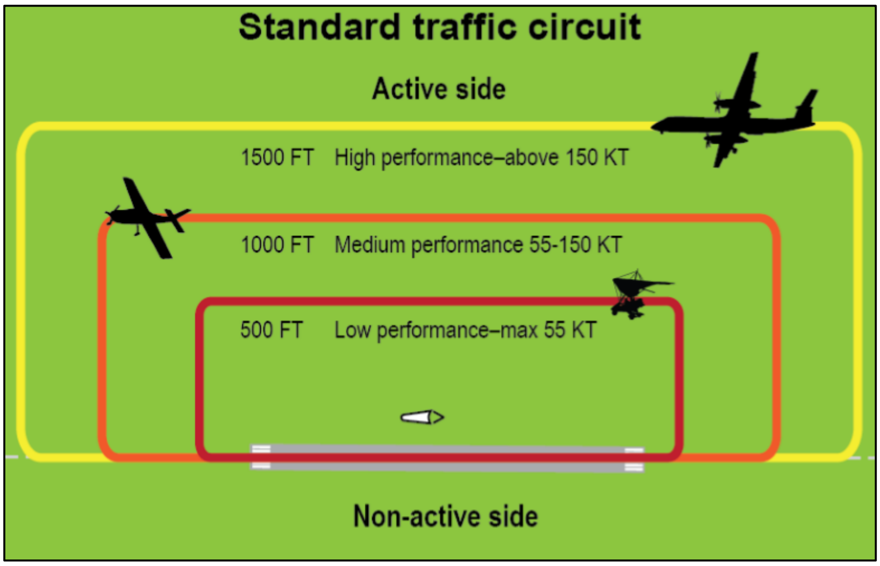

Figure 3 Lateral and vertical separation in the standard aerodrome traffic circuit

Paragraph 7.11 refers to a distance that is “normally” well outside the circuit area and where no traffic conflict exists, which is at least 3 nm. The paragraph is copied below:

> *7.11 Departing the circuit area*
>
> *7.11.1 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 should be 500 ft or more above the circuit height and 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.*

3.5. Rules of flight

3.5.1. Flight under Day Visual Flight Rules (Day VFR)

According to Australia’s Aeronautical Information Package (AIP) the meteorological conditions required for visual flight in the applicable (class G) airspace at or below 3,000 ft AMSL or 1,000 ft AGL (whichever is the higher) are: 5,000 m visibility, clear of clouds and in sight of ground or water.

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

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

3.5.2. Flight under Night Visual Flight Rules (Night VFR)

With respect to flight under the VFR at night CASR 91.277 requires that the pilot in command of an aircraft flying VFR at night must not fly below the appropriate lowest safe altitude (unless during take-off and landing operations, within 3 nm of an aerodrome).

3.5.3. Flight under 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 that are not in the vicinity of an aerodrome are effectively redundant to an aircraft being operated under the IFR.

3.6. Aircraft operator characteristics

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

Flight under day VFR is conducted above 500 ft 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 proposed WTGs would be sufficiently visually conspicuous to pilots conducting VFR operations within the vicinity of the Project Site to enable appropriate obstacle avoidance manoeuvring.

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

3.7. Passenger transport operations

Scheduled and non-scheduled passenger transport operations are generally operated under the IFR.

3.8. 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 in areas outside city and township built-up areas. These operations are usually conducted at altitudes well above 500 ft AGL for passenger comfort and fuel efficiency.

3.9. Military operations

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

Refer to Section 5 for a detailed response from the Department of Defence.

3.10. Aerial application operations

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

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

3.10.1. Aerial Application Association Australia (AAAA)

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

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

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

- *Identified the process for advising of the location height and presence of the structure to the relevant authorities, and*
- *Ensure that the proposal is in keeping with CASA requirements for structures near aerodromes, including temporary landing areas.*

3.10.2. Aerial application operators

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

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

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, and the utilise the AAAA formal risk management programme.

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

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

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

3.11. Emergency services

3.11.1. Royal Flying Doctor Service

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

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

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

3.11.2. Aerial firefighting

Aerial firefighting operations (firebombing in particular) are conducted under 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.*

Aviation Projects considers that it may be impractical to stop and lock the turbine blades in a Y configuration due to the time needed to stop and lock the turbine and the risk to personnel having to climb into the WTG tower as a bush fire approaches. WTG blades can be feathered to effectively stop or reduce the rotation rate of the turbine to a very slow speed.

4. INTERNAL CONTEXT

4.1. Wind farm site description

The Project Site is located approximately 300km north of Perth and 15km east of Eneabba townsite, within the Shire of Carnamah LGA.

Figure 4 and Figure 5 show a few roadside views of the Project site. (Source: Aviation Projects).

Figure 4 Project Site roadside view 1

Figure 5 Project Site roadside view 2

4.2. Wind turbine generator (WTG) description

The project site would comprise up to 140 WTGs, with a maximum blade tip height of 250 m AGL.

The ground elevation for the highest WTG location is 314 m AHD, which, with a 250 m WTG height, results in a maximum overall height of 564 m AHD (1850.4 ft AMSL).

Figure 6 Illustrates the project layout identifying the highest WTGs' location (source: Google Earth).

'Micrositing' of WTGs means an alteration to the siting of a WTG and any consequential changes to access tracks and internal power cable routes. The potential micrositing of the WTGs has been considered in the assessment. The estimate of the overall maximum height being based on the highest ground level of the nominal WTG position. The micrositing of the WTGs is not likely to result in a change in the Project's maximum overall blade tip height. This AIA assumes a maximum blade tip height of 250 m AGL is implemented at all WTG locations.

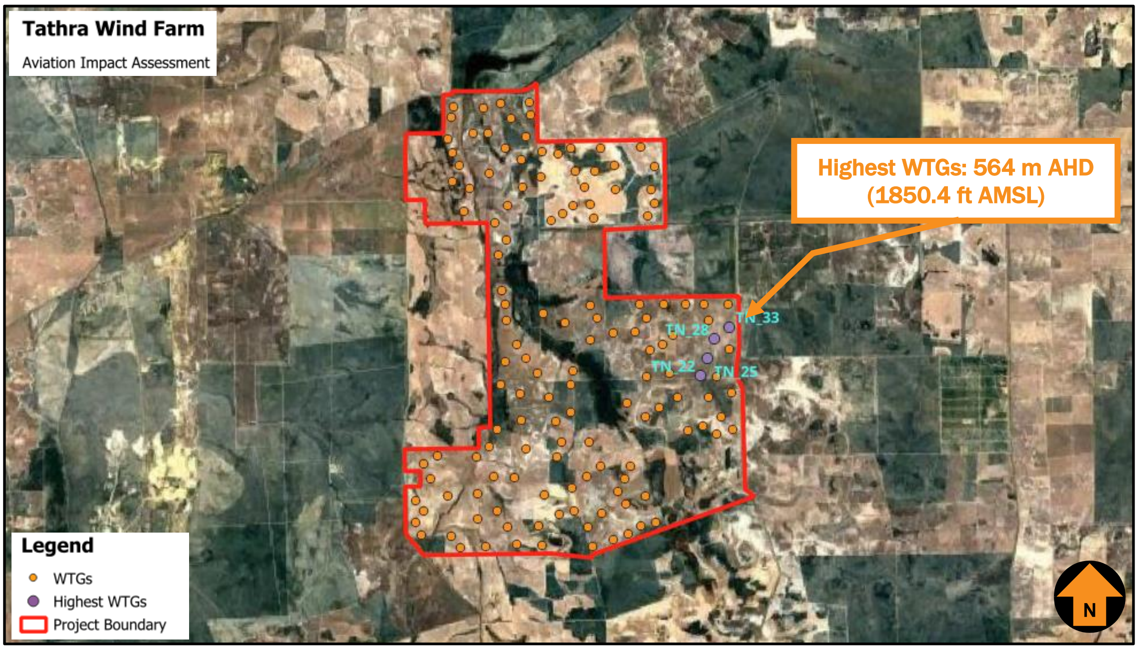

Figure 6 Project Site layout and highest WTG location

4.3. Transmission line

The location of the transmission lines is provided in Figure 7 (Source: SynergyRED, Google Earth).

Figure 7 Transmission lines related to the Project.

5. CONSULTATION

The following list of stakeholders were identified as requiring consultation:

1. Airservices Australia
2. Department of Defence
3. Shire of Carnamah
4. Western Australia Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service
5. Royal Flying Doctor Service
6. St John WA
7. Western Australia Department of Fire and Emergency Services

Details and results of the consultation activities will be provided in Table 1.

Table 1 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices Australia				
Department of Defence				
Shire of Carnamah				
Western Australia Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service				
Royal Flying Doctor Service				
St John WA				
Western Australia Department of Fire and Emergency Services				

6. AVIATION IMPACT STATEMENT

6.1. Overview

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

To facilitate these assessments, all wind farm proposals submitted to Airservices Australia must include an AIS.

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

- The operation of certified aerodromes within 30 nm of the wind farm
- Grid and air route LSALTs
- Airspace protection
- Aviation navigation and communication facilities
- ATC surveillance radar installations
- Local aircraft operations.

6.2. Nearby certified aerodromes

A certified aerodrome is an aerodrome regulated by the Civil Aviation Safety Authority (CASA) under Part 139 of the Civil Aviation Safety Regulations (CASR), with defined standards established in Part 139 (Aerodromes) Manual of Standards (MOS) 2019.

There are no certified aerodromes located within 30 nm of the proposed site. The closest airport is Morawa Airport (YMRW), approximately 81 km/43 nm northeast of the Project Site.

The 30 nm radius represents the 25 nm minimum sector altitude (MSA) for aerodromes with terminal instrument flight procedures. The 25 nm MSA is determined by assessing obstacles within 30 nm (25 nm plus 5 nm buffer) of the aerodrome reference point or navigational aid on which the MSA is based.

The location of the project site relative to Morawa Airport (YMRW) is shown in Figure 8 (Source: SynergyRED, Google Earth). The orange circle around the airport represents a distance of 30 nm from the aerodrome reference point of the airport.

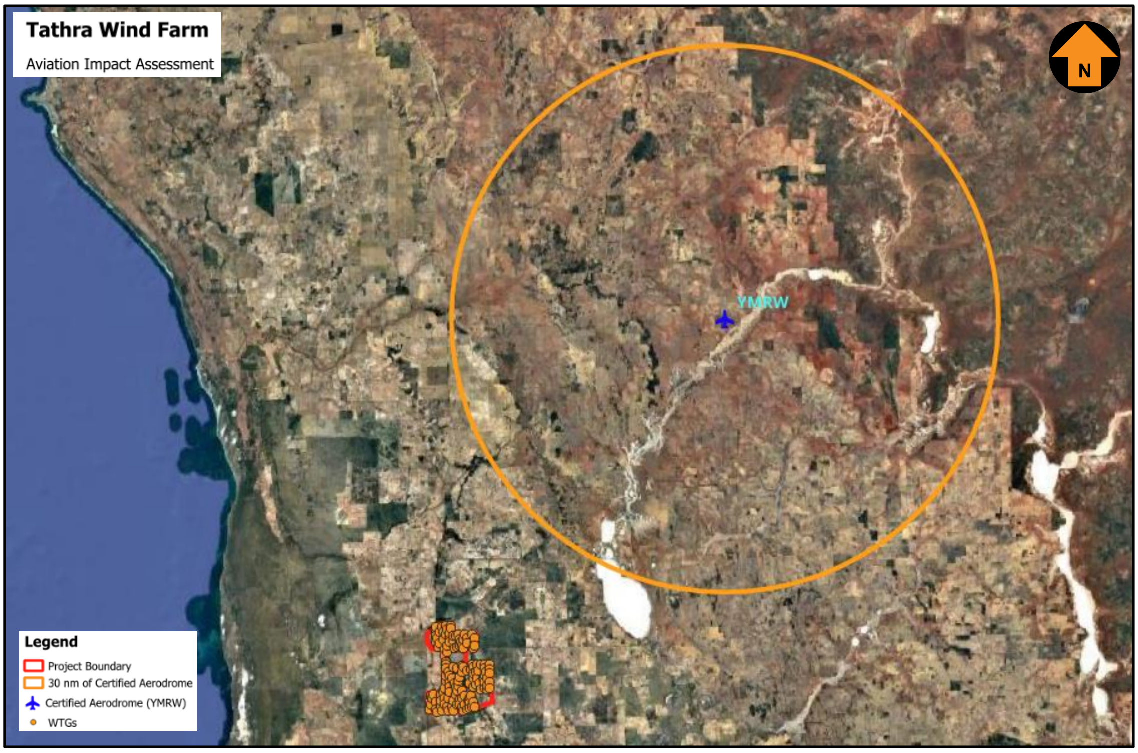

Figure 8 Location of Certified Airports in relation to Project Site

6.3. Grid and Air routes LSALT

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

6.3.1. Grid LSALT

The Project Site is within an airspace grid with LSALT of 2800 ft AMSL, which provides clearance above obstacles with heights up to 1800 ft AMSL.

Figure 9 shows the grid LSALT in proximity to the project site (source: ERC Low National, OzRunways, May 2025, Google Earth). An impact analysis of the Grid LSALT is provided in Table 2.

Table 2 Grid LSALT impact analysis

Grid LSALT	*Protection Surface*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
2800 ft AMSL	1800 ft AMSL	Yes, the highest WTG would exceed by 15.4 m (50.4 ft)	LSALT raised by 100 ft	Minor

The highest WTG is 564 m AHD (1850.4 ft AMSL), which would be higher than the 1800 ft obstacle height limit by 15.4 m (50.4 ft).

Therefore, the WTGs would impact the Grid LSALT. LSALTs may only be raised in 100-ft increments, so the grid LSALT would need to be raised by 100 ft to 2900 ft AMSL.

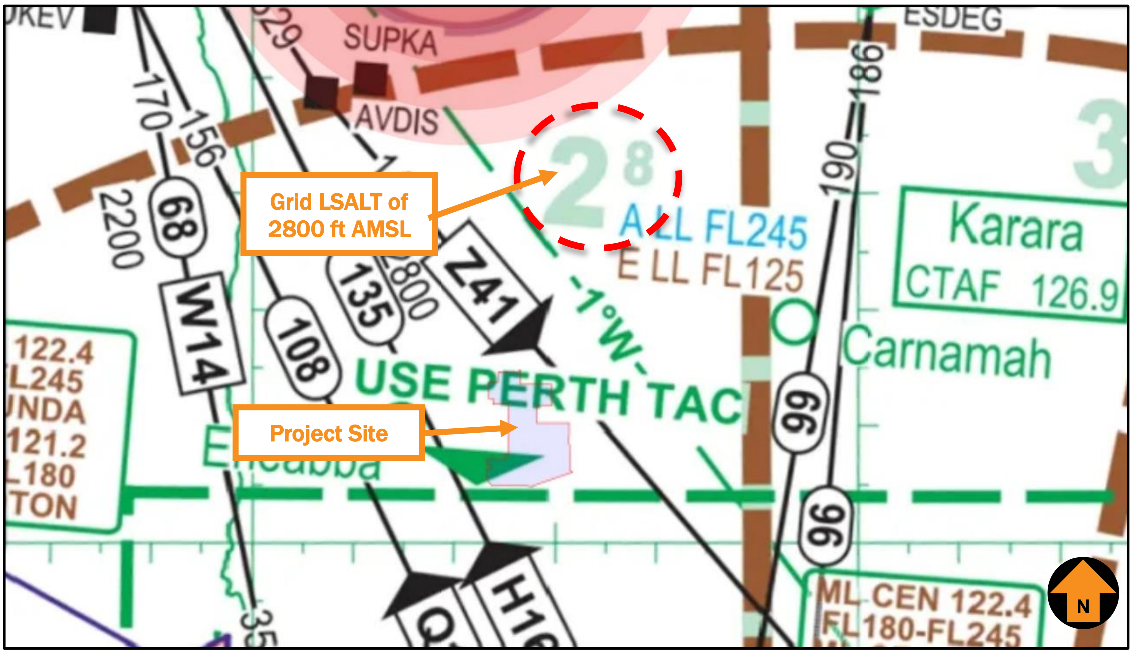

Figure 9 Grid LSALT in proximity to the Project Site

6.3.2. Air Route LSALTs

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

There are three (3) air routes within the protection area of the Project Site. An impact analysis of the air routes is provided in Table 3.

The highest WTG is 564 m AHD (1850.4 ft AMSL), which would be higher than air routes Z41's protection surface. Air route Z41 would need to be raised by 100 ft to 2900 ft AMSL.

Table 3 Air route impact analysis

Air route	*Waypoint pair*	*Route LSALT*	*Protection Surface*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
Z41	AVDIS to HINDS	2800	1800	The highest WTG higher than protection surface by 15.4 m (50.4 ft)	LSALT raised by 100 ft to 2900 ft	Minor
H16	AVNEX to GEL VOR	2800	1800	The highest WTG within the protection area is lower than the protection surface only by 0.64 m (2.1 ft)	Nil	N/A

Air route	Waypoint pair	Route LSALT	Protection Surface	Impact on airspace design	Potential solution	Impact on aircraft ops
Q20	ANVEX to ONGAR	2900	1900	Nil	Nil	N/A

6.4. Airspace Protection

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

The Project would not have an impact on controlled or designated airspace.

6.5. Aviation facilities

NASF Guideline G, *Protection of Aviation Facilities - Communication, Navigation and Surveillance (CNS)* and CASR Part 139 MOS specify the area where development of buildings and structures has the potential to cause unacceptable interference to CNS facilities.

The project site is located a sufficient distance away from nearby certified airports and aviation facilities and would not have an impact.

6.6. ATC Surveillance Radar installations

Airservices Australia requires an assessment of the potential for the WTGs that may affect radar line of sight. The three closest radar facilities to the project site are:

- Perth Preliminary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR), which is located approximately 228 km south of the Project Site.
- Kalamunda Air Route Surveillance Radar (RSR), which is located approximately 239 km south of the Project Site.

EUROCONTROL guidelines for assessing the potential impact on wind turbines on radar surveillance sensors stipulate the following assessment requirements:

Primary Surveillance Radar (PSR)

- Zone 1 0-500 m: Not permitted
- Zone 2 500 m – 15 km: Detailed assessment
- Zone 3: Further than 15 km but within maximum instrumented range and in radar line of sight: Simple assessment
- Zone 4: Anywhere within maximum instrumented range but not in radar line of sight or outside the maximum instrumented range: No assessment.

Secondary Surveillance Radar (SSR)

- Zone 1: 0 - 500 m: Not permitted
- Zone 2: 500 m - 16 km but within maximum instrumented range and in radar line of sight: Detailed assessment

- Zone 4: Further than 16 km or not in radar line of sight: No assessment

(Zone 3 is not established for secondary surveillance radar)

The project site is outside the line-of-sight range of Perth PSR/SSR and Kalamunda RSR radars and would not impact these facilities.

6.7. AIS Summary

Based on the WTG layout and maximum blade tip height of up to 250 m AGL, the blade tip elevation of the highest WTG, would not exceed 564 m AHD (1850.4 ft AMSL) and;

- There is no certified airport located within 30 nm (56 km) from the Project Site.
- The WTGs would impact the Grid LSALT, which would need to be raised by 100 ft to 2900 ft AMSL.
- The WTGs would impact the air route LSALT—Z41, which would need to be raised by 100 ft to 2900 ft AMSL.
- The project area is located within Class G airspace and outside all controlled airspace, Prohibited Restricted and Danger areas.
- The WTGs would not impact the aviation navigation facilities.
- The WTGs would not impact the closest ATC surveillance radar installations.
- The WTGs must be reported to CASA, and construction details must be provided to Airservices.

7. UNCERTIFIED AERODROMES

Searching various aviation datasets will identify uncertified aerodromes near the project area. They are not subject to CASR Part 139 regulations.

The aviation datasets used for the search are:

- AIP aeronautical charts effective 12 June 2025
- OzRunways - which sources its data from Airservices Australia (AIP). The aeronautical data provided by OzRunways is approved under CASR Part 175
- Australian Government National Map website (www.nationalmap.com.au).

As a guide, an area of interest within a 3 nm radius of an uncertified aerodrome is used to assess the potential impacts of proposed developments on aircraft operations at or within the vicinity of the uncertified aerodrome. The 3 nm radius is considered to be the area in which aircraft are making preparations to join the circuit prior to landing and within which to manoeuvre after take-off to depart from the aerodrome.

Figure 10 Shows the location of an uncertified aerodrome relative to the Project Site and a nominal 3 nm buffer from the closer uncertified aerodromes (source: Google Earth).

The Project Site would be within 3 nm of one (1) uncertified aerodrome – Judeen Aerodrome.

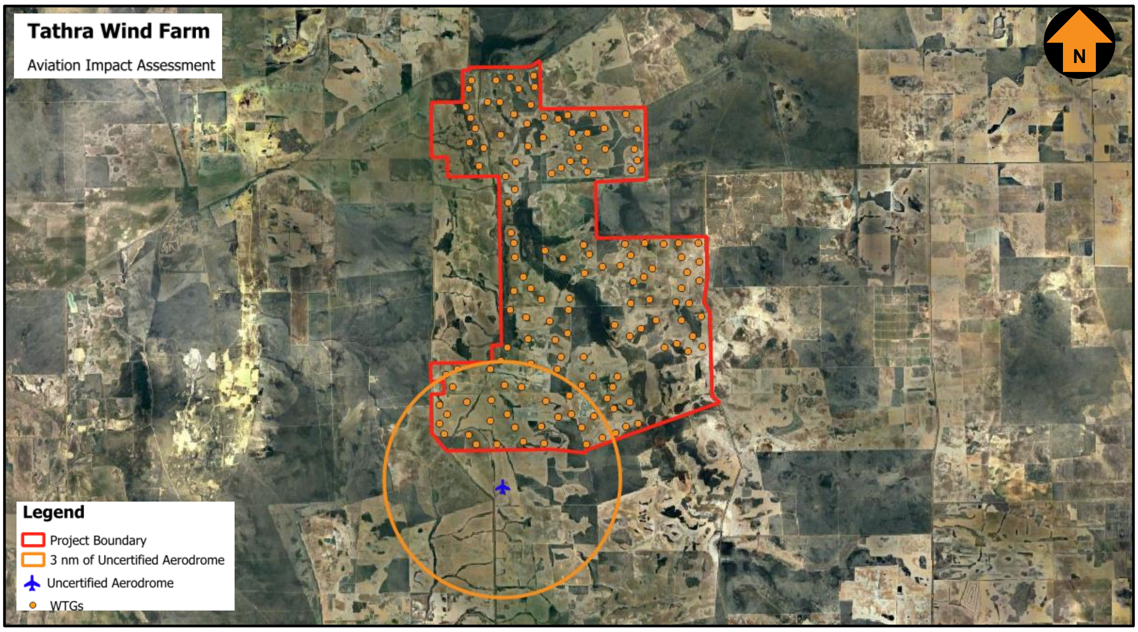

Figure 10 Uncertified Aerodrome in the vicinity of the Project Site

7.1. Judeen Aerodrome

The Judeen Aerodrome is approximately 1.4 km south of the closest WTG. There is no information published about the uncertified aerodrome in aeronautical publications and publicly available information sources. Satellite imaging shows a prepared runway, as shown in Figure 11 (Source: Google Earth).

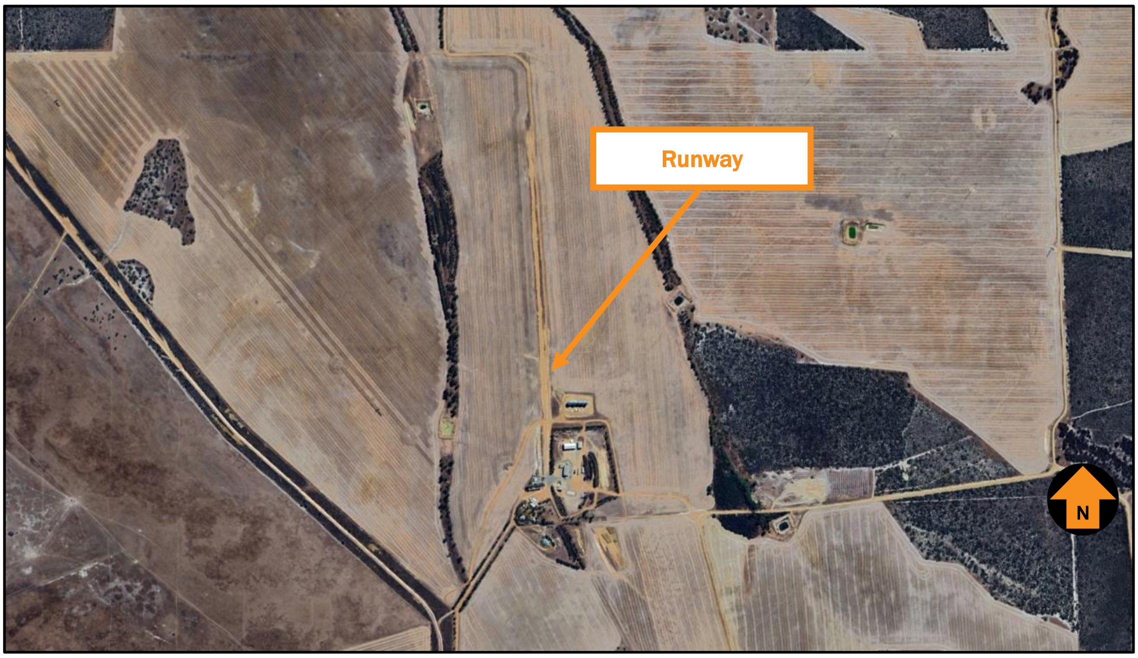

Figure 11 Close-up Google Earth image of Judeen Aerodrome's runway

Approximately 27 WTGs are proposed to be located within 3 nm of this aerodrome, as shown in Figure 12 (Source: SynergyRED, Google Earth).

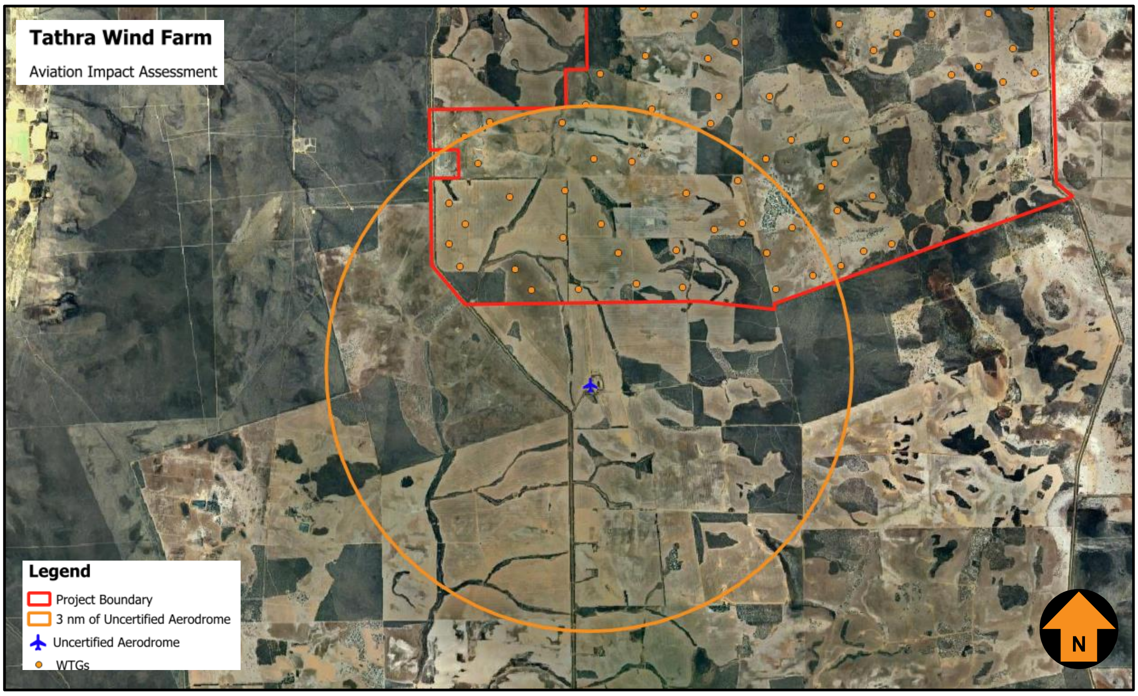

Figure 12 WTGs within 3 nm of Judeen Aerodrome

Aircraft typically operate in circuit patterns when arriving and departing from an aerodrome. AC 91-10 '*Operations in the vicinity of non-controlled aerodromes*' describes the standard traffic circuit and heights at which aircraft should fly. This is shown in Figure 3 (Section 3.4.2).

In addition, various entry and departure procedures for aircraft joining and departing a standard traffic circuit are described. Figure 2 in Section 3.4.2 shows the standard arrival and joining procedures for a standard traffic circuit.

WTGs within a 3 nm radius of the aerodrome have slightly lower ground elevations to the runway elevations. With maximum tip heights of 250 m/820 ft AGL, these WTGs would, therefore, be considered potentially hazardous obstacles for aircraft operating in the circuit area and would need to be considered by pilots intending to operate there to ensure that they can avoid them by prescribed margins.

WTGs within 3 nm of the aerodrome that would be considered potentially hazardous obstacles are shown in Figure 13 (Source: SynergyRED, Google Earth). Consultation with the landowner would be required to determine the type of flight operations normally conducted there.

The standard circuit described in AC-91-10 normally consists of 5 'legs; upwind, crosswind, downwind, base and final.

The upwind leg is maintained after take-off until the aircraft reaches at least 500 ft above the runway before turning left and continuing to climb to circuit altitude. It normally takes 1 nm to climb to 500 ft and in any case a pilot can turn prior to 500 ft to avoid obstacles or high terrain.

The aircraft continues climbing to circuit altitude and this is usually reached during the crosswind leg or early in the downwind leg.

The normal circuit altitude maintained on the downwind leg is 1000 ft above the aerodrome for light aircraft or 500 ft for ultralight aircraft.

The pilot selects a point on the downwind where they turn onto the base leg, commence descent to position the aircraft on a slope that ensures they can reach the runway on a slope that allows them to land in the initial part of the runway and to avoid any obstacles such as trees and fences in close proximity to the runway end.

The downwind leg spacing is usually within 1 nm of the runway or closer, to allow the aircraft to reach the runway in the event of an engine failure.

A straight-in approach can be conducted if terrain and obstacle allow a normal descent profile to the runway. If a straight-in approach is not practical, then a standard circuit should be flown. Pilots need to be aware of the wind strength and direction prior to making a decision about which runway to land on so they would normally overfly the aerodrome to observe a wind sock or other features that would indicate wind speed and direction to enable to aircraft to land as close to into-wind as possible.

Four (4) WTGs would be within the 1 nm circuit operation area of the aerodrome, and a few WTGs would be located close to the straight-in approach path.

Uncertified aerodromes do not have the same regulatory status and protections as certified aerodromes. Potential impacts upon an uncertified aerodrome caused by a wind farm would not preclude the regulatory approval of the wind farm under the Position Statement. However, it is highly recommended that any wind farm be designed to avoid, minimise, and/or mitigate impact(s) on private aerodromes.

Advised by SynergyRED, this uncertified aerodrome's operator is a landowner for the Tathra Wind Farm. A preliminary discussion with the landowner has been conducted, and they have indicated that moving or removing it would have a minor impact on their current operations, expressing their willingness to do so. Continuous consultation with the landowner during the construction process would be recommended.

Figure 13 WTGs in relation to circuit operation of Judeen Aerodrome

7.2. Western Australia Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service

Wotto Nature Reserve and Tathra National Park are next to the Project Site's boundary. Some low-level flight operations might occur in both parks, which would require a safe flight corridor without turbines along the park's boundaries.

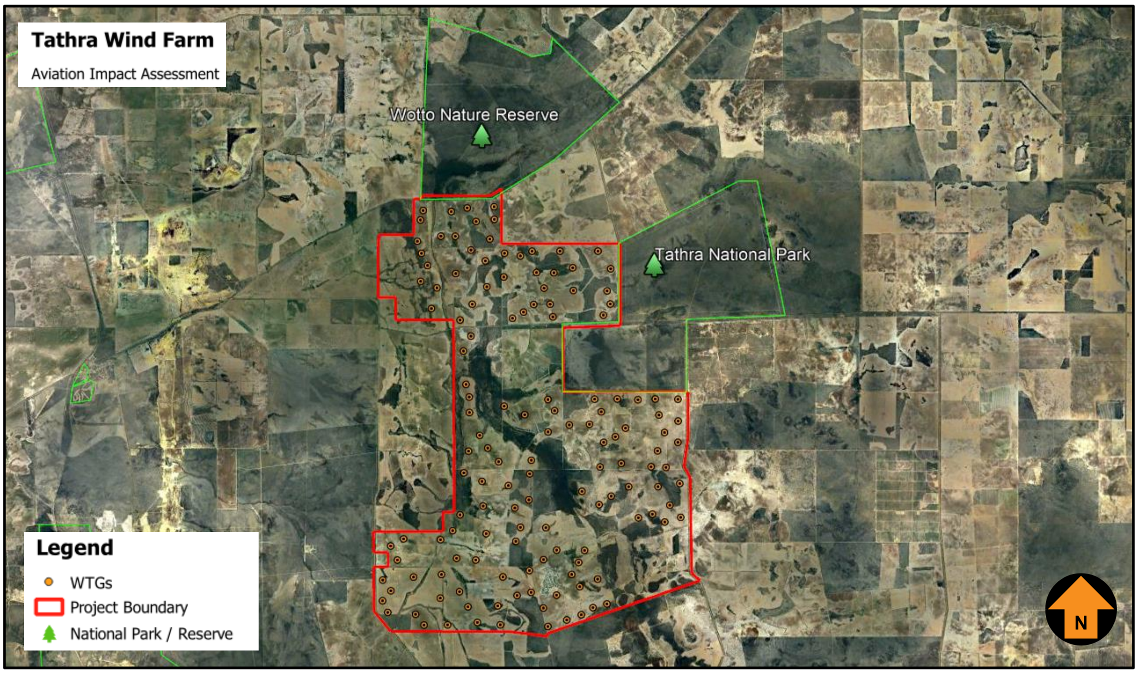

Figure 14 National Park boundary related to WTGs

Figure 14 (Source: Google Earth) shows the park boundary in relation to the Project Site. Liaison with Western Australia Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service would be required regarding the buffer area of the boundary.

8. POTENTIAL WAKE TURBULENCE IMPACTS

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

NASF Guideline D provides guidance regarding WTG wake turbulence which states:

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

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

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

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

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

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

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

Assessment

A 180 m rotor diameter has been used for the wake turbulence analysis. Based on this scenario, NASF Guideline D suggests the effects of wake turbulence could be noticeable from the WTGs within 2880 m of the runway and the nominal circuit area, depending on wind direction.

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

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

Two of those studies are referred to below.

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

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

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

> *At University of Liverpool, a full CFD method [4] was used with the HMB solver to study wind turbine wakes. The CFD results showed good agreement for the blade surface pressure distributions and flow field velocities with the wind tunnel measurements. The wake was then solved on a very fine mesh able to capture the wake vortices up to 8 radii downstream of the blades on the MEXICO wind turbine rotor.*
>
> *In general, the LIDAR measurements captured the regular wake mean velocity patterns. Statistic LIDAR data indicate that the effects of wind turbine rotor wake, in term of velocity deficit, are limited within a downwind distance of 5D. This is generally in agreement with the results of the full CFD method and the velocity deficit models.*
>
> *For a wind turbine with size similar to the WTN250, and using the Beddoes circulation formula, the off-line simulation results indicate that the wind turbine wake did not pose any hazards to the encountering aircraft 5 diameters further from the wind turbine. The dominant upset that the wake generated is a yawing moment on the aircraft. The wake generated crosswind, is smaller than the maximum crosswind of 17.75 ft/s for an airport (codes A-I or B-I) that is expected to accommodate single engine aircraft. These conclusions are in line with that found in the piloted flight simulation.*

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

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

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

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

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

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

Table 4 Wake Turbulence Distances

1 RD (m)	*7 RD (m)*	*10 RD (m)*	*16 RD (m)*
180	1260	1800	2880

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

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

The downwind turbulence from WTGs beyond 7 RD may be felt by the pilot of a light aircraft but the pilot will only need to make minor control adjustments to maintain control of the aircraft's attitude, altitude and heading. Such turbulence is likely to be classified as Light on an intensity scale published by the Australian Bureau of Meteorology shown in Figure 15.

Within the 7 RD boundary the turbulence is considered to create a medium hazard which is likely to equate to pilots experiencing "Moderate" turbulence in which the *"Pilot remains in control at all times."* (Figure 15)

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

Figure 15 Turbulence intensities[1]

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

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

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

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

8.1. Judeen Aerodrome

Figure 16 Shows 10 times (1800 m) around the relevant boundary WTGs in relation to the Judeen Aerodrome (sources: Google Earth).

Whilst there are four (4) WTGs infringing the standard 1 nm circuit in either direction, when the wind blows from the north, northwest or northeast, downwind wake turbulence from the nearest WTGs would be experienced by aircraft operating within the standard circuit area.

With a north-westerly wind, it would be usual for aircraft to land from the south to the north, and departing aircraft would take off in the same direction and would experience some degree of turbulence prior to reaching an altitude above the WTGs. This turbulence is likely to be similar to turbulence already existing at the aerodrome due to the undulating nature of the terrain, which causes turbulence in similar winds over the aerodrome. The turbulence would not be considered to cause a pilot serious problems in controlling the aircraft, nor would it compromise the aircraft's structure.

With a southeasterly wind, it would be usual for aircraft to land and take off from the north to the south. There is no downwind wake turbulence from the southeast.

The nearby Warradarge wind farm would also create some degree of turbulence within the standard circuit area of this uncertified aerodrome.

Pilot's that are qualified for low-level operations in suitable aircraft may be able to operate at the aerodrome by using smaller circuits but the requirements for pilots without a low-level qualification would most likely mean that they cannot operate from this aerodrome in accordance with CASR Part 91.

Consultation with the landowner is critical to determine the landowner's use of the aerodrome and their impression of the likely impact to their aerodrome.

Mitigation measures that may reduce the impact to flight operations at the aerodrome include:

- The landowner may agree to relocate the runway further south to avoid the impact, which could make the WTGs and associated turbulence from outside the circuit operations of the aerodrome.
- In a north-westerly wind when the turbulence extends from the south of the WTGs:
    - Aircraft would land from the south in order to have a head wind for landing therefore avoiding the turbulence area but would be flying in very close proximity to the WTGs
    - Aircraft would take-off to the north and either climb at a higher rate to reach 500 ft earlier than normal or turn prior to reaching 500 ft AGL to avoid any turbulence. The turbulence is likely to be less impact the pilot's ability to control the aircraft using normal control inputs
- In a southerly wind, any turbulence from the WTGs would not infringe the standard circuit area.

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

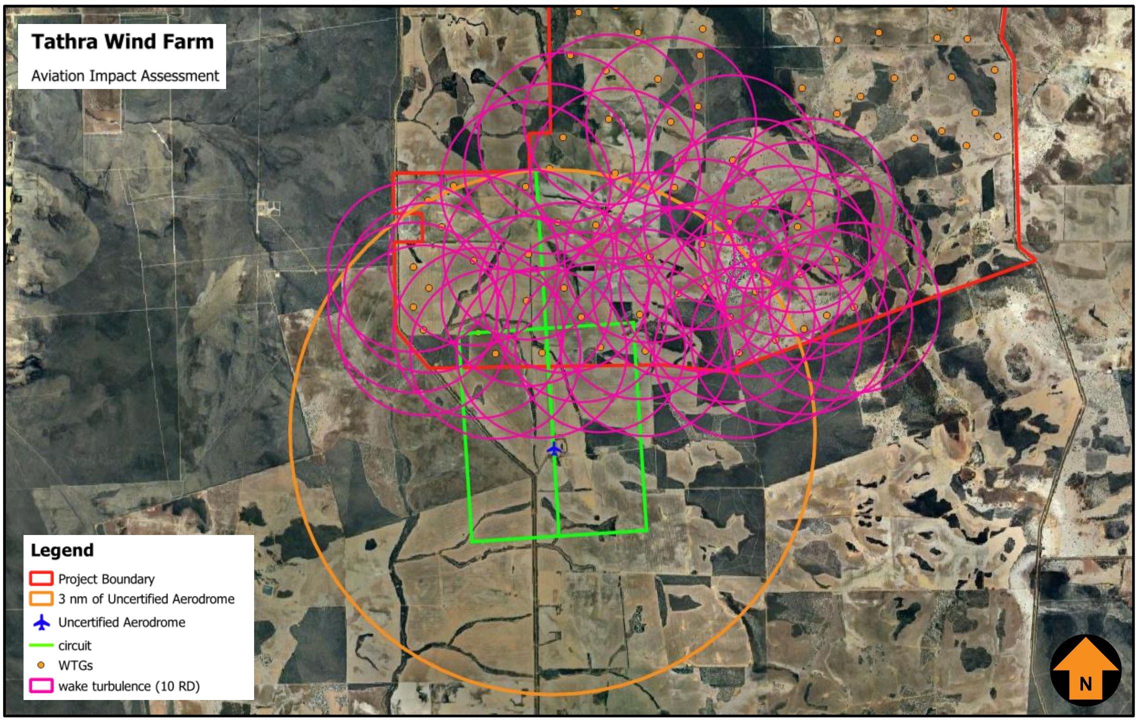

Figure 16 Possible extent of wake turbulence from WTGs to Judeen Aerodrome

9. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 11 It is concluded that aviation lighting is not likely to be required.

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

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

WA Department of Fire and Emergency Services normally recommends aviation obstacle lighting and markings be placed on the wind farms to protect emergency services aviation aircraft

9.1. Transmission Line

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

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

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

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

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

10. 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 considered.

10.1. 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.

10.2. 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.

10.3. National aviation occurrence statistics 2010-2019

The Australian Transport Safety Bureau (ATSB) published a summary of aviation occurrence statistics for the period 2010-2019 (AR-2020-047, Final - 4 November 2020). A later version of this report is not yet available. Aviation Projects subscribes to the ATSB occurrence reports. There have been no collisions or incidents involving wind farms since 2019.

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

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

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

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

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

Figure 17 refers to Fatal Accident Rate by operation type per million departures over the 6-year period (source: ATSB). Note the rates presented are not the full year range of the study (2010–2019). This was due to the availability of exposure data (departures and hours flown) which was only available between these years. According to the ATSB report, the number of fatal accidents per million departures for GA aircraft over the 6-year reporting period ranged between 6.6 in 2014 and 4.9 in 2019.

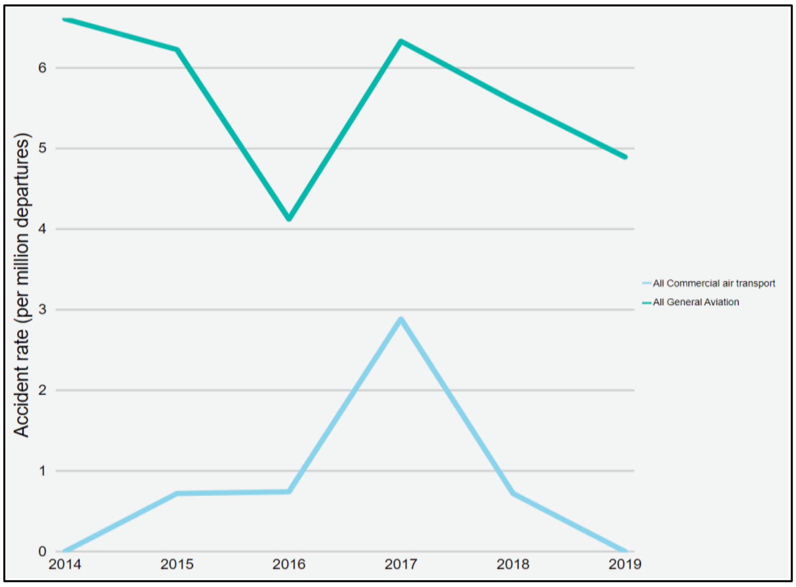

Figure 17 Fatal Accident Rate (per million departures) by Operation Type

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

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

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

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

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

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

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

10.4. Worldwide accidents involving wind farms

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

Based on the statistics set out in the Global Wind Energy Council (GWEC) report 2024, Total installations of 117GW in 2023 represents a 50% year-on-year increase from 2022..

Based on the Australia's Clean Energy Council statistics there were 110 wind farms in Australia at 2023. Aviation Projects has researched public sources of information, accessible via the world wide web, regarding aviation safety occurrences associated with wind farms. Occurrence information published by Australia, Canada, Europe (Belgium, Denmark, France, Germany, Norway, Sweden and The Netherlands), New Zealand, the United Kingdom and the United States of America was reviewed.

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

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

made contact with two WTGs. The aircraft was damaged but landed safely. No fatalities were recorded.

  - In both of the above cases, it is difficult to conclude that obstacle lighting would have prevented the accidents.

- One fatal accident, near Highmore, South Dakota in 2014 occurred at night in Instrument Meteorological Conditions (IMC).

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

There is one accident occurred in near Nettersheim, Kreis Euskirchen, North Rhine Westphalia, Germany in August 2024. Unconfirmed information suggests that the aircraft impacted a wind turbine in poor visibility conditions. The accident resulted in one fatality and 2 occupants.

11. RISK ASSESSMENT

A risk management framework comprises 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.

11.1. Risk Identification

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

Based on an extensive review of accident statistics data (see summary in Section 8 above) and stakeholders who were consulted during the preparation of this AIA (see Section 5), 4 identified risk events associated with WTGs and WMTs relate to aviation safety or potential visual impact, and are listed as follows:

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

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

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

11.2. Risk Analysis, Evaluation and Treatment

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

A summary of the level of risk associated with the Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table 7 through to Table 10.

Table 7 Aircraft collision with wind turbine generator (WTG)

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

Discussion

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

There have been 5 reported occurrences worldwide of aircraft collisions with a component of a WTG structure since the year 2000 as discussed in Section 10. These reports show a range of situations where pilots were conducting various flying operations at low level and in the vicinity of wind farms in both IMC and VMC. No reports of aircraft collisions with wind farms in Australia have been found.

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

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

Refer to the discussion of worldwide accidents in Section 10.

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

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

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

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

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

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

There have been 5 reports of aircraft collisions with WTGs worldwide, which have resulted in a range of consequences, where aircraft occupants sustained minor injury in some cases and fatal injuries in others (see Section 10). Similarly, aircraft damage sustained ranged from minor to catastrophic. One of these accidents resulted from structural failure of the aircraft before the collision with the WTG. Only two relevant accidents occurred during the day, and only one resulted in a single fatality. It is assessed that collision with a WTG resulting in multiple fatalities and damage beyond repair is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments (without lighting) • The Project site is clear of the OLS of any certified aerodrome. • Aircraft are restricted to a minimum height of 500 ft (152.4 m) AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. The proposed WTGs would be a maximum height of 250 m (820.2 ft) AGL at the top of the blade tip. The rotor blade at its maximum height would be approximately 97.6 m (320.2 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • Aircraft are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles (including terrain) which are within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night). • Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities undertaken specifically for and prior to undertaking such authorised flights. Any obstacle including WTGs in the path of the authorised flight would be specifically risk assessed during that process. • The WTGs are typically coloured white so they should be visible to pilots during the day. • The 'as constructed' details of WTGs are required to be notified to Airservices Australia two weeks prior, so that the location and height of all WTGs can be noted on aeronautical maps and charts. • Because the Project WTGs are proposed to be above 100 m AGL, there is a statutory requirement to report the WTGs to CASA and notified to Airservices Australia prior to construction.	
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8 (Unacceptable).	
Current Level of Risk	8 - Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Details of the Project should be communicated to local and regional aircraft operators prior to construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically: a. Engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the WTG blades prior to the commencement of the subject aircraft operations within the Project site. b. Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, which would involve notification to Airservices Australia.	

<table>
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Residual Risk

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

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

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.

</td></tr>
<tr><td align="right">Residual Risk</td><td>7 - Tolerable</td></tr>
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Table 8 Harsh manoeuvring leading to controlled flight into terrain

Risk ID:	2. 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 WTG would result in harm to people and damage to property.

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

The Project is clear of the OLS of any aerodrome.

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

The proposed WTGs would be a maximum of 250 m (820.2 ft) AGL at the top of the blade tip. The rotor blade at its maximum height would be approximately 97.6 m (320.2 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL.

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

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

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

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

Assumed risk treatments

- The WTGs are typically coloured white so they should be visible during the day.
- Final details of WTG coordinates and elevation should be provided to Airservices Australia at least two weeks prior to construction commencing, so that the location and height of WTGs can be noted on aeronautical maps and charts.
- Since the WTGs would be higher than 100 m AGL, there is a statutory requirement to report the WTG to CASA.

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

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

Untreated Likelihood	Possible

Current Treatments (without lighting) • The Project is clear of the OLS of any aerodrome. • Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. • WTGs would be a maximum of 250 m (820.2 ft) AGL at the top of the blade tip. The rotor blade at its maximum height would be approximately 97.6 m (320.2 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs. • The WTGs and masts would be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart. • If cloud descends below the WTG hub, obstacle lighting would be obscured and therefore ineffective. • 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 WTGs are typically coloured white, typical of most WTGs operational in Australia, so they should be visible during the day. • Final details of WTG coordinates and elevation should be provided to Airservices Australia at least two weeks prior to construction commencing, so that the location and height of wind farms can be noted on aeronautical maps and charts. • Since the WTGs would be higher than 100 m AGL, there is a statutory requirement to report the WTGs to CASA.
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.

Current Level of Risk	8 – Unacceptable

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

Risk Decision	Unacceptable

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

• Ensure details of the Project WTGs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction. • Although there is no requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the Project site.		
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 9 Effect of the Project on operating crew

Risk ID:	3. Effect of the Project on operating crew

Discussion

Introduction or imposition of additional operating procedures or limitations can affect an aircraft's operating crew.

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

Consequence

The worst credible effect a wind farm could have on flight crew would be the imposition of operational limitations, and in some cases, the potential for use of emergency procedures. This would be a Minor consequence.

Consequence	Minor

Untreated Likelihood

The imposition of operational limitations is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments

- The Project is clear of the OLS of any aerodrome.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas.
- The WTGs and masts would be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart.
- WTGs would be a maximum of 250 m (820.2 ft) AGL at the top of the blade tip. The rotor blade at its maximum height would be approximately 97.6 m (320.2 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.
- 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 WTGs are typically coloured white so they should be visible during the day.

• Final details of WTG coordinates and elevation should be provided to Airservices Australia at least two weeks prior to construction commencing, so that the location and height of wind farms can be noted on aeronautical maps and charts. • Since the WTGs would be higher than 100 m AGL, there is a statutory requirement to report the WTGs to CASA.	
Level of Risk The level of risk associated with a Possible likelihood of a Moderate consequence is 5.	
Current Level of Risk	5 - Tolerable
Risk Decision A risk level of 6 is classified as Tolerable: Treatment action possibly required to achieve ALARP - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.	
Risk Decision	Accept, conduct cost benefit analysis
Recommended Treatments WMTs installed prior to WTG installation and those that are not in relatively close proximity to a WTG should be lit to ensure they are visible in low light and deteriorating atmospheric conditions The following additional treatments will provide an additional margin of safety: • Ensure details of the Project WTGs and WMTs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction. • Although there is no requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for such aircraft operations in the vicinity of the Project site.	
Residual Risk Notwithstanding the current level of risk is considered **Tolerable,** the additional Recommended Treatments listed above will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **Tolerable.** **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew, without obstacle lighting on the Project WTGs and Permanent WMTs in close proximity to a WTG, and with obstacle lighting for temporary WMTs installed prior to WTG installation and WMTs that are not in close proximity to a WTG.**	
Residual Risk	5 – Tolerable

Table 10 Effect of obstacle lighting on neighbours

Risk ID:	4. Effect of obstacle lighting on neighbours

Discussion

This scenario discusses the consequential impact of a decision to install obstacle lighting on the wind farm.

Installation and operation of obstacle lighting on WTGs or 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 WTGs or WMTs would be higher than 150 m (492 ft) AGL, they must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.

Level of Risk

The level of risk associated with an Almost certain likelihood of a Moderate consequence is 8.

Current Level of Risk	8 - Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

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

Residual Risk	7 - Tolerable

12. CONCLUSIONS

The key conclusions of this AIA are summarised as follows:

12.1. Planning considerations

The Project, as proposed, satisfies the planning provisions of Shire of Carnamah's Local Planning Policy – Wind Farms/Turbines and will not create incompatible intrusions or compromise the safety of existing airports and associated navigation and communication facilities.

12.2. Aviation Impact Statement

Based on the WTG layout and maximum blade tip height of 250 m AGL, the blade tip elevation of the highest WTG would not exceed 564 m AHD (1850.4 ft AMSL) and:

- There is no certified airports located within 30 nm (56 km) from the Project Site.
- The WTGs would impact the Grid LSALT, which would need to be raised by 100 ft to 2900 ft AMSL.
- The WTGs would impact the air route LSALT—Z41, which would need to be raised by 100 ft to 2900 ft AMSL.
- The project area is located within Class G airspace and outside all controlled airspace, Prohibited Restricted and Danger areas.
- The WTGs would not impact the aviation navigation and communication facilities.
- The WTGs would not impact the closest ATC surveillance radar installations.
- The WTGs must be reported to CASA, and construction details must be provided to Airservices.

12.3. Aircraft operator characteristics

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

Aircraft flying at night in visual conditions are permitted to descend or climb to or from an appropriate minimum altitude only when within 3 nm of the aerodrome. The existence of WTGs within the 3 nm area would require careful consideration of flight paths in the vicinity of the Judeen Aerodrome that would likely cause some flight restrictions in that area.

WTGs are generally not a safety concern to aerial agricultural operators.

Wotto Nature Reserve and Tathra National Park are next to the Project Site's boundary. Some low-level flight operations might occur in both parks, which will require a safe flight corridor without turbines along the park's boundaries. Liaison with Western Australia Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service would be required regarding the buffer area of the boundary.

Restrictions may be imposed on the operation of the uncertified aerodrome located immediately south of the Project due to the proximity of the Project and the proximity of the operational Warradarge Wind Farm.

12.4. Hazard marking and lighting

The following conclusions apply to hazard marking and lighting:

- With respect to CASR Part 139 Division 139.E., the proposed WTGs must be reported to CASA.
- CASA will review the proposed WTG development and make a recommendation for obstacle lighting if required.
- With respect to marking of WTGs, an off-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.

12.5. Summary of risks

A summary of the level of residual risk associated with the Project with the Recommended Treatments implemented is provided in Table 11.

Table 11 Summary of Residual Risks

Identified Risk	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine generator (WTG)	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Communicate details of the Project WTGs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Communicate details of the Project WTGs and WMTs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Effect on crew	Minor	Possible	5	**Acceptable without obstacle lighting (ALARP)** Communicate details of the Project WTGs and WMTs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights	Moderate	Likely	7	**Acceptable without obstacle lighting** (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact.

13. RECOMMENDATIONS

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

Notification and reporting

1. Details of WTGs 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. Final details of WTG coordinates and elevation should be provided to Airservices Australia at least two weeks prior to construction commencing, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com

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 WTGs 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.

6. Consultation with Western Australia Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service will be required regarding the buffer area of the boundary.

Marking of WTGs

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

Lighting of WTGs

8. CASA will determine whether obstacle lighting is recommended for the WTGs. Lighting the WTGs is not a formal requirement.

9. WA Department of Fire and Emergency Services normally recommends aviation obstacle lighting and markings be placed on the wind farms to protect emergency services aviation aircraft.

Micrositing

10. Providing the micrositing of the planned WTGs it is not likely to result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Aerial firefighting

11. The developer or operator should consider the guidance contained in the National Council for Fire and Emergency Services, Wind Farms and Bushfire Operations to ensure:

    a. Liaison with the relevant fire and land management agencies is ongoing and effective

    b. Access is available to the wind farm site by emergency services for on-ground firefighting operations

    c. Wind turbines are shut down immediately during emergency operations.

    d. 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. This may not always be possible due to the risk to equipment and personnel as a fire approaches or exists in or near to the WTGs.

Aviation Projects considers that it may be impractical to stop and lock the turbine blades in a Y configuration due to the time needed to stop and lock the turbine and the risk to personnel having to climb into the WTG tower as a bush fire approaches. WTG blades can be feathered to effectively stop or reduce the rotation rate of the turbine to a very slow speed.

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

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

ANNEXURES

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

ANNEXURE 1 – REFERENCES

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

- Airservices Australia
  - Aeronautical Information Package and Designated Airspace Handbook effective 12 June 2025
- Civil Aviation Safety Authority
  - Civil Aviation Regulations 1988 (CAR)
  - Civil Aviation Safety Regulations 1998 (CASR)
  - Advisory Circular (AC) 91-02 V1.2, *Guidelines for aeroplanes with MTOW not exceeding 5700 kg – suitable places to take off and land*, dated November 2022
  - Advisory Circular (AC) 91-10 v1.4: *Operations in the vicinity of non-controlled aerodromes*, dated May 2025
  - CASR Part 173 MOS– *Standards Applicable to Instrument Flight Procedure Design*, version 1.8, dated August 2022
  - CASR Part 139 MOS– *Aerodromes*, F2024C00161 registered 16/02/2024
  - Advisory Circular 139.E-01 v1.0—*Reporting of Tall Structures*, dated December 2021
  - Advisory Circular (AC) 139.E-05 v1.1 *Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome* (October 2022)
- Department of Infrastructure, Transport, Regional Development, Communications and Arts, Australian Government, National Airport Safeguarding Framework, Guideline D *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*, dated July 2012
- The Department of Planning, Lands and Heritage has published *Position Statement: Renewable energy facilities* (March 2020)
- International Civil Aviation Organization (ICAO):
  - Annex 14—*Aerodromes*
  - Doc 8168 *Procedures for Air Navigation Services—Aircraft Operations* (PANS-OPS)
- OzRunways, dated May 2025
- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*
- Shire of Carnamah's *draft local planning policy – wind farms/turbines*

ANNEXURE 2 – DEFINITIONS

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

Term	*Definition*
Runway	A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.
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.

ANNEXURE 3 – CASA REGULATORY REQUIREMENTS – LIGHTING AND MARKING

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

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

Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

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

Manual of Standards Part 139—Aerodromes

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

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

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

    Note CASA recommends the use of flashing red medium-intensity obstacle lights.
4. *Medium-intensity obstacle lights must be used if:*
    a. *the object or structure is an extensive one; or*

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

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

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

5. For subsection (4), low-intensity and medium-intensity obstacle lights may be used in combination.

6. High-intensity obstacle lights:

a. must be used on objects or structures whose height exceeds 150 m; and

b. must be flashing white lights.

7. Despite paragraph (6) (b), a medium-intensity flashing red light may be used if necessary, to avoid an adverse environmental impact on the local community.

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

8. Subject to subsection (9), for wind turbines in a wind farm, medium-intensity obstacle lights must:

a. mark the highest point reached by the rotating blades; and

b. be provided on a sufficient number of individual wind turbines to indicate the general definition and extent of the wind farm, but such that intervals between lit turbines do not exceed 900 m; and

c. all be synchronised to flash simultaneously; and

d. be seen from every angle in azimuth.

Note: This is to prevent obstacle light shielding by the rotating blades of a wind turbine and may require more than 1 obstacle light to be fitted.

9. If it is physically impossible to light the rotating blades of a wind turbine:

a. the obstacle lights must be placed on top of the generator housing; and

b. a note must be published in the AIP-ERSA indicating that the obstacle lights are not at the highest position on the wind turbines.

10. If the top of an object or structure is more than 45 m above:

a. the surrounding ground (ground level); or

b. the top of the tallest nearby building (building level); then the top lights must be medium-intensity lights, and additional low-intensity lights must be:

c. provided at lower levels to indicate the full height of the structure; and

d. spaced as equally as possible between the top lights and the ground level or building level, but not so as to exceed 45 m between lights.

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

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

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

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

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

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

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

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

International Civil Aviation Organisation

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

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

> *6.2.4 Wind turbines*
>
> *6.2.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.*
>
> *Note 1. — Additional lighting or markings may be provided where in the opinion of the State such lighting or markings are deemed necessary.*
>
> *Note 2. — See 4.3.1 and 4.3.2*
>
> *Markings*
>
> *6.2.4.2 Recommendation. — The rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study.*
>
> *Lighting*
>
> *6.2.4.3 Recommendation. — When lighting is deemed necessary, in the case of a wind farm, i.e. a group of two or more wind turbines, the wind farm should be regarded as an extensive object and the lights should be installed:*
>
> > *a) to identify the perimeter of the wind farm;*
> >
> > *b) respecting the maximum spacing, in accordance with 6.2.3.15, between the lights along the perimeter, unless a dedicated assessment shows that a greater spacing can be used;*
> >
> > *c) so that, where flashing lights are used, they flash simultaneously throughout the wind farm;*
> >
> > *d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located; and*
> >
> > *e) at locations prescribed in a), b) and d), respecting the following criteria:*

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

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

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

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

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

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

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

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

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

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

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

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

Section 4.3 Objects outside the OLS states the following:

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

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

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

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

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

Light characteristics

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

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

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

CASR 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 WTGs and recommends that medium intensity lighting is installed.

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

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

Marking of WTGs

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

It is generally accepted that a non-reflective shade of off-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.

ANNEXURE 4 – RISK FRAMEWORK

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

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

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

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

Likelihood

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

Table 1 Likelihood Descriptors

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

Consequence

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

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

Table 2 Consequence Descriptors

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

Risk matrix

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

Table 3 Risk Matrix

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

Actions required

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

Table 4 Actions Required

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

ANNEXURE 5 – PROJECT TURBINE COORDINATES AND HEIGHTS

Reference file: TTWF_Wind_Turbine_Data_R1.xlsx

WTG_ID	Easting - MGA2020, Zone 50	Northing – MGA2020, Zone 50	Base Elevation (m AHD)	Tip Height (m AGL)	Max Height (m AHD)	Max Height (ft AMSL)
ES_1	346080	6705431	226	250	476	1561.7
ES_2	346200	6706311	240	250	490	1607.6
ES_3	346240	6703771	208	250	458	1502.6
ES_4	346260	6704931	230	250	480	1574.8
ES_5	346305	6706705	230	250	480	1574.8
ES_6	346520	6704431	224	250	474	1555.1
ES_7	346700	6702651	234	250	484	1587.9
ES_8	346920	6703511	224	250	474	1555.1
ES_9	347060	6705651	236	250	486	1594.5
ES_10	347480	6706671	248	250	498	1633.9
ES_11	347660	6705651	254	250	504	1653.5
ES_12	347700	6704111	236	250	486	1594.5
ES_13	347900	6702191	236	250	486	1594.5
ES_14	348060	6700911	226	250	476	1561.7
ES_15	348140	6706831	268	250	518	1699.5
ES_16	348180	6699531	230	250	480	1574.8
ES_17	348320	6699011	222	250	472	1548.6
ES_18	348320	6705091	260	250	510	1673.2
ES_19	348340	6698371	226	250	476	1561.7
ES_20	348360	6701531	230	250	480	1574.8
ES_21	348400	6702851	232	250	482	1581.4
ES_22	348520	6706271	280	250	530	1738.8
ES_23	348928	6704648	268	250	518	1699.5
ES_24	348999	6703578	258	250	508	1666.7
ES_25	349100	6705551	282	250	532	1745.4
ES_26	349260	6706891	266	250	516	1692.9

ES_27	349280	6706371	270	250	520	1706.0
ES_28	349700	6703991	288	250	538	1765.1
ES_29	349720	6704971	304	250	554	1817.6
ES_30	350080	6702291	260	250	510	1673.2
ES_31	350380	6704871	304	250	554	1817.6
ES_32	350540	6702551	280	250	530	1738.8
ES_33	350860	6705071	294	250	544	1784.8
ES_34	350960	6702871	286	250	536	1758.5
ES_35	351060	6704191	300	250	550	1804.5
ES_36	351380	6703551	292	250	542	1778.2
ES_37	351640	6702891	282	250	532	1745.4
ES_38	351760	6702371	264	250	514	1686.4
ES_39	351780	6704191	288	250	538	1765.1
ES_40	352020	6705091	272	250	522	1712.6
ES_41	352560	6704411	264	250	514	1686.4
ES_42	352600	6703471	250	250	500	1640.4
ES_43	353600	6705111	258	250	508	1666.7
ES_44	353860	6702471	248	250	498	1633.9
ES_45	354000	6703471	250	250	500	1640.4
ES_46	354140	6704391	250	250	500	1640.4
ES_47	354140	6702931	266	250	516	1692.9
TN_1	349780	6698651	236	250	486	1594.5
TN_2	350640	6698311	258	250	508	1666.7
TN_3	351600	6698951	250	250	500	1640.4
TN_4	351620	6697611	240	250	490	1607.6
TN_5	351880	6698491	256	250	506	1660.1
TN_6	352500	6697911	258	250	508	1666.7
TN_7	353060	6695171	244	250	494	1620.7
TN_8	353340	6697951	274	250	524	1719.2
TN_9	353540	6698991	250	250	500	1640.4
TN_10	353780	6694631	254	250	504	1653.5
TN_11	353800	6696191	266	250	516	1692.9

TN_12	353820	6698471	276	250	526	1725.7
TN_13	353940	6697211	290	250	540	1771.7
TN_14	354280	6694991	274	250	524	1719.2
TN_15	354420	6697451	306	250	556	1824.1
TN_16	354480	6699011	266	250	516	1692.9
TN_17	354680	6696351	288	250	538	1765.1
TN_18	354840	6697811	292	250	542	1778.2
TN_19	355000	6695391	280	250	530	1738.8
TN_20	355340	6698991	290	250	540	1771.7
TN_21	355420	6694111	264	250	514	1686.4
TN_22	355920	6696231	314	250	564	1850.4
TN_23	356000	6694271	278	250	528	1732.3
TN_24	356060	6699031	294	250	544	1784.8
TN_25	356180	6696891	314	250	564	1850.4
TN_26	356220	6695411	298	250	548	1797.9
TN_27	356220	6698371	304	250	554	1817.6
TN_28	356460	6697651	314	250	564	1850.4
TN_29	356520	6693951	266	250	516	1692.9
TN_30	356540	6696211	310	250	560	1837.3
TN_31	356720	6694651	284	250	534	1752.0
TN_32	357000	6699031	308	250	558	1830.7
TN_33	357020	6698131	314	250	564	1850.4
TN_34	357020	6697251	304	250	554	1817.6
TN_35	357120	6695551	290	250	540	1771.7
TN_36	357180	6694151	256	250	506	1660.1
TS_1	344820	6690531	230	250	480	1574.8
TS_2	344820	6691391	212	250	462	1515.7
TS_3	345040	6690051	218	250	468	1535.4
TS_4	345136	6692807	250	250	500	1640.4
TS_5	345160	6690951	218	250	468	1535.4
TS_6	345422	6692231	232	250	482	1581.4
TS_7	345667	6693107	232	250	482	1581.4

TS_8	346100	6691531	210	250	460	1509.2
TS_9	346200	6689991	208	250	458	1502.6
TS_10	346560	6689551	224	250	474	1555.1
TS_11	347200	6693091	204	250	454	1489.5
TS_12	347220	6690671	214	250	464	1522.3
TS_13	347260	6691651	212	250	462	1515.7
TS_14	347540	6689571	210	250	460	1509.2
TS_15	347700	6693471	210	250	460	1509.2
TS_16	347880	6692331	218	250	468	1535.4
TS_17	348000	6694131	210	250	460	1509.2
TS_18	348020	6690951	220	250	470	1542.0
TS_19	348140	6695871	218	250	468	1535.4
TS_20	348320	6696771	224	250	474	1555.1
TS_21	348380	6690331	228	250	478	1568.2
TS_22	348680	6692271	230	250	480	1574.8
TS_23	348780	6689691	230	250	480	1574.8
TS_24	348780	6697431	238	250	488	1601.0
TS_25	348900	6695531	248	250	498	1633.9
TS_26	348960	6694511	238	250	488	1601.0
TS_27	349100	6693371	242	250	492	1614.2
TS_28	349120	6696911	256	250	506	1660.1
TS_29	349580	6696351	244	250	494	1620.7
TS_30	349620	6690391	258	250	508	1666.7
TS_31	349740	6689611	264	250	514	1686.4
TS_32	349820	6691591	260	250	510	1673.2
TS_33	350000	6695371	262	250	512	1679.8
TS_34	350280	6694451	272	250	522	1712.6
TS_35	350340	6693071	264	250	514	1686.4
TS_36	350420	6690831	274	250	524	1719.2
TS_37	350520	6693651	262	250	512	1679.8
TS_38	350860	6694791	262	250	512	1679.8
TS_39	350880	6695871	254	250	504	1653.5

TS_40	350920	6691871	288	250	538	1765.1
TS_41	350940	6696431	242	250	492	1614.2
TS_42	351000	6690971	298	250	548	1797.9
TS_43	351500	6692331	288	250	538	1765.1
TS_44	351520	6690331	282	250	532	1745.4
TS_45	351580	6693651	262	250	512	1679.8
TS_46	351720	6689571	278	250	528	1732.3
TS_47	352040	6692731	272	250	522	1712.6
TS_48	352060	6690871	272	250	522	1712.6
TS_49	352500	6689851	264	250	514	1686.4
TS_50	352680	6691731	290	250	540	1771.7
TS_51	352960	6692231	276	250	526	1725.7
TS_52	353020	6691231	268	250	518	1699.5
TS_53	353100	6690071	268	250	518	1699.5
TS_54	353200	6692731	262	250	512	1679.8
TS_55	353580	6690371	258	250	508	1666.7
TS_56	353760	6691551	252	250	502	1647.0
TS_57	354160	6690531	250	250	500	1640.4

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