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Appendix 21 - Aviation Impact Assessment

AVIATION PROJECTS

July 2024

AVIATION IMPACT ASSESSMENT

BULLAWAH WIND FARM PROJECT

Prepared for Umwelt (Australia) Pty Limited

AVIATION PROJECTS

DOCUMENT CONTROL

Document Title: Bullawah Wind Farm Project – Aviation Impact Assessment

Reference: 102206-02

Prepared by: L Wang

Reviewed by: K Tonkin

Released by:

REVISION HISTORY

Version	*Description*	*Transmitted*	*Reviewed by*	*Date*
0.1	First draft	25 January 2024		
0.2	Draft Final	11 June 2024		
0.3	Updated report	21 June 2024		
0.4	Updated report	21 June 2024		
0.5	Updated Draft Final Report	26 July 2024		

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AVIATION PROJECTS

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ACRONYMS

AAAA	Aerial Application Association of Australia
AC	Advisory Circular
AFAC	Australasian Fire and Emergency Services Council
AGL	above ground level
AHD	Australian Height Datum
AIA	aviation impact assessment
AIP	Aeronautical Information Package
AIS	aviation impact statement
ALA	aircraft landing area
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
AS	Australian Standards
AsA	Airservices Australia
ATSB	Australian Transport Safety Bureau
BoM	Bureau of Meteorology
BWF	Bullawah Wind Farm Pty Ltd
CAAP	Civil Aviation Advisory Publications
CAO	Civil Aviation Orders
CAR	Civil Aviation Regulation (1988)
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation (1998)
CFIT	controlled flight into terrain
CNS	communications, navigation and surveillance
CTAF	common traffic advisory frequency
DAH	Designated Airspace Handbook
EIS	environmental impact statement
ERC-H	en-route chart high
ERC-L	en-route chart low
ERSA	En Route Supplement Australia

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

UNITS OF MEASUREMENT

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

DEFINITIONS

Definitions of key aviation terms are included in Annexure 2

NOTES

Nil

EXECUTIVE SUMMARY

Introduction

Bullawah Wind Farm Pty Ltd (BWF) proposes to develop the Bullawah Wind Farm (the Project), located approximately 36 km south east of Hay, and 38 km southeast of Hay Airport, within the South West Renewable Energy Zone (South West REZ). The Project Area is located within the Hay Shire, Murrumbidgee and Edward River Local Government Areas (LGAs). The Project will include the installation, operation, maintenance and decommissioning of up to 143 wind turbine generators (WTGs), battery storage, ancillary infrastructure and temporary facilities associated with construction of the Project. The Project design incorporates up to 143 wind turbines, with a maximum blade-tip height of 300 m above ground level, and an installed capacity of up to 815.1 megawatts (MW).

Aviation Projects has been engaged by Umwelt (Australia) Pty Ltd (Umwelt) to prepare this Aviation Impact Assessment for inclusion within the Environmental Impact Statement (EIS) for the Project.

The Project requires an aviation impact assessment (AIA) to be undertaken in accordance with the:

- New South Wales State Planning Framework (including the Project SEARs (SSD-50505215)
- Civil Aviation Safety Regulations 1998 and associated Manuals of Standards and guidance material provided by CASA
- National Airports Safeguarding Framework (NASF) Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*
- Specific requirements as advised by Airservices Australia for the information contained within an Aeronautical Impact Study (AIS).

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

This AIA report includes an AIS and a qualitative risk assessment to determine the need for obstacle lighting on wind turbine generators (WTGs) and/or wind monitoring towers (WMTs).

Project description

The includes the following:

The key components of the Project include:

- up to 143 (three (3) blade) WTGs, with a maximum blade-tip height of 300 metres (m) above ground
- a 359 MW / 718 MWh battery energy storage facility
- permanent ancillary infrastructure including internal roads, hardstands, main and collector substations, switchyards, operations and maintenance facilities, underground and overhead electricity transmission lines and poles, telecommunications facilities and utility services, permanent meteorological masts (up to 200 m above ground) and water storage tanks
- temporary facilities including temporary workforce accommodation, site offices, amenities, construction compounds and laydown areas, on-site borrow pits, rock crushing facilities, concrete or asphalt batching plants, minor ‘work front’ construction access roads, environmental management and monitoring and signage

- off-site road works, involving upgrades to the proposed local transport route and establishment of site access points to facilitate delivery of wind turbine components to the Project Area as required.

It is noted that permanent meteorological masts are sometimes referred to as Wind Monitoring Towers (WMTs) and are described as such within this report.

It is also noted that two (2) temporary WMTs have already been erected on site by BWF. These temporary WMTs are exempt development under the provisions of State Environmental Planning Policy (Transport and Infrastructure) 2021 and do not form part of the Project.

Project construction and grid connection will occur in two (2) stages. The conceptual staging plan for the Project involves:

- Stage 1 (South), located mostly south of North Boundary Road, connecting to the existing 220 kV transmission line which runs through the Project Area
- Stage 2 (North) located north of North Boundary Road, connecting to the approved (but not yet constructed) 330 kV Eastern Section of Project EnergyConnect, which will also run through the Project Area.

Conclusions

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

Planning considerations

1. The Project satisfies both the Hay Local Environmental Plan 2011 and Deniliquin Local Environmental Plan 2013. It will not create incompatible intrusions, adversely affect or compromise the safety of existing airports and associated navigation and communication facilities. There are no relevant aviation safety provisions under the Conargo Local Environmental Plan 2013.

Certified airports

2. The Project is located within 30 nautical miles (nm) (55.56 km) of one Certified airport – Hay Airport (YHAY).
3. The WTGs will not impact on the circling areas associated with Hay Airport.
4. The WTGs will impact on 25 nm MSA surfaces, which need to be raised by 700 ft to 2400 ft or sectorized for the Project Area.
5. The WTGs will not impact PANS-OPS surfaces. However due to requirement of increasing the 25 nm minimum sector altitude (MSA) to 2400 ft the minimum altitudes in some segments would need to be increased.

Obstacle Limitation Surfaces

6. The Project is located outside the horizontal extent of obstacle limitation surfaces (OLS) of certified airports.

Aircraft Landing Areas (ALAs)

7. The Project is located more than three (3) nm from any ALA
8. A host landowner contacted by the proponent provided details of an unlisted private landing ground within the Project Area (Host ALA). The location of the several WTGs in close proximity to the Host ALA is likely to cause a hazard to safe flight operations there, both in terms of the size of the WTGs and

the likely downwind turbulence created by them, over the ALA. The owner/operator of this ALA may consider these impacts as a limitation on the use of their airstrip and further consultation would be beneficial to understanding the potential extent of these impacts

Air Routes and Lowest Safe Altitude (LSALT)

9. The WTGs will infringe the Grid LSALT, which will need to be increased to accommodate the Project. The increase will not create an adverse impact to flight operations.
10. The WTGs will impact the LSALT related for several air routes requiring an increase to the route LSALT. The increases to the LSALTs will not create an adverse impact to flight operations on those routes.

Airspace

11. The Project is located outside of controlled airspace (Class G airspace) and Special Use Airspace.

Aviation Facilities

12. The Project WTGs will not infringe any protection areas associated with aviation navigation facilities.

Radar

13. The Project Area is located outside of the Area of Interest for assessment of potential impact from the development on surveillance radar. The Project will not impact the Mount Macedon Route Surveillance Radar (RSR).

Aviation Impact Statement (AIS)

14. Based on the WTG layout and maximum blade tip height of up to 300 m above ground level (AGL), the blade tip elevation of the highest WTG, which is WTG34, will not exceed 402.6 m AHD (1320.9 ft AMSL) and:

   a) There is one certified airport located within 30 nm (55.56 km) from the Project, Hay Airport (YHAY).

   b) Hay Airport (YHAY):

      - The WTGs will not impact on the OLS surfaces.
      - The WTGs will not impact on the circling areas.
      - The WTGs will impact on 25 nm MSA surfaces, which need to be raised by 700 ft to 2400 ft AMSL or sectorized for the Project Area.
      - The WTGs will not impact PANS-OPS surfaces. However due to requirement of increasing the 25 nm MSA to 2400 ft the minimum altitudes in some segments would need to be increased.

   c) There is no aircraft landing area (ALA) identified within 3 nm of the Project Area.

   d) A host landowner contacted by the proponent provided details of an unlisted private landing ground within the Project Area (Host ALA). The location of the several WTGs in close proximity to the Host ALA is likely to cause a hazard to safe flight operations there, both in terms of the size of the WTGs and the likely downwind turbulence created by them, over the ALA. The owner/operator of this ALA may consider these impacts as a limitation on the use of their airstrip and further consultation would be beneficial to understanding the potential extent of these impacts

e) The WTGs will on impact the Grid LSALT, which need to be raised by 200 ft to 2400 ft AMSL.

f) The WTGs will impact on two air routes' LSALT:

- Q60, which will need to be increased by 200 ft to 2400 ft AMSL.
- W762, which will need to be increased by 200 ft to 2400 ft AMSL.

g) The Project Area is located within Class G airspace and outside all controlled airspace, Prohibited Restricted and Danger areas.

h) The WTGs will not impact on the aviation navigation facilities of nearby certified airports.

i) The WTGs will not impact on the closest radar installations.

j) There is no cumulative effect caused from any existing, approved or proposed wind farms in the vicinity of the Project.

k) The WTGs must be reported to CASA and construction details provided to Airservices Australia.

Obstacle lighting risk assessment

15. 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.
16. Over the 12-year period between 2010-2022, no aircraft collided with a WTG or a WMT in Australia.
17. There is no regulatory requirement to mark or light power poles or overhead transmission lines.

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 review of the Development Application.

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

Mitigation Measures

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

Notification and reporting

1. Details of WTGs and WMTs exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. 'As constructed' details of WTG coordinates and elevation should be provided to Airservices Australia, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com
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 Project 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.

Marking of WTGs and WMTs

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

7. It is not mandatory to mark the WMTs, however the following markings are recommended to be implemented in consideration of potential day VFR aerial work operations in accordance with NASF Guideline D:

a. obstacle marking for at least the top 1/3 of the mast and be painted in alternating contrasting bands of colour

b. marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires; and

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

Lighting of WTGs and WMT

8. There is no statutory requirement to light the WTGs. However, CASA may provide recommendations for lighting.

9. Aviation Projects does not consider that the WMTs will require an obstacle light installed at the top to ensure aviation safety standards are met.

Micrositing

10. Provided the micrositing is within 100 m 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 would be required from micrositing and the conclusions of this AIA would remain the same.

Triggers for review

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

a. following any significant design changes (i.e. increase in WTG height or movement of WTGs beyond micrositing allowances)

b. following any changes to the regulatory framework for the assessment of the Project

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

Aerial firefighting

12. The developer or operator should ensure that:

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

    b. access is available to the Project Area by emergency services response for on-ground firefighting operations

    c. 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.

1. INTRODUCTION

1.1. Situation

Bullawah Wind Farm Pty Ltd (BWF) proposes to develop the Bullawah Wind Farm (the Project), located approximately 36 km south east of Hay, and 38 km southeast of Hay Airport, within the South West Renewable Energy Zone (South West REZ). The Project Area is located within the Hay Shire, Murrumbidgee and Edward River Local Government Areas (LGAs). The Project will include the installation, operation, maintenance and decommissioning of up to 143 wind turbine generators (WTGs), battery storage, ancillary infrastructure and temporary facilities associated with construction of the Project. The Project design incorporates up to 143 wind turbines, with a maximum blade-tip height of 300 m above ground level, and an installed capacity of up to 815.1 megawatts (MW).

Aviation Projects has been engaged by Umwelt (Australia) Pty Ltd (Umwelt) to prepare this Aviation Impact Assessment for inclusion within the Environmental Impact Statement (EIS) for the Project.

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

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

1.2. Purpose and scope

The purpose and scope of work is to prepare an AIA to allow the Proponent to understand the aviation environment surrounding the Project for consideration by Airservices Australia, CASA and Department of Defence; and to support the development application.

The AIA specifically responds to the NSW Planning Secretary’s Environmental Assessment Requirements (SEARs) for the Project which provide that the assessment of aviation safety in the EIS must:

- assess the impact of the development under the National Airports Safeguarding Framework Guideline D: Managing Wind Turbine Risk to Aircraft;
- provide associated height and co-ordinates for each turbine assessed;
- assess potential impacts on aviation safety, including cumulative effects of wind farms in the vicinity, potential wake / turbulence issues, the need for aviation hazard lighting and marking, including of wind monitoring masts, considering defined air traffic routes, aircraft operating heights, approach / departure procedures, radar interference, communication systems, navigation aids, and use of emergency helicopter access;
- identify aerodromes within 30 km of the turbines and consider the impact to nearby aerodromes and aircraft landing areas;
- address impacts on obstacle limitation surfaces; and
- assess the impact of the turbines on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the turbines and transmission line.

Additionally, the AIA addresses the following key legislation, approvals, and guidance material:

- National Airspace Safeguarding Framework Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers* effective July 2012

- Civil Aviation Safety Authority (CASA) MOS Part 139.
- Specific requirements as advised by Airservices Australia.

1.3. Methodology

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

- Confirm the scope and deliverables with the Proponent (or representative)
- Review client material
- Review relevant regulatory requirements and information sources
- Prepare a draft AIA and supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified
- Include an AIS for assessment by Airservices Australia
- Include a qualitative risk assessment to determine need for obstacle lighting and marking that Identifies risk mitigation strategies that could provide an acceptable alternative to night lighting. The risk assessment will be completed following the guidelines in *ISO 31000:2018 Risk Management – Guidelines*
- Consult with aviation regulators, Airservices Australia and the Department of Defence
- Consult with relevant aerodrome operators to seek endorsement of the proposal to change instrument approach procedures (if applicable)
- Consult/engage with aviation stakeholders to negotiate acceptable outcomes (if required)
- Finalise the AIA report for client acceptance when responses received from stakeholders for client review and acceptance.

1.4. Aviation Impact Statement (AIS)

The AIS included in this report (see Section 6) includes the following specific requirements as advised by Airservices Australia (Source: Airservices Australia Web Page: Additional information required for our assessment):

Aerodromes:

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

Air Routes:

- Nominate air routes published in Aeronautical Information Package (AIP) which are located near/over the Project Area and review potential impacts of Project operations on aircraft using those air routes
- Specify two waypoint names located on the routes which are located before and after the obstacles.

Airspace:

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

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the Project Area.

1.5. Material reviewed

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

- 20240117_ProjectLayout.zip
- WTG_Elevation_240123.csv
- 22110_BayWa_Bullawah WF - RFI Register_V02a.xlsx.
- PROJDES_BayWa_WTGs_240529.csv
- 20240529_UpdatedWTGsDwellings.zip
- 22110_WTG_Coords Check_Umwelt 220725_toAP.xlsx

2. BACKGROUND

2.1. Site overview

The Project Area is located approximately 38 km southeast of Hay Airport in New South Wales and within three Local Government Areas (LGAs), Hay Shire Council LGA, Edward River Council LGA and Murrumbidgee Council LGA.

An overview of the Project Area relative to Hay in NSW is provided in Figure 1 (source: Umwelt, Google Earth).

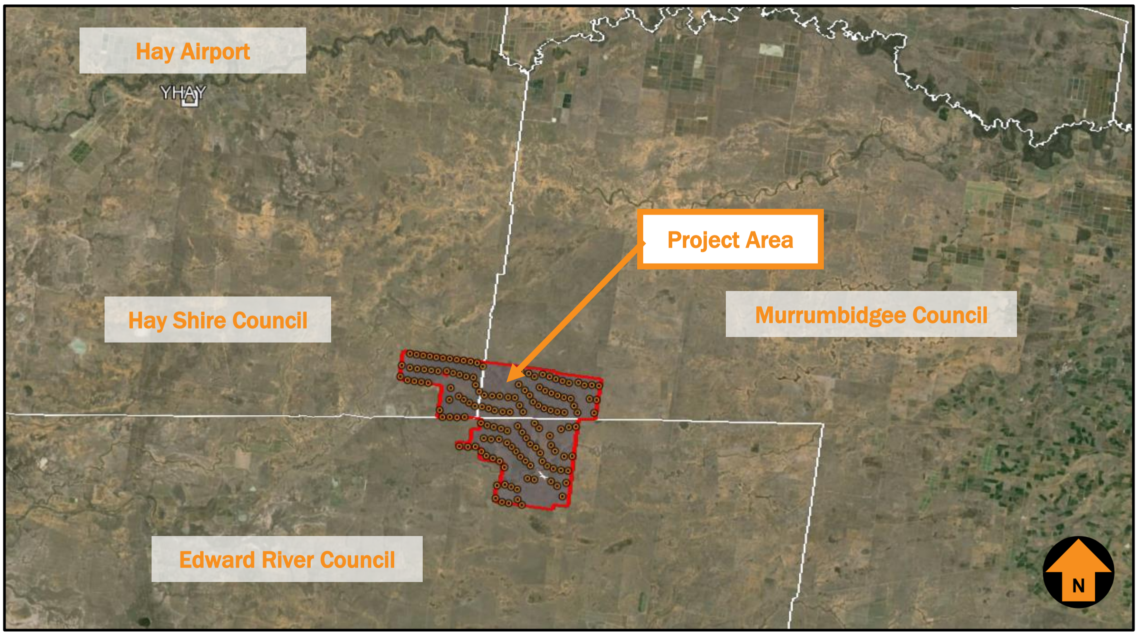

Figure 1 Project Area overview

2.2. Project description

The key components of the Project include:

- up to 143 (three (3) blade) WTGs, with a maximum blade-tip height of 300 metres (m) above ground level (AGL)
- a 359 MW / 718 MWh battery energy storage facility
- permanent ancillary infrastructure including internal roads, hardstands, main and collector substations, switchyards, operations and maintenance facilities, underground and overhead electricity transmission lines and poles, telecommunications facilities and utility services, permanent meteorological masts (up to 200 m above ground) and water storage tanks
- temporary facilities including temporary workforce accommodation, site offices, amenities, construction compounds and laydown areas, on-site borrow pits, rock crushing facilities, concrete or asphalt batching plants, minor ‘work front’ construction access roads, environmental management and monitoring and signage
- off-site road works, involving upgrades to the proposed local transport route and establishment of site access points to facilitate delivery of wind turbine components to the Project Area as required.

It is noted that permanent and temporary meteorological masts are sometimes referred to as Wind Monitoring Towers (WMTs) and are described as such within this report.

WTGs will have rotor diameter of up to approximately 200 m, with maximum tip heights of 300 m AGL.

Based on the proposed Project WTG layout and maximum blade tip height of 300 m AGL, the highest wind turbine (WTG33) will not exceed 403m (1322.2 ft AMSL).

Project construction and grid connection will occur in two (2) stages. The conceptual staging plan for the Project involves:

- Stage 1 (South), located mostly south of North Boundary Road, connecting to the existing 220 kV transmission line which runs through the Project Area
- Stage 2 (North) located north of North Boundary Road, connecting to the approved (but not yet constructed) 330 kV Eastern Section of Project EnergyConnect, which will also run through the Project Area.

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

The methodology for preparing the risk assessment is contained in the NASF Guideline D *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers*.

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

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, CASA and Airservices

3.2. Hay Shire Council

The Hay Local Environmental Plan 2011 establishes mandatory considerations for consent authorities to ensure new developments do not create incompatible intrusions or compromise the safety of existing airports and associated navigation facilities.

> *6.3 Airspace operations*
>
> *1) The objectives of this clause are as follows:*
>
> *a. to provide for the effective and ongoing operation of the Hay Aerodrome by ensuring that such operation is not compromised by proposed development that penetrates the Limitation or Operations Surface for that airport,*
>
> *b. to protect the community from undue risk from that operation.*

2) *If a development application is received and the consent authority is satisfied that the proposed development will penetrate the Limitation or Operations Surface, the consent authority must not grant development consent unless it has consulted with the relevant Commonwealth body about the application.*

3) *The consent authority may grant development consent for the development if the relevant Commonwealth body advises that:*

    a. *the development will penetrate the Limitation or Operations Surface but it has no objection to its construction, or*

    b. *the development will not penetrate the Limitation or Operations Surface.*

4) *The consent authority must not grant development consent for the development if the relevant Commonwealth body advises that the development will penetrate the Limitation or Operations Surface and should not be constructed.*

3.3. Edward River Council

The Deniliquin Local Environmental Plan 2013 establishes mandatory considerations for consent authorities to ensure new developments do not create incompatible intrusions or compromise the safety of existing airports and associated navigation facilities. This plan applies to the portion of the Project Area within the Edward River LGA.

6.6 Airspace operations

1) The objectives of this clause are as follows:

    a. to provide for the effective and ongoing operation of the Deniliquin Airport by ensuring that such operation is not compromised by proposed development that penetrates the Limitation or Operations Surface for that airport,

    b. to protect the community from undue risk from that operation.

2) If a development application is received and the consent authority is satisfied that the proposed development will penetrate the Limitation or Operations Surface, the consent authority must not grant development consent unless it has consulted with the relevant Commonwealth body about the application.

3) The consent authority may grant development consent for the development if the relevant Commonwealth body advises that—

    a. the development will penetrate the Limitation or Operations Surface, but it has no objection to its construction, or

    b. the development will not penetrate the Limitation or Operations Surface.

4) The consent authority must not grant development consent for the development if the relevant Commonwealth body advises that the development will penetrate the Limitation or Operations Surface and should not be carried out.

The Project is located approximately 75 km north of Deniliquin and does not impact upon flight operations at Deniliquin Airport.

3.4. Conargo Local Environmental Plan 2013

There are no relevant aviation safety considerations applicable to the Project under the Conargo Local Environmental Plan 2013, which applies to the portion of the Project within the Murrumbidgee LGA.

3.5. Civil Aviation Safety Authority (CASA)

The following CASA publications inform pilots of their obligations at non-certified ALAs in uncontrolled airspace.

3.5.1. 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

This Advisory Circular (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).

3.3 Performance Information

3.3.1 The AFM, POH, owner's manual or placarding should provide relevant performance information, but presentations are not standardised. Learning how to find and interpret a particular aircraft's performance information should be part of a pilot's familiarisation with the aeroplane.

4 Information about aerodrome publications

4.1.3 There are no standards for aerodromes that are not certified (listed in the En Route Supplement Australia (ERSA) as an uncertified aerodrome), but noting regulation 91.410 requires the aerodrome to be suitable. CASA has published recommended criteria for landowners or operators of these aerodromes, but these recommendations are guidelines only.

4.2.2 The ERSA only provides limited information for uncertified aerodromes and these aerodromes are not subject to NOTAM action, except in certain circumstances (refer to the ERSA for further details).

4.2.3 Take-off and landing guides are also commercially available which provide information for pilots about many aerodromes not included in the ERSA. Pilots should note that the information in these guides may not be subject to regular updating, and these aerodromes are not supported with NOTAM information. Pilots should therefore consider ways of mitigating the risk of such a document's information being out of date or inaccurate.

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.

5 Permission to operate

5.1.1 Pilots and operators must consider ownership and management requirements for aircraft operations into any aerodrome. Unless a landing place is unambiguously open for public use for aviation purposes, the pilot should assume that permission is required from the land owner or occupier before using land or water for take-off and landing.

3.5.2. AC 91-10 v1.1, Operations in the vicinity of non-controlled aerodromes, dated November 2021

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.

2 Introduction

2.1.3 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.

4 Related safety actions at non-controlled aerodromes

4.1.5 Prior to operating at any non-controlled aerodrome, pilots should satisfy themselves that it is suitable for their operation by reference to ERSA, other commercial aerodrome guides, the company operations manual or by contacting the aerodrome operator.

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.

7.2.3 If a secondary runway is being used (e.g. for crosswind or low-level circuits), pilots using the secondary runway should not impede the flow of traffic using the active runway.

7.2.4 Aerodromes that have right-hand circuits are listed in the ERSA.

7.4 Circuit Heights

7.4.1 By convention, aircraft should fly the standard traffic circuit at the heights shown.

7.4.2 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.

7.7 Final approach

7.7.1 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 v1.1. are shown in Figure 2 and Figure 3.

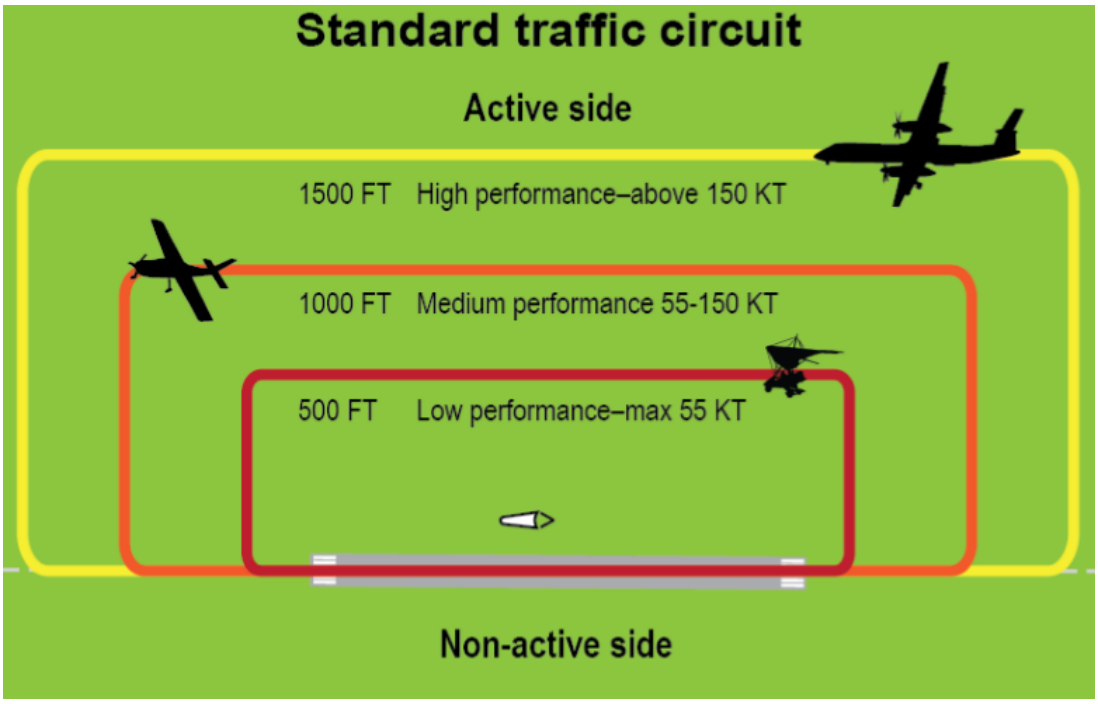

Figure 2 Lateral and vertical separation in the standard aerodrome traffic circuit

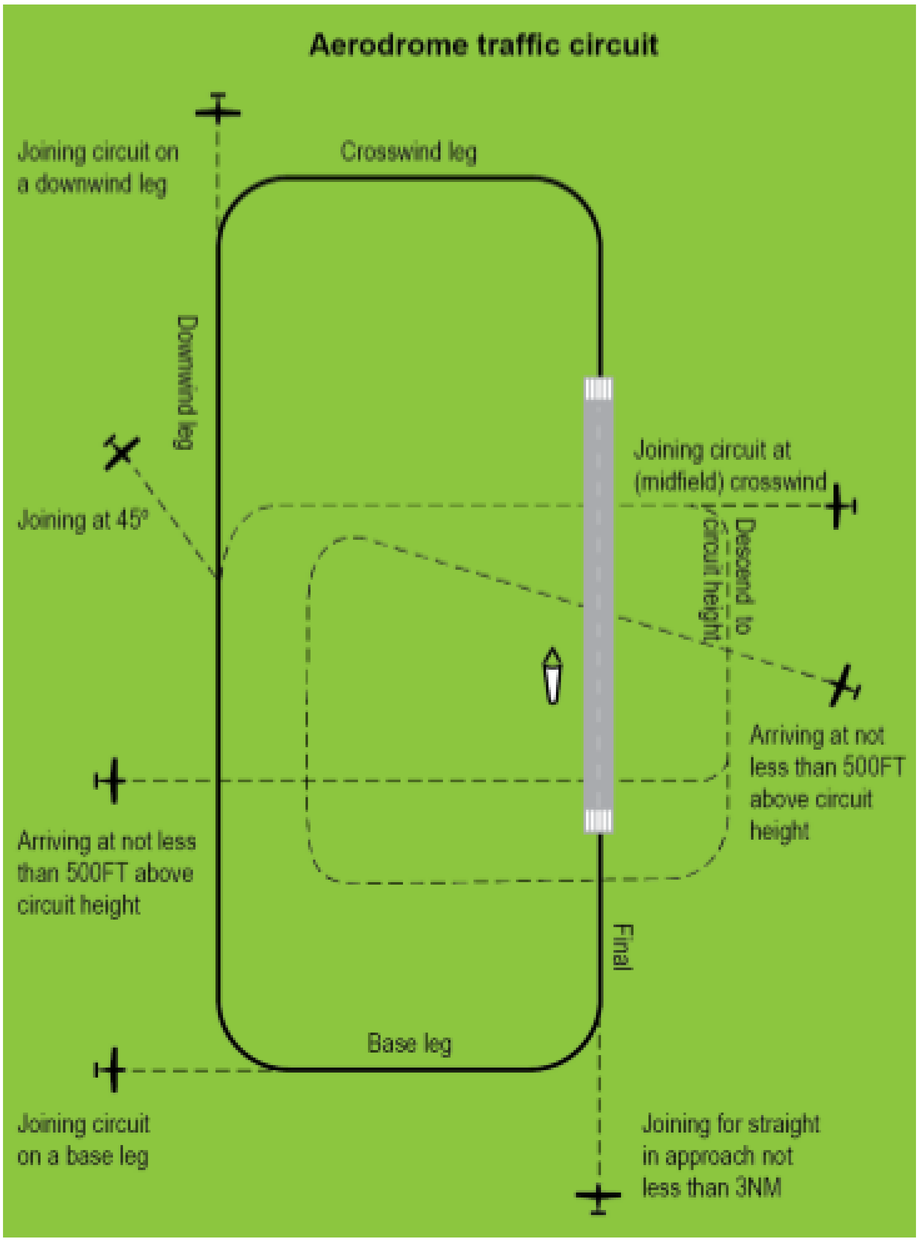

Figure 3 Aerodrome standard traffic circuit, showing arrival and joining procedures

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

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

3.6. Aircraft operations at non-controlled aerodromes

There are several uncontrolled aerodromes in the vicinity of the project area. Advisory Circulars (ACs) provide advice and guidance from CASA to illustrate a means, but not necessarily the only means, of complying with the regulations, or to explain certain regulatory requirements. Advisory Circular (AC) 91-10 v1.1 Operations in the vicinity of non-controlled aerodromes provides guidance for pilots flying at or in the vicinity of non-controlled aerodromes, with respect to CASR 91..

3.7. Rules of flight

3.7.1. 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.

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

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

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

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

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

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

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

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

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

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

3.7.3. 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 not within the vicinity of an aerodrome are effectively redundant to an aircraft being operated under the IFR.

3.8. Aircraft operator characteristics

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

Operations conducted under VFR are required to remain in visual meteorological conditions (VMC) (at least 5,000 m horizontal visibility at a similar height of the WTGs) and clear of the highest point of the terrain by 500 ft vertical distance and 300 m horizontal distance. In VMC, the WTGs will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. VFR operators will most likely avoid the Project Area once WTGs are erected.

Flight under day VFR is conducted above 500 ft 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 will be sufficiently visually conspicuous to pilots conducting VFR operations within the vicinity of the project area 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.

3.9. Passenger transport operations

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

3.10. 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.

3.11. 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.

3.12. 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 lower than 100 ft AGL.

Aerial application operations are conducted in the area. One (1) Host aircraft landing area (ALA) is located within the Project Area and is used for aerial application operations (refer to Section 6.5.1).

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.

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

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

3.12.1. Aerial Application Association of Australia (AAAA)

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

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

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

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

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

3.12.2. Local aerial application operators

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

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

Based on previous studies 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 Area and on neighbouring properties, subject to final WTG locations and by implementing recommendations provided in this report at Section 10.

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.

3.13. Emergency services

3.13.1. 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.

3.13.2. 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.

3.14. Accident statistics

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

3.14.1.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.

3.14.2.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.

3.14.3. National aviation occurrence statistics 2010-2019

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

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

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

A breakdown of aircraft and fatalities by general aviation sub-categories is provided in Table 1 (source: ATSB).

Table 1 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 4 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.

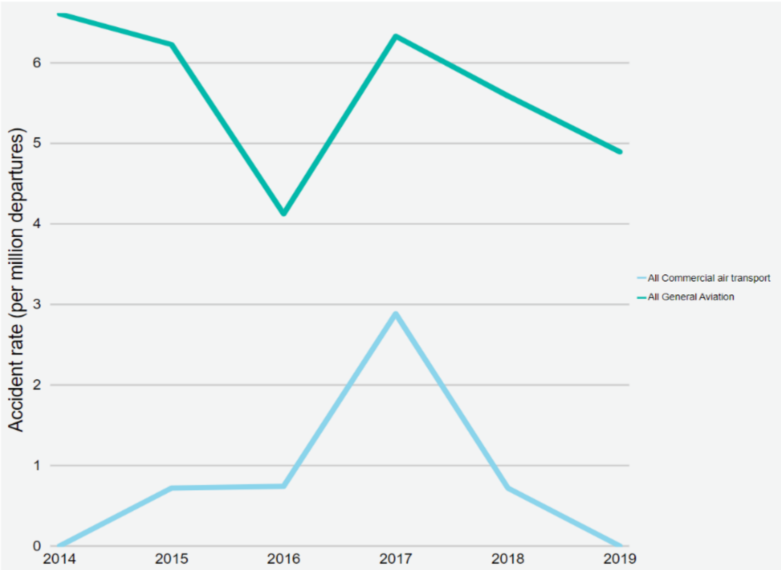

Figure 4 Fatal Accident Rate (per million departures) by Operation Type

In 2018, there were nine (9) fatal accidents and nine (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 eight (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 2 (source: ATSB).

Table 2 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.

3.14.4.Worldwide accidents involving wind farms

Worldwide since aviation accident statistics have been recorded, there have been a total of four (4) 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 four (4) accidents and the relevant factors applicable to this assessment is incorporated in this section.

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

Based on the Australia's Clean Energy Council statistics there were 102 wind farms in Australia at the end of 2019. Aviation Projects has researched public sources of information, 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 four (4) recorded aviation accidents involving a wind farm are summarised as follows:

- One accident, which resulted in two (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 (2) accidents involving collision with a WTG were during the day, as follows:
  - One (1) 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 (1) 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 (1) 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 (1) fatal accident, near Highmore, South Dakota in 2014 occurred at night in Instrument Meteorological Conditions (IMC). The NTSB determined the probable cause(s) of this accident to be the pilot's decision to continue the flight into known deteriorating weather conditions at a low altitude

and his subsequent failure to remain clear of an unlit WTG. Contributing to the accident was the inoperative obstacle light on the WTG, which prevented the pilot from visually identifying the WTG.

There is one (1) 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.

4. INTERNAL CONTEXT

4.1. Project Area description

The Project Area is located approximately 38 km southeast of Hay Airport in New Sales Wales, Australia.

The Project Area is to comprise of up to 143 WTGs. The maximum blade tip height of the proposed WTGs will be 300 m above ground level (AGL).

The ground elevation for the highest WTG location (WTG33) is 103 m AHD which with a 300 m WTG height, results in a maximum overall height of 403 m AHD (1322.2 ft AMSL).

Figure 5 illustrates the Project layout identifying the highest WTG location, WT33 (source: Umwelt, Google Earth).

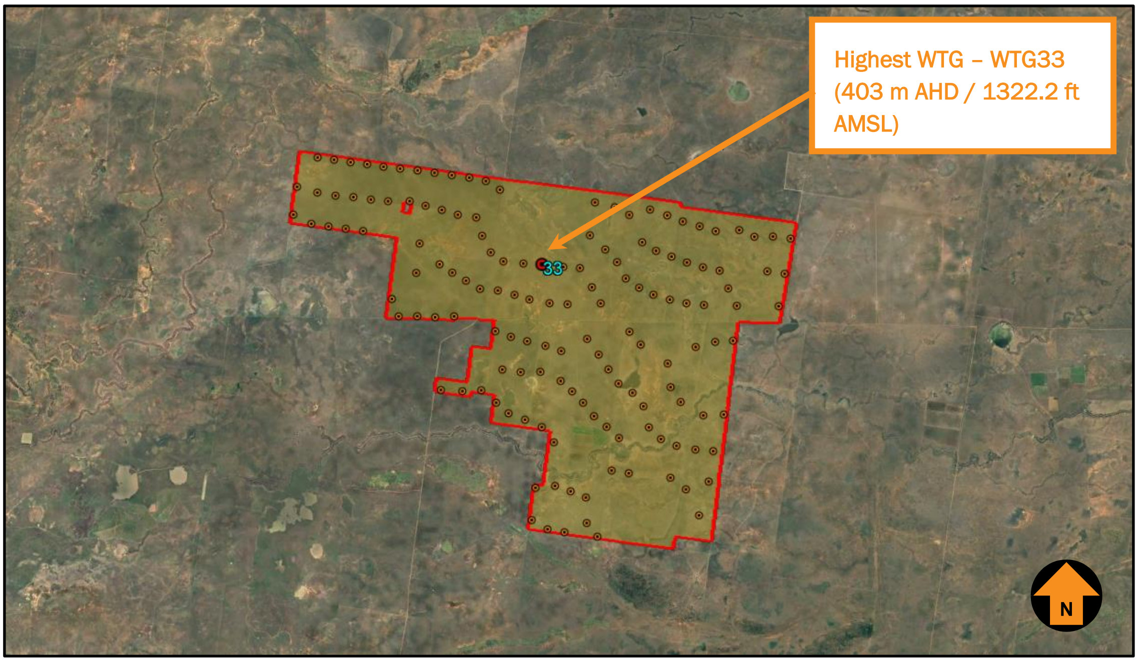

Figure 5 Project layout and highest WTG location

'Micro-siting' refer to the process of locating WTGs, battery storage, ancillary infrastructure and temporary infrastructure during detailed design without further approval, providing that:

- ground disturbance is wholly contained within the Development Corridor, with the exception of meteorological masts (i.e. the WMT referred to throughout this report).
- no WTG is moved more than 100 m from the relevant GPS coordinates identified in the Project's EIS
- the revised location of the blade of a WTG is at least 50 m from the canopy of existing hollow-bearing trees; or where the proposed location of the blade of a WTG is already within 50 m of the canopy of existing hollow-bearing trees, the revised location is not any closer to the existing hollow-bearing trees
- permanent meteorological masts are installed within the Project Area at all times and within the Development Corridor where reasonable and feasible.

The potential micro-siting of the WTGs has been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level is within 100 m of the nominal WTG position. The micro-siting of the WTGs is not likely to result in a change in the maximum overall blade tip height of the Project.

4.2. Wind monitoring tower description

The Project includes the installation of up to seven (7) permanent WMTs up to 200 m in height. The locations of the permanent WMTs are shown indicatively in Figure 6 (Source: Umwelt, Google Earth).

Additionally, it is noted that two (2) temporary WMTs up to 110 m have already been installed on site.

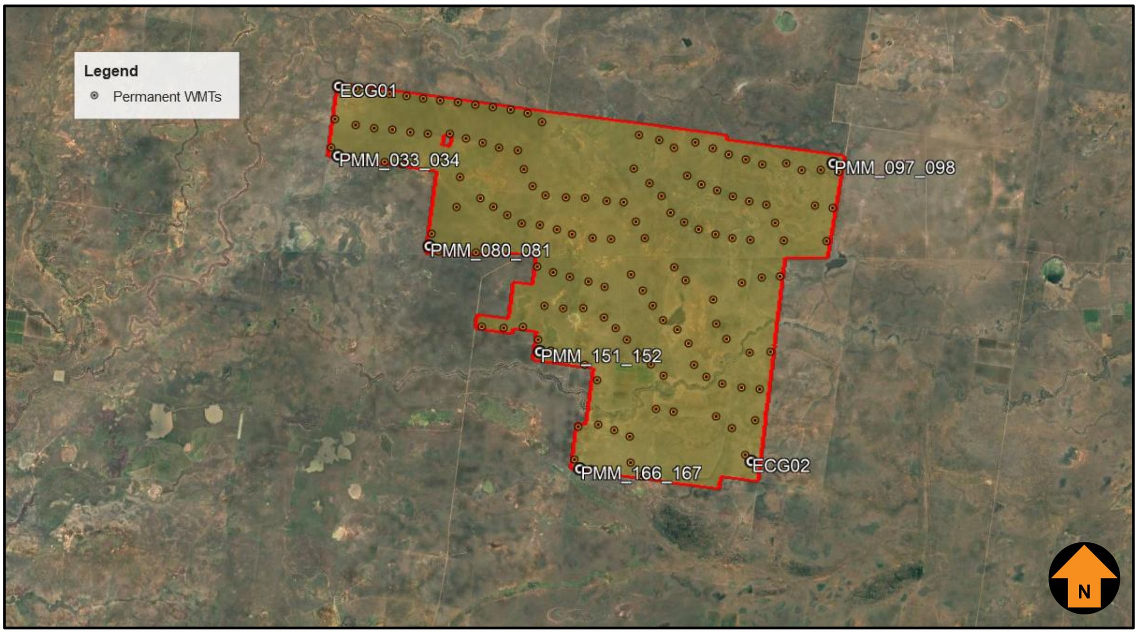

Figure 6 Permanent WMTs Location

5. CONSULTATION

The following list of stakeholders were identified as requiring consultation:

1. Airservices Australia
2. Department of Defence
3. Hay Shire Council
4. Edward River Council
5. Murrumbidgee Council
6. Royal Flying Doctor Service
7. Fire and Emergency
8. Aerial operators

Aviation Projects will conduct the initial consultation and provide details and results of the consultation activities in Table 3.

The final draft version of the AIA will be provided to each identified stakeholder upon approval from the client to proceed.

Table 3 Stakeholder consultation details

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
Airservices	21 June 2024 Email to Airservices			
Department of Defence	21 June 2024 Email to Department of Defence			
Hay Shire Council	21 June 2024 Email to Hay Shire Council	27 June 2024 Email from Jasmine Gregory (Executive Assistant – Planning and Compliance)	Unfortunately, I must advise that we do not have the skills to assess this, and we will be reliant on CASA for their assessment of this.	No Action required
Edward River Council	21 June 2024 Email to Edward River Council	24 June 2024 Email from Mark Dalzell	Deniliquin Regional Airport is located approximately 75km south of the subject area and the development will not impact operations of the Deniliquin Regional Airport. Based on this information, Edward River Council has no comments regarding the development with respect to impacts on the Deniliquin Regional Airport.	No Action require
Murrumbidgee Council	21 June 2024			

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
	Email to Murrumbidgee Council			
Royal Flying Doctor Service	21 June 2024 Email to Royal Flying Doctor Services			
Fire and Emergency	21 June 2024 Email to Fire and Emergency	24 June 2024 Email from Lynden Moyes (Team leader Fore Safety)	Fire and Rescue NSW (FRNSW) have reviewed the below email and attached "Bullawah Wind Farm Project – Aviation Impact Assessment" (Doc Ref 102206-02) and find the aviation impact assessment has limited scope with regard to fire and life safety. FRNSW offers no commentary to this aviation assessment.	No Action require
Aerial Operators	21 June 2024 Email to Aerial Operator (Agflite)			

6. AVIATION IMPACT STATEMENT

6.1. Overview

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

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

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

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

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

6.2. Nearby certified aerodromes

There is one airport that is certified by the Civil Aviation Safety Authority (CASA) under Civil Aviation Safety Regulations (1998) (CASR) Part 139 and located within 30 nm of the proposed site – Hay Airport (YHAY).

The location of the Project Area relative to Hay (YHAY), Griffith (YGTH) and Deniliquin (YDLQ) Airports is shown in Figure 7 (Source: Umwelt, Google Earth). The orange circle around each airport represents a distance of 30 nm from the aerodrome reference point of each airport.

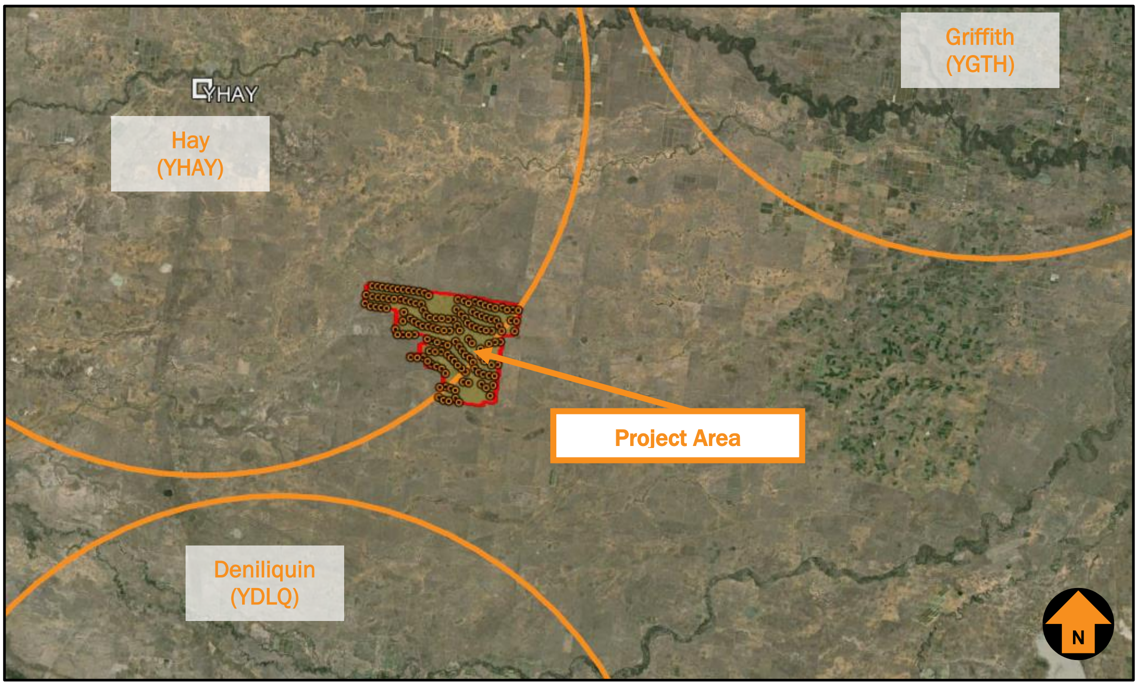

Figure 7 Location of Certified Airports in relation to Project Area

6.3. Hay Airport (YHAY)

Hay Airport is a certified aerodrome. It is operated by Hay Shire Council with a published aerodrome elevation of 93 m AHD (305 ft AMSL) (source: Airservices Australia (AsA), FAC, RDS, dated 05 September 2024).

Hay aerodrome reference point (ARP) coordinates published in Airservices Australia's Designated Airspace Handbook (DAH) are Latitude 34°31'53"S and Longitude 144°49'47"E.

6.3.1. Instrument procedures

A check of Aeronautical Information Package (AIP) via the Airservices Australia website showed that Hay Airport is served by non-precision instrument flight procedures (source: AsA, effective 05 September 2024).

Table 4 identifies the aerodrome and procedure charts for Hay Airport, designed by Airservices Australia (AsA) as indicated.

Table 4 Hay Airport (YHAY) aerodrome and procedure charts

Chart name	Effective date
AERODROME CHART	15 August 2019 (Am 160)
RNP RWY 04	15 June 2023 (Am 175)
RNP RWY 22	15 June 2023 (Am 175)

6.3.2. MSA surfaces

The minimum sector altitude (MSA) is applicable for each instrument approach procedure at Hay Airport. An image of the MSA published for Hay Airport is shown in Figure 8 (source: AsA, 15 June 2023).

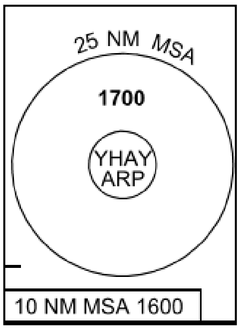

Figure 8 MSA at Hay Airport

The CASR Part 173 Manual of Standards requires a minimum obstacle clearance (MOC) of 984 ft to be applied above the highest terrain or obstacle within the applicable segment.

Obstacles within 25 nm MSA of Hay Airport's ARP define the minimum height at which an IFR aircraft can fly when within 25 nm of the airport when not in visual flight conditions.

The proposed Project is partly within the 25 nm MSA areas of Hay Airport. The orange circles represent the 25 nm MSA of Hay airport as shown in Figure 9 (Source: Umwelt, Google Earth).

The 25 nm MSA is 518.2 m AHD (1700 ft AMSL), protection surface elevation is 218.2 m AHD (716 ft AMSL).

The highest WTG within 25 nm MSA is WTG33, which is 403 m AHD (1322.2 ft AMSL). It will infringe the 25 nm MSA by 184.8 m (606.2 ft).

The Project will infringe on the 25 nm PANS-OPS surface of Hay Airport. The 25 nm MSA will need to be increased by 700 ft to 2400 ft or sectorised for the Project Area.

The increase to the 25 nm MSA would require a commensurate increase in the commencement altitude and the minimum holding altitude for the two RNP approach procedures. There is sufficient distance between the initial approach fixes of the RNP procedures to accommodate the minimum altitude increase without affecting aircraft operations or efficiency.

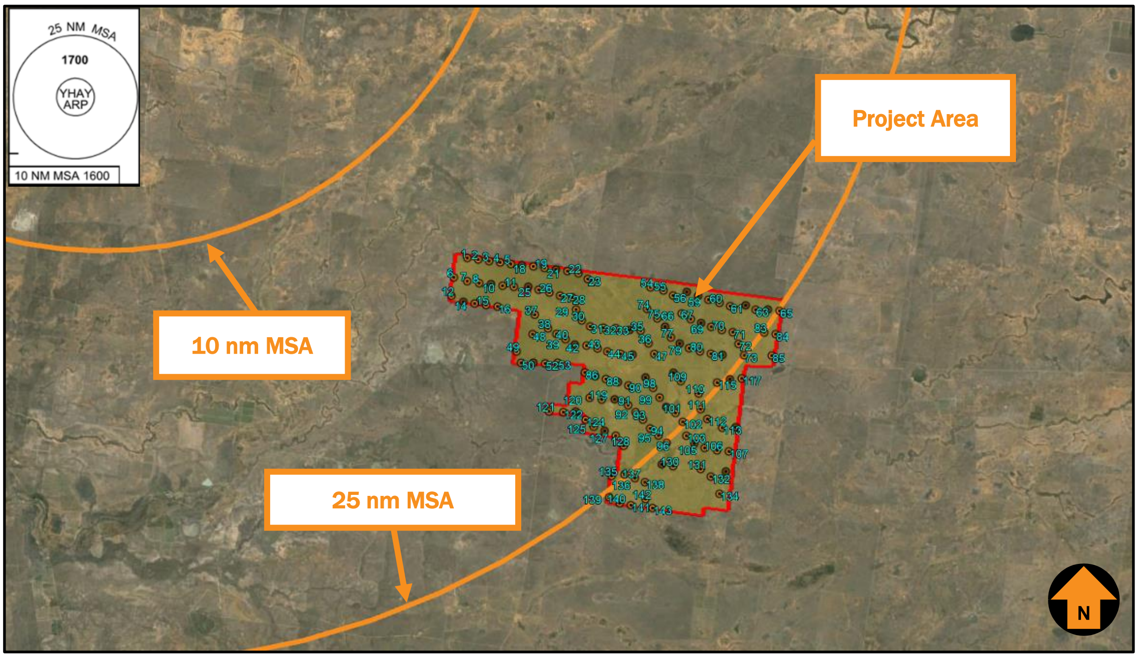

Figure 9 Hay Airport MSA

An impact analysis of Hay Airport's MSA is provided in Table 5

Table 5 Hay Airport MSA Impact analysis

MSA	*Minimum altitude*	*PANS-OPS surface*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
25 nm	1700 ft AMSL	716 ft AMSL	Higher than the PANS-OPS surface by 606.2 ft	Increase minimum altitude by 700 ft or sectorise to exclude the Project Area	Yes

6.3.3. IFR Circling areas

A circling approach is an extension of an instrument approach to the specified circling minima (lowest altitude permitted without visual reference to the ground) at which point the pilot will visually manoeuvre the aircraft to align with the runway for landing. Typically, a circling approach is only conducted where there is no runway-aligned instrument procedure, or if the runway used for the approach procedure is not suitable for landing.

Circling areas are established by the instrument flight procedure designer based on ICAO specifications, related to the performance category of the design aircraft. The circling area is determined by drawing an arc centred on the threshold of each usable runway and joining these arcs by tangents. The most demanding aircraft category provided for in Hay Airport's instrument flight procedure's is Category C.

The radii for each relevant category of aircraft are provided below:

- Category A – 1.67 nm / 3.09 km

- Category B – 2.65 nm / 4.91 km
- Category C – 4.21 nm / 7.79 km

The Project is located 20 nm / 37 km from the threshold of Runway 33 and is therefore beyond the circling area for all runway ends at Hay Airport.

The Project will not impact circling areas established for instrument flight procedures.

6.3.4. PANS-OPS Surfaces

A detailed assessment of the PANS-OPS surfaces associated with the published instrument approach procedures was undertaken.

The Project will be located outside both RNP RWY 04 and RNP RWY 22 procedures' surfaces of Hay Airport. It will not have any impact on approach procedures.

Table 6 details the assessment for each instrument approach procedure.

Table 6 Hay Airport PANS-OPS Assessment

Airport Instrument Approach Title	*Minimum Altitude over Project (ft AMSL)*	*PANS-OPS Surface (ft AMSL)*	*Impact on procedure by WTGs*	*Potential solution*	*Impact on aircraft ops*
RNP RWY 04	1700 (MSA)	716	Nil – outside protection surface	N/A	N/A
RNP RWY 22	1700 (MSA)	716	Nil – outside protection surface	N/A	N/A

The Project would not affect any PANS-OPS procedure, however due to requirement of increasing the 25 nm MSA to 2400 ft the minimum altitudes in some segments would need to be increased.

Figure 10 and Figure 11 details the YHAY RNP RWY 04 and 22 instrument approach chart. The altitudes that would need to be amended to accommodate the Project are circled in orange. The Project would be depicted on the plan view of this chart in the correct location for pilot reference.

The increase to the PANS-OPS segments of this approach is commensurate with the increases required by the 25 nm MSA increase to 2400 ft.

There is sufficient distance within the procedure for aircraft to conduct the normal 3° final approach path of the RNP procedure without affecting aircraft operations or efficiency.

The final missed approach altitude would also need to be increased to 2400 ft without impact to both RNP RWY approach procedures.

The increase would still allow normal IFR flight operations using this procedure.

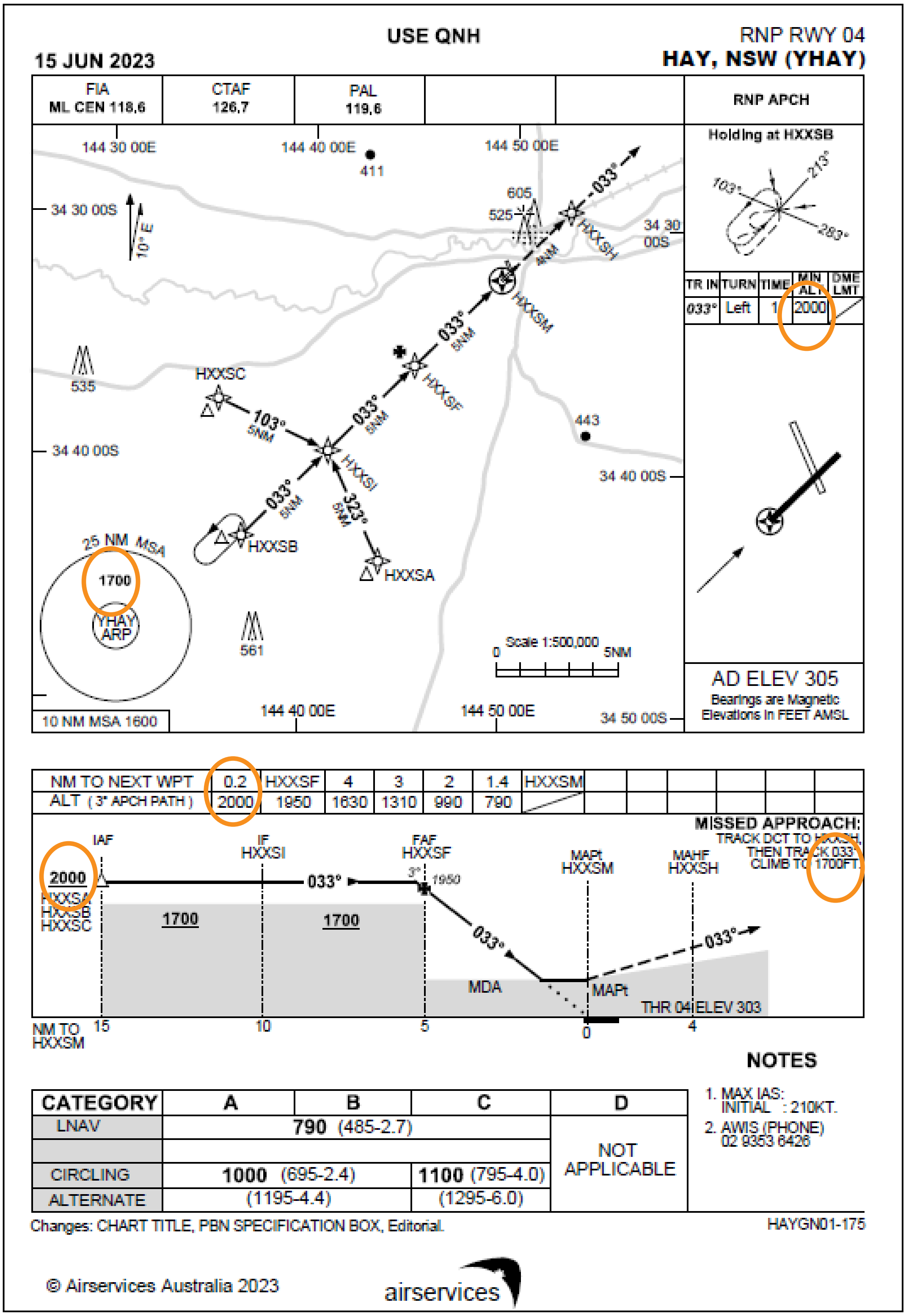

Figure 10 YHAY RNP RWY 04

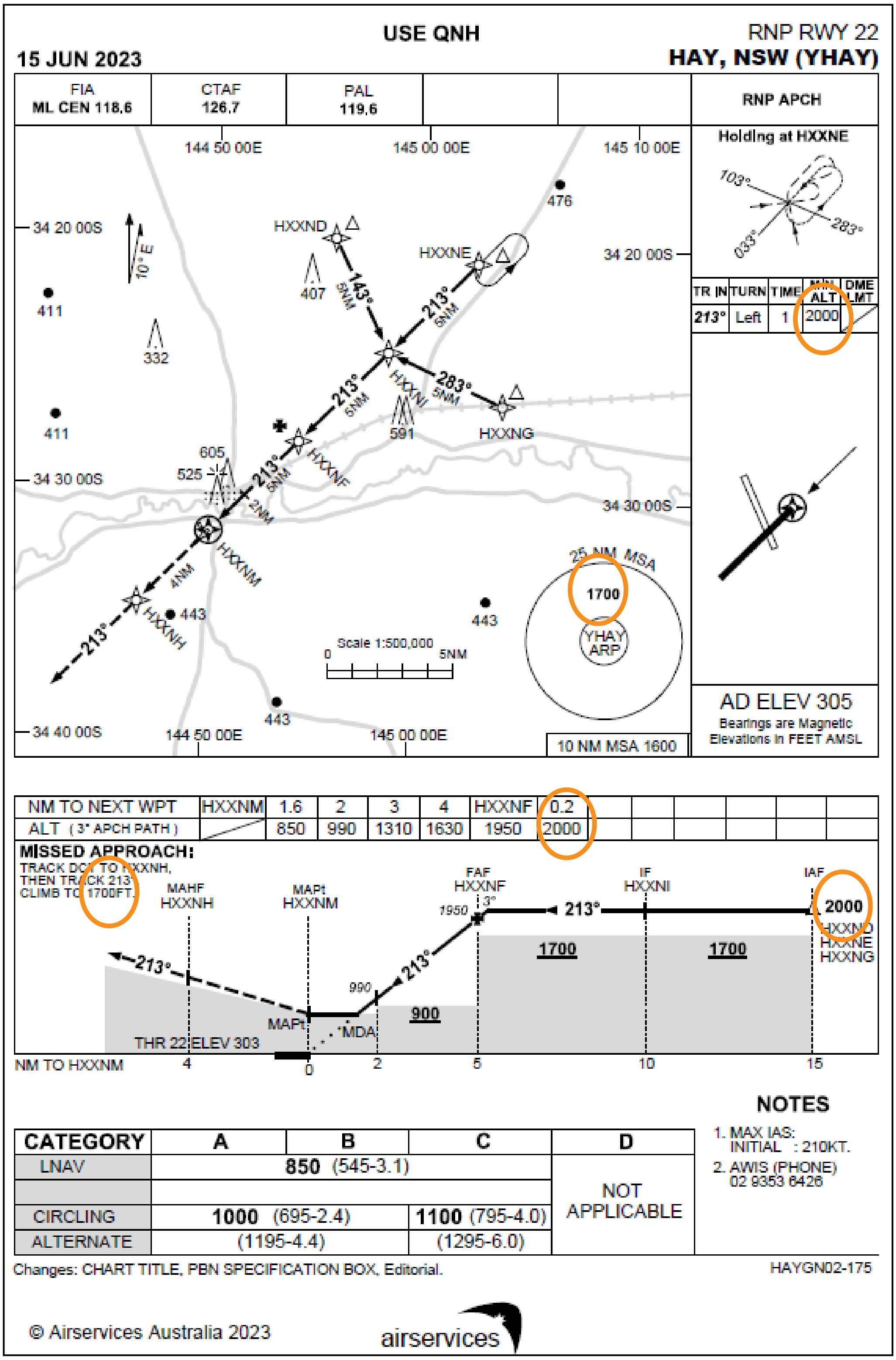

Figure 11 YHAY RNP RWY 22 instrument approach chart

6.4. Obstacle Limitation Surfaces

Obstacle Limitation Surface (OLS) is established for each certified aerodrome runway. For the Code 3 non-precision runway at Hay Airport, the maximum lateral extent of the OLS is up to 5.5 km for the conical surface and 15 km for the take-off and approach surfaces.

The closest WTG in the project area is located approximately 38 km to the south-east of Hay Airport, which is beyond the horizontal extent of the obstacle limitation surfaces of Hay Airport.

6.5. Nearby aircraft landing areas (uncertified aerodromes)

A search of various aviation datasets identified Aircraft Landing Areas (ALAs) in proximity to the Project Area. The aviation datasets used are:

- AIP aeronautical charts effective 05 September 2024.
- OzRunways - which sources its data from Airservices Australia (AIP). The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.
- Australian Government National Map online.

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

Figure 12 shows the location of nearby ALAs relative to the Project Area and a nominal three (3) nm buffer from the closer ALAs (source: Umwelt).

Steam Plains (OZSMP), Cooinbil (OZCIB) and two (2) Unknown ALAs are the closest in relation to the Project Area. The Project Area is located outside a radius of three (3) nm of all identified ALAs. Aircraft operations at these ALA will not be impacted by the WTGs.

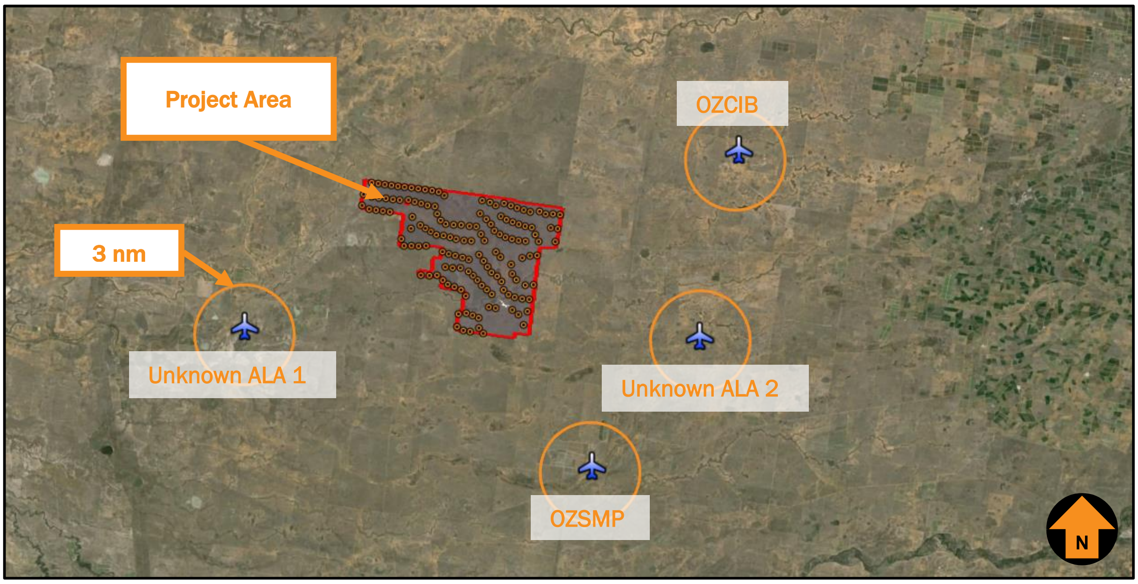

Figure 12 ALAs in the vicinity of the Project Area

A host landowner contacted by the proponent provided details of an unlisted private landing ground within the Project Area (Host ALA). The landowner operates his own aircraft from this location and according to information provided the landing ground is comprised of two separate runway directions, as shown in Figure 13 (Source: Umwelt, Google Earth)

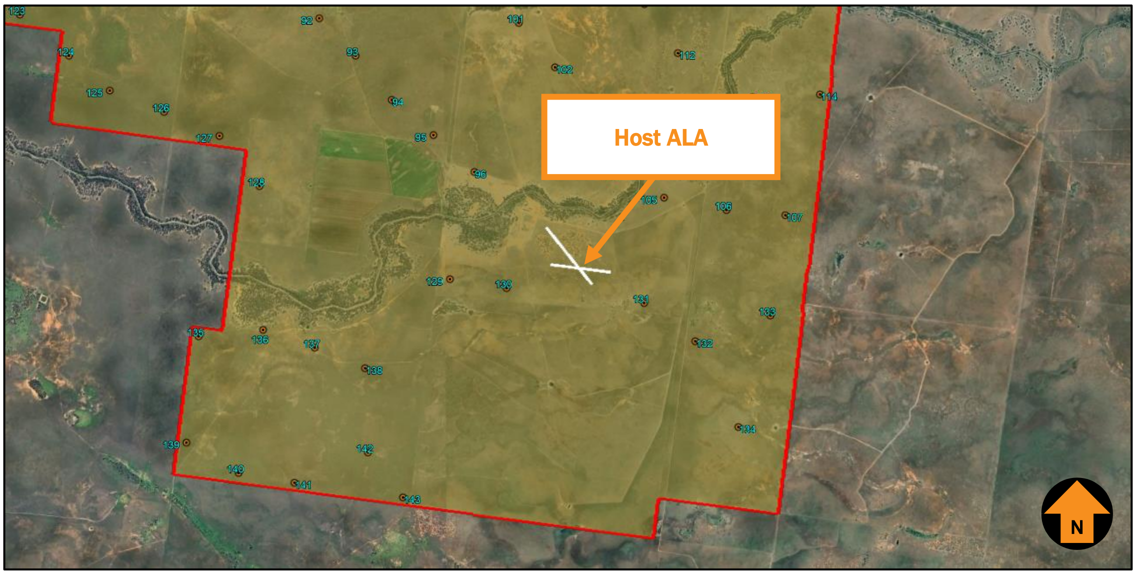

Figure 13 shows the private landing ground within the Project Boundary

6.5.1. Host ALA

The Host ALA is within the Project Boundary. Limited published information is available about the ALA.

As a guide, an area of interest within a 3 nm radius of an ALA is used to assess the potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA. Approximately 38 WTGs are proposed to be located within 3 nm of this ALA (refer to Figure 14).

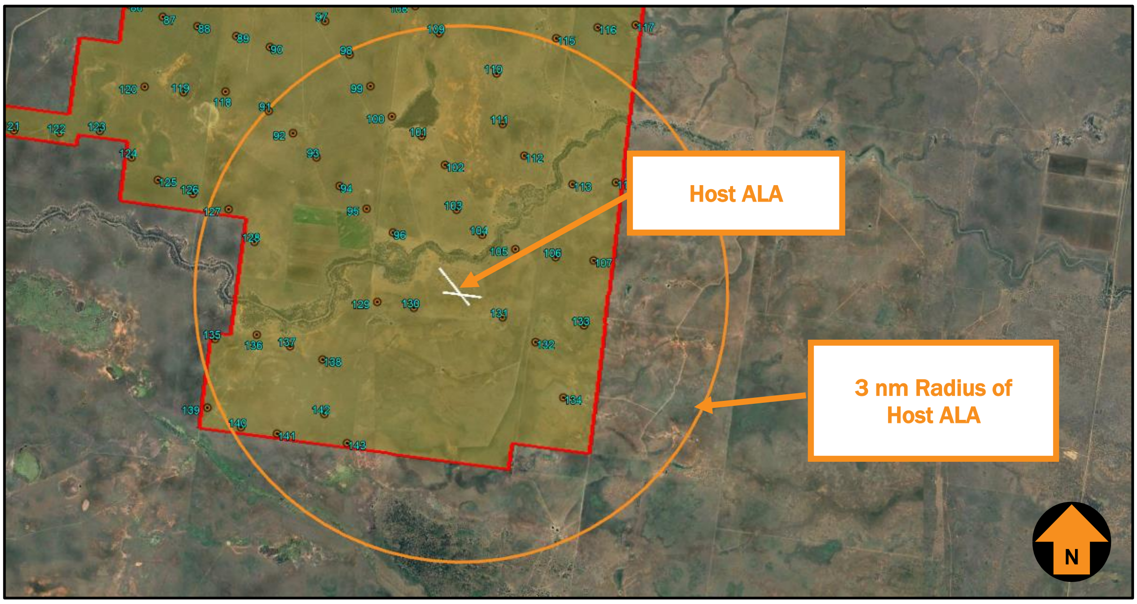

Figure 14 Host ALA in relation to The Project

Aircraft typically operate in circuit patterns when arriving and departing from an aerodrome. CASA 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 2 (Section 3.5.2).

In addition, various entry and departure procedures are described for aircraft joining and departing a standard traffic circuit. Figure 3 in Section 3.5.2 shows the standard arrival and joining procedures for a standard traffic circuit.

Circuit operations will be affected by the proposed wind farm. By regulation and for safety reasons, aircraft are required to conduct left hand circuits when operating at an aerodrome unless otherwise not available due to terrain or populous areas, etc, and notified in AIP. Left hand circuits after take-off and for landing on both runways, would need to fly above the proposed wind farm. This could have a major impact to flight operations at Host ALA, as shown in Figure 15 (Source: Google Earth).

Private ALA do not hold the same regulatory status and protections as certified aerodromes. Potential impacts upon a private ALA that are caused by a wind farm would not preclude the regulatory approval of the wind farm under State Code 23. However, it is highly recommended that any wind farm is designed to avoid, minimise and/or mitigate impact(s) on private ALA.

Such measures could include:

- Amend landing procedures to avoid the wind farm
- Relocate or re-orientate the ALA

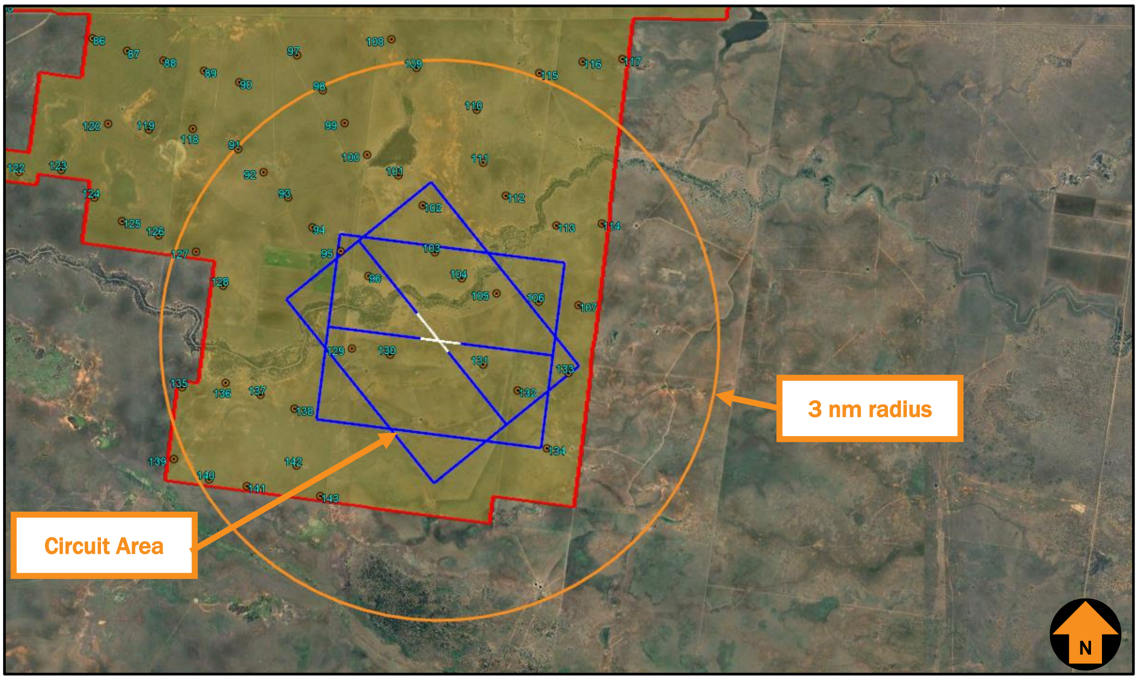

Figure 15 WTGs in relation to circuit operation of Host ALA

6.6. 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…*

For the purpose of the wake turbulence analysis, a 200 m rotor diameter has been used. Based on this scenario, the effects of wake turbulence could be noticeable at 3200 m from the WTGs.

Aviation Projects, through various research performed by AP teams, has determined that any adverse turbulence would most likely be confined to within seven (7) rotor diameters of a WTG, but considers that a conservative area of 10 rotor diameters is likely to be the maximum area where wake turbulence from WTGs would be felt by pilots operating downstream of a WTG.

For WTGs with a 200 m rotor diameter, this area would therefore extend to a distance of 2000 m.

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.

Figure 16 shows ten (10) times (2000 m) (green) and 16 times (3200 m) (blue) around the relevant boundary WTGs in relation to nearby ALAs, except the Host ALA (sources: Umwelt, Google Earth). There is no impact on nearby ALAs (outside the Project Boundary).

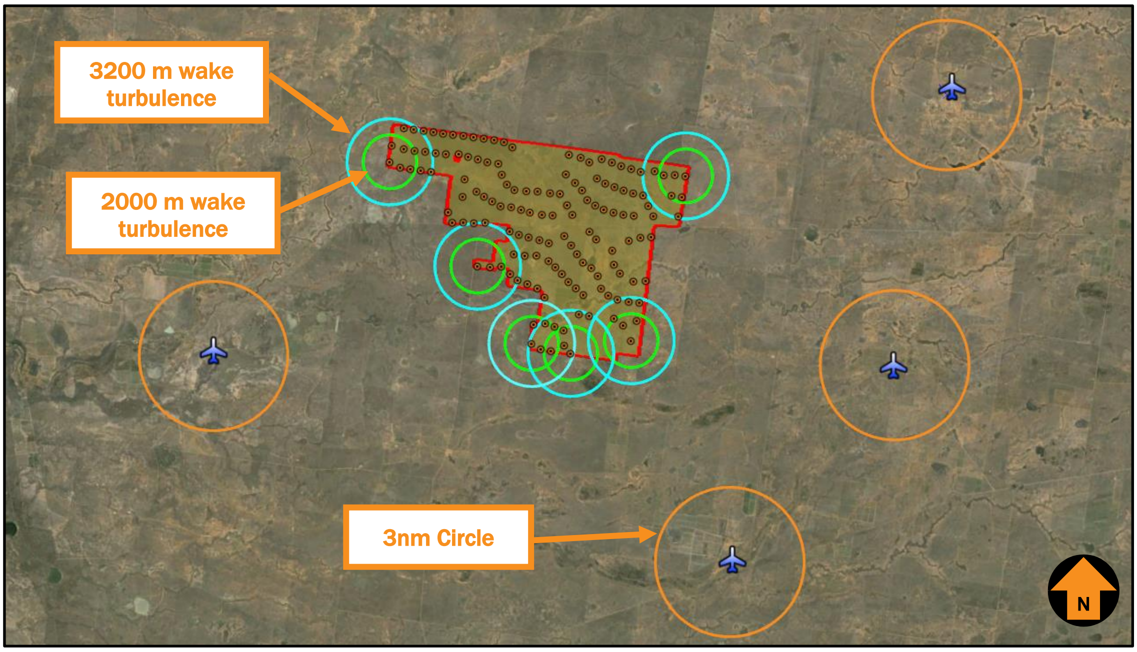

Figure 16 Possible extent of Wake Turbulence from WTGs

Figure 17 shows the relevant boundary of WTGs in relation to the Host ALA (sources: Umwelt, Google Earth).

When the wind is blowing from all direction, downstream wake turbulence from the closer WTGs will likely extend into the circuit area of the aerodrome and may create an impact to aircraft operations of the Host ALA.

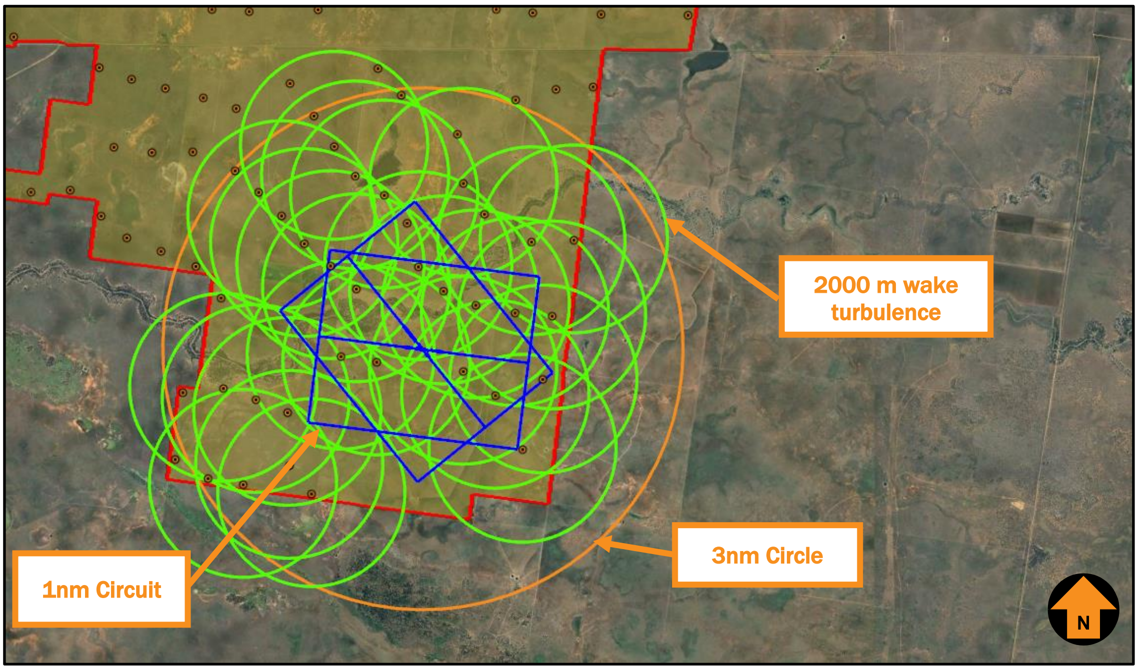

Figure 17 Possible extent of wake turbulence from WTGs

<u>Summary</u>

The location of the several WTGs in close proximity to the Host ALA is likely to cause a hazard to safe flight operations there, both in terms of the size of the WTGs and the likely downwind turbulence created by them, over the ALA.

The owner/operator of this ALA may consider these impacts as a limitation on the use of their airstrip and further consultation would be beneficial to understanding the potential extent of these impacts.

6.7. Grid and Air routes LSALT

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

6.7.1. Grid LSALT

The Project Area is located within the Grid LSALT of 2200 ft AMSL with a protection surface of 1200 ft AMSL. Figure 18 shows the grid LSALTs in proximity to the Project Area (source: ERC Low National, OzRunways, July 2024, Google Earth).

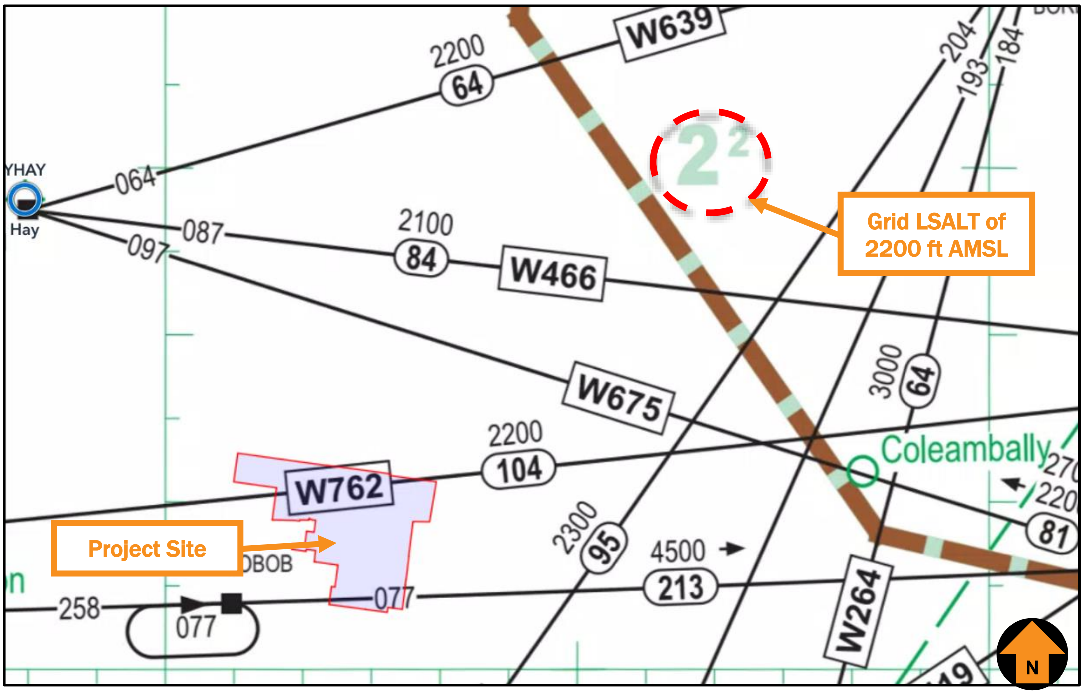

Figure 18 Grid LSALTs in proximity to the Project Area

An impact analysis of the surrounding air routes is provided in Table 7.

The highest WTG (WTG33) is 403 m AHD (1322.2 ft AMSL), which is higher than the obstacle height limit by 37.2 m (122.2 ft). Therefore, the Grid LSALT will need to be raised by 200 ft to 2400 ft.

Table 7 Grid ISALT impact analysis

Grid ISALT	*Protection Surface*	*Highest WTG*	*Impact on Grid LSALT*	*Potential solution*	*Impact on aircraft ops*
2200 ft AMSL	1200 ft AMSL	WTG33 1322.2 ft AMSL	Highest WTG will exceed by 122.2 ft	LSALT raised by 200 ft	N/A.

6.7.2. Air Route LSALTs

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

There are few air routes within seven (7) nm of the Project Area. An impact analysis of the surrounding air routes is provided in Table 8.

There are 96 WTGs within the relevant area of air route Q60. The highest WTG (WTG33) is 403 m AHD (1322.2 ft AMSL), which is higher than air route's LSALT by 37 m (122 ft). Therefore, air route Q60's LSALT will need to be raised by 200 ft.

There are 140 WTGs within the relevant area of air route W762. The highest WTG(WTG33) is 403 m AHD (1322.2 ft AMSL), which is higher than air route's LSALT by 37 m (122 ft). Therefore, air route W762's LSALT will need to be raised by 200 ft.

Table 8 Air route impact analysis

Air route	Waypoint pair	Route LSALT	Protection Surface	Covered WTGs	Infringe WTGS	Impact on airspace design	Potential solution	Impact on aircraft ops
Q60	WG VOR to TOBOB	2200 ft AMSL (Grid)	1200 ft AMSL	96 WTGs	All 96 WTGs	Highest WTG will exceed by 122 ft	LSALT raised by 200 ft	There will be no impact on aircraft operations after raised air route LSALT
H247	TOBOB to CULIN	4500 ft AMSL	3500 ft AMSL	118 WTGs	Nil	Nil	N/A	N/A
W762	TREST to VINOP	2200 ft AMSL (Grid)	1200 ft AMSL	140 WTGs	All 140 WTGs	Highest WTG will exceed by 121 ft	LSALT raised by 200 ft	There will be no impact on aircraft operations after raised air route LSALT

6.8. Airspace Protection

In Australia, there are two major types of airspace: controlled, and uncontrolled. Controlled airspace in Australia is actively monitored and managed by air traffic controllers. To enter controlled airspace, an aircraft must first gain a clearance from an air traffic controller.

Uncontrolled airspace has no supervision by air traffic control so no clearance is required to operate in uncontrolled airspace. The large majority of light aircraft and helicopters operate outside or underneath controlled airspace.

In uncontrolled airspace, pilots are often not visible to air traffic control but must still follow visual flight rules or instrument flight rules. In uncontrolled airspace controllers do not provide separation but provide a Flight Information Service and Traffic Information Service to aircraft flying on instrument flight rules and on request to aircraft flying on visual flight rules.

As well as being broken into controlled or uncontrolled airspace, Australian airspace is further divided into different classes, where internationally agreed rules for visual flight and instrument flying apply.

Depending on how far and how high an aircraft wants to fly, it will pass through different classes of airspace, in which different rules will apply to it.

The diagram shown in Figure 19 (source: Airservices Australia web page) represents the classes of airspace in Australia and how they connect and overlap. The level of service an aircraft receives from air traffic control and the classes of airspace in which it can fly, are determined by whether it is operating under visual flight rules (VFR) or instrument flight rules (IFR).

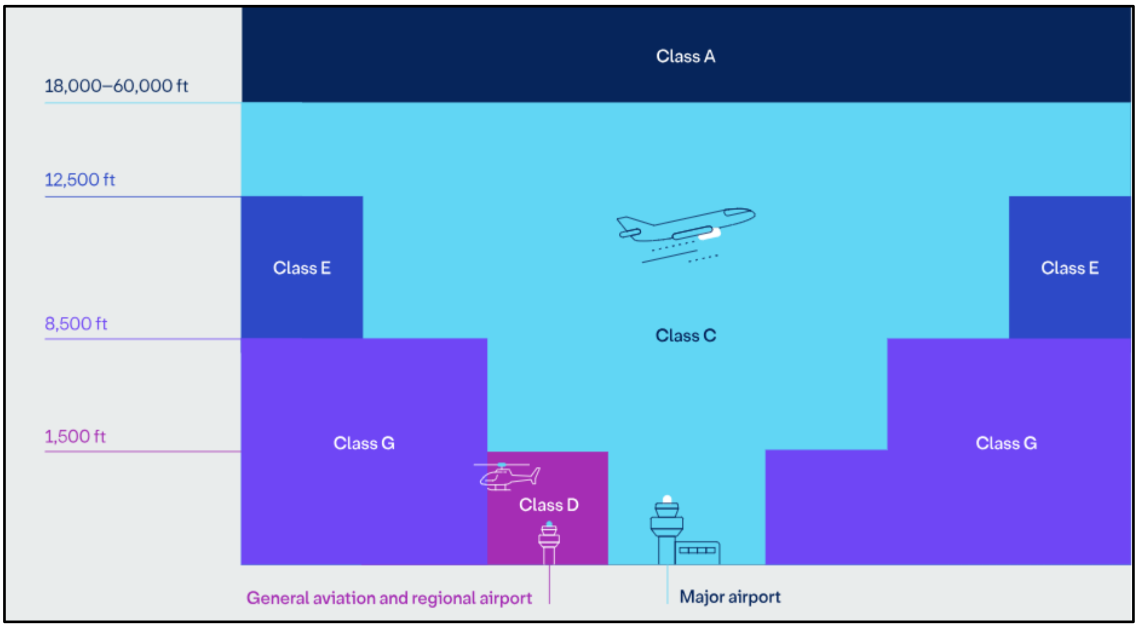

Figure 19 Australian Airspace architecture

Class A: This high-level en route controlled airspace is used predominately by commercial and passenger jets. Only IFR flights are permitted and they require an ATC clearance. All flights are provided with an air traffic control service and are positively separated from each other.

Class C: This is the controlled airspace surrounding major airports. Both IFR and VFR flights are permitted and must communicate with air traffic control. IFR aircraft are positively separated from both IFR and VFR aircraft. VFR aircraft are provided traffic information on other VFR aircraft.

Class D: This is the controlled airspace that surrounds general aviation and regional airports equipped with a control tower. All flights require ATC clearance.

Class E: This mid-level en route controlled airspace is open to both IFR and VFR aircraft. IFR flights are required to communicate with ATC and must request ATC clearance.

Class G: This airspace is uncontrolled. Both IFR and VFR aircraft are permitted and neither require ATC clearance.

Note: At towered airports the class of airspace may change subject to the time of day.

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

6.9. Aviation navigation facilities

NASF Guideline G (Protection Aviation Facilities - Communication, Navigation and Surveillance (CNS)) and Part 139 MOS 2019 specify the area where the development of buildings and structures has the potential to cause unacceptable interference to CNS facilities.

The Project Area is located a sufficient distance away from nearby certified airports and aviation facilities and will not have an impact.

6.10. ATC Surveillance Radar Systems

Airservices Australia requires an assessment of the potential for the WTGs to affect radar line of sight. There is one radar facilities close to the Project Area:

- Mount Macedon Route Surveillance Radar (RSR), which is located approximately 275 km to the southwest.

EUROCONTROL guidelines for assessing the potential impact of 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 Area is outside the line-of-sight range of those radars and will not impact those facilities.

6.11. Cumulative effects of wind farms in the vicinity

Cumulative impacts are a result of incremental, sustained and combined effects of human action and natural variations over time and can be both positive and negative. They can be caused by the compounding effects of a single project or multiple projects in an area, and by the accumulation of effects from past, current and future activities as they arise.

A search of various aviation datasets identified wind farms in proximity to the project area. The aviation datasets used are:

- Deniliquin Visual Navigation Chart (VNC) – dated 13 June 2024
- NSW State Significant Application Web Page

Below is the list of built or proposed Wind Farms in the vicinity, shown in Figure 20 (Source: Google Earth, NEW State Significant Application Web Page, Sydney VNC, Newcastle VNC):

- Pottinger Wind Farm (SSD-59235464) – adjoining, the boundaries touch.

- Dinawan Wind Farm (SSD-50725708) – 16 km from the centre of Bullawah to the closest edge of boundary.
- Argoon Wind Farm (SSD-64935522) – 41.15 km from the centre of Bullawah to the closest edge of boundary
- Yanco Delta Wind Farm (SSD-41743746) – 26.25 km from the centre of Bullawah to the closest edge of boundary
- The Plains Wind Farm (SSD-50629707) – 20 km from the centre of Bullawah to the closest edge of boundary
- Tchelery Wind Farm – 78.27 km from the centre of Bullawah to the closest edge of boundary.

In accordance with AC91 – 10 v1.1 Operations in the vicinity of non-controlled aerodromes, a 3nm radius has been adopted to identify the potential for cumulative impacts of other developments (namely, windfarm developments). The Host ALA is the only ALA within three (3) nm of Bullawah Wind Farm, and while this ALA is impacted by the Project, there is no cumulative effect caused from any nearby wind farm.

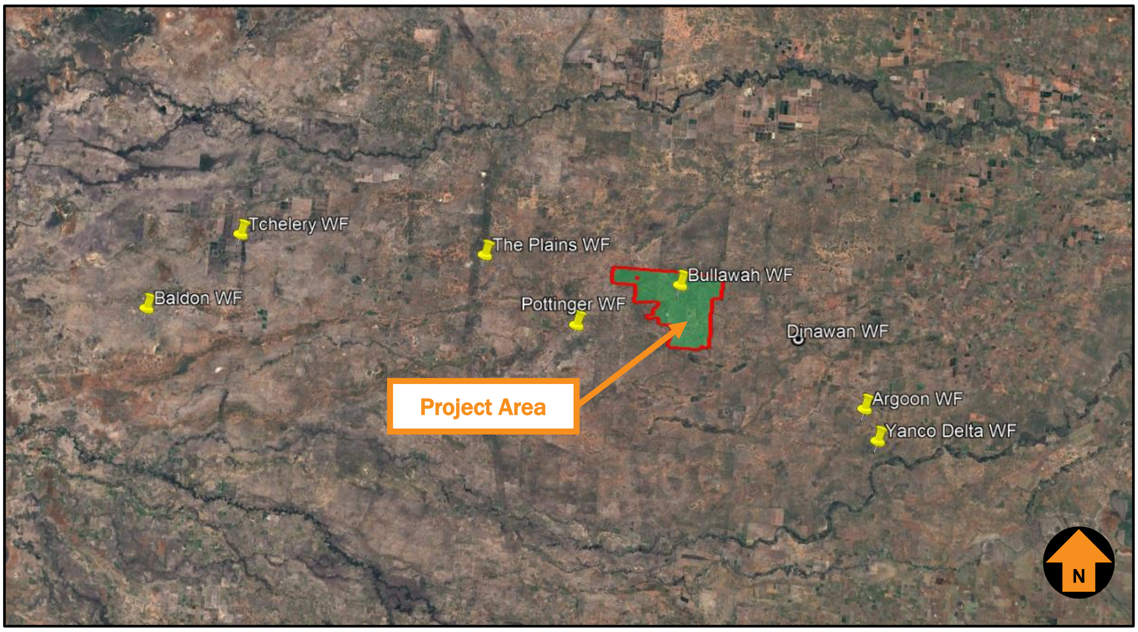

Figure 20 Proposed Project in relation to NSW government listed wind farms in the vicinity.

6.12. AIS Summary

Refer to Section 9.2 for detailed Aviation Impact Statement summary.

6.13. Mitigation Measures

Refer to Section 10 for detailed recommendations.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 8 it is concluded that aviation lighting is likely to not be required for WTGs.

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

7.1. Wind monitoring towers (WMTs)

Given that aerial operators might use the airspace within the Project Area and that it is expected that WMTs will be constructed prior to WTGs, the WMTs may be free-standing and not surrounded by any other obstacles. Therefore, the proposed permanent WMTs should be marked with red/white/red bands as per the NASF Guideline D. Aviation Projects considers that the WMTs will not require an obstacle light. CASA will review and give recommendations about lighting.

7.1.1. National Airport Safeguarding Framework Guideline D

National Airport Safeguarding Framework (NASF) Guideline D: Managing the Risk To Aviation Safety of Wind Turbine Installation (Wind Farms)/Wind Monitoring Towers provides guidance to State/Territory and local government decision-makers, airport operators and developers of wind farms to jointly address the risk to civil aviation arising from the development, presence and use of wind farms and wind monitoring towers.

> *When wind turbines over 150 metres above ground level are to be built within 30 kms of a certified or registered aerodrome, the proponent should notify the Civil Aviation Safety Authority (CASA) and Airservices. If the wind farm is within 30km of a military aerodrome, Defence should be notified.*
>
> *The Aeronautical Information Service of the Royal Australian Air Force (RAAF AIS) maintains a database of tall structures in the country. The RAAF AIS should be notified of all tall structures meeting the following criteria:*
>
> - *30 metres or more above ground level for structures within 30km of an aerodrome; or*
> - *45 metres or more above ground level for structures located elsewhere.*
>
> *Marking and lighting of wind monitoring towers*
>
> *Before developing a wind farm, it is common for wind monitoring towers to be erected for anemometers and other meteorological sensing instruments to evaluate the suitability or otherwise of a site. These towers are often retained after the wind farm commences operations to provide the relevant meteorological readings. These structures are very difficult to see from the air due to their slender construction and guy wires. This is a particular problem for low flying aircraft including aerial agricultural operations. Wind farm proponents should take appropriate steps to minimise such hazards, particularly in areas where aerial agricultural operations occur. Measures to be considered should include:*
>
> - *the top 1/3 of wind monitoring towers to painted in alternating contrasting bands of colour. Examples of effective measures can be found in the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998. In areas where aerial agriculture operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers;*
> - *marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires;*

- *ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation; or*
- *a flashing strobe light during daylight hours.*

7.1.2. Civil Aviation Safety Authority - regulatory context

The Civil Aviation Safety Authority (CASA) regulates aviation activities in Australia. Applicable requirements include the Advisory Circular (AC) 139 E 0.1-v1.0 and AC.139 E 0.5-v1.1. Relevant provisions are outlined in further detail in the following section.

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

Advisory Circular (AC) 139.E-01 v1.0—*Reporting of Tall Structures*, CASA guides 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.

> *2.2.1 The hazards that such buildings or structures may pose to aircraft requires assessment. CASA routinely performs such assessments however needs to be first notified of the obstacle, structure of source of a hazardous plume. The need to report such hazards is outlined in this AC.*
>
> *2.2.2 If you are the person who owns, controls or operates the object, structure or a source of a hazardous plume which is either present, imminent or has been approved for erection/construction, details need to be provided about:*
>
> *− the construction, extension or dismantling of tall structures if the top is:*
>
> *o 100 m or more above ground level*
>
> *or*
>
> *o affects the obstacle limitation surface of an aerodrome as defined in*
>
> *2.2.3 In addition, tall structures may pose a specific hazard for the operation of low-flying Defence aircraft or to the flight paths of arriving/departing aircraft (refer Paragraph 2.1.3). Therefore, the RAAF and Airservices Australia require information on structures that are 30 m or more above ground level—within 30 km of an aerodrome or 45 m or more above ground level elsewhere for the RAAF, or 30 m or more above ground level elsewhere for Airservices Australia.*
>
> *2.2.4 Information provided for the database should be accurate and readily interpreted. The tall structure report form has been designed to help owners and/or developers in this respect. The form is available on the Airservices Australia website (including a spreadsheet for reporting multiple structures) at:* https://www.airservicesaustralia.com/industry-info/airport-development-assessments/

Advisory Circular AC 139.E-05-v1.1 Obstacles including wind farms outside the vicinity of a CASA certified aerodrome – October 2022

AC 139.E-05-v1.1 provides advice about the lighting and marking of wind farms and other tall structures in submissions to planning authorities who are considering a wind farm or tall structure proposal.

> *2.1.2 Regardless of CASA advice, planning authorities make the final determination whether a wind farm or a tall structure not in the vicinity of a CASA regulated aerodrome will require lighting or marking.*
>
> *2.2.1 All wind turbine developments and tall structures should be assessed to determine whether they could be a risk to aviation safety. This AC augments the information in the National Aerodromes*

Safeguarding Framework (NASF) Guideline D and provides additional guidance on the assessment of wind farm developments and guidance for establishing what reasonable measures may be put in place to mitigate any adverse effect the wind farm development could be to aviation safety.

2.2.2 For the purposes of this AC, navigable airspace is considered to be the airspace above the minimum altitudes of VFR and IFR flight, including airspace required to ensure the safe take-off and landing of an aircraft. Generally, minimum altitude limits equate to 500 ft (152 m) or 1 000 ft (305 m) above ground level depending on the situation, i.e., whether or not the flying is over a populous area. The presence of wind turbines, wind monitoring masts and other tall obstacles may create a risk to the safety of flight, due to the risk of collision. An entity that is proposing to introduce a hazard into navigable airspace, such as a wind farm, must mitigate the risk of the hazard on airspace users to ensure an acceptable level of safety is maintained.

2.2.4.1 Part 139 of the Civil Aviation Safety Regulations 1998 (CASR), regulates obstacles within the vicinity of certified aerodromes. This is supported by Part 139 (Aerodromes) Manual of Standards (MOS) which provides the definition of an obstacle as well as the standards for marking and lighting of an obstacle. Any wind turbine (where the height is defined to be the maximum height reached by the tip of the turbine blades), wind monitoring mast or other tall structure that penetrates an Obstacle Limitation Surface (OLS) of an aerodrome will be assessed in accordance with the provisions of Part 139 of CASR and the MOS.

2.2.6.1 Outside the vicinity of an aerodrome, which is defined as being outside the OLS of an aerodrome, wind farms and other tall structures may constitute a risk to low-flying aviation operations which may be conducted down to 500 ft above ground level (AGL) over non-populous areas. Additionally, wind monitoring masts can also be hazardous to aviation, given they are very thin and difficult to see… Wind farms can also affect the performance of communications, navigation and surveillance (CNS) equipment operated by Airservices or the Department of Defence.

2.5 Aviation hazard lighting - International best practice

2.5.2 Australian regulations state that aircraft in uncontrolled airspace may operate under visual flight rules (VFR), which requires the pilot to remain clear of clouds and to adhere to visibility minima.

> *- in Class G airspace below 3000 ft Above Mean Sea Level (AMSL) or 1000 ft AGL (whichever is the higher) – remain clear of cloud with minimum visibility of 5000 m.*
>
> *− in Class G airspace below 10 000 ft AMSL (subject to the above) – remain 1000 ft vertically and 1500 m horizontally from cloud and with 5000 m visibility.*

Note: Helicopters may be permitted to operate in lower visibility and that further exemptions may apply to special cases such as military, search and rescue, medical emergency, agricultural and fire-fighting operations.

2.5.4 2000 candela medium intensity obstacle lighting recommendation satisfies the 5000 m VFR visibility requirements, according to practical exercises undertaken by the FAA and documented in AC 70/7460-1L (FAA, 2015).

2.5.5 In Australia, CASA has accepted the use of 200 candela lighting in some circumstances due to a lack of back lighting in rural and remote areas, meaning that a lower intensity light is still visible to pilots at an acceptable distance to permit a pilot to see and avoid the obstacle.

2.6 Hazard Lighting

2.6.1 This describes the reasoning behind CASA's preference to recommend aviation hazard lighting for tall structures and aircraft detection systems for wind farms.

2.6.2 Hazard lighting for wind farms and other tall structures is intended to alert pilots, flying at low altitude, to the presence of an obstacle allowing them sufficient awareness to safely navigate around or avoid it. The pilot is responsible for avoiding other traffic and obstacles based on the "alerted" see-and-avoid principle.

2.6.3 Unless the wind farm or tall structure is located near an airport, it is not expected to pose a risk to regular public transport operations. The kind of air traffic that is usually encountered at low altitude in the vicinity of a wind farm or tall structure includes light aircraft (private operators, flight schools, sport aviation, agricultural, survey, fire spotting and control) and helicopters (military, police, medical emergency services, survey, fire spotting and control). Hazard lights are therefore designed to provide pilots with sufficient awareness about the presence of the structure(s), so they can avoid it. This means that the intensity of the hazard lights should be such that the acquisition distance is sufficient for the pilot to recognise the danger, take evasive action and avoid the obstacle by a safe margin in all visibility conditions. This outcome considers the potential speed of an aircraft to determine the distance by which the pilot must become aware of the obstacle to have enough time and manoeuvrability to avoid it.

2.7 CASA's commitment to aviation safety

2.7.1 CASA will consider the lighting intensity management and systems that achieve an acceptable level of aviation safety on a case-by-case basis during its assessment.

2.7.2 A CASA determination will consider the environmental setting when determining the need and level of lighting required on a wind farm or tall structure. This may include consideration of lower lighting intensities for obstacles away from an aerodrome. The backlighting of some locations is almost non-existent, meaning the risk of an aviation hazard light being compromised by background lighting from a rural and remote town is lower than would otherwise apply in a residential area closer to a city.

8. RISK ASSESSMENT

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

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

8.1. 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 3.14) and stakeholders who were consulted during the preparation of this AIA (see Section 5), five (5) identified risk events associated with WTGs and WMTs relate to aviation safety or potential visual impact, and are listed as follows:

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

It should be noted that according to guidance provided by the Commonwealth Department of Infrastructure Transport, Regional Development, 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 five (5) risk events identified here are assessed in detail in the following section.

8.2. 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 9 through to Table 13.

Table 9 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 four (4) reported occurrences worldwide of aircraft collisions with a component of a WTG structure since the year 2000 as discussed in Section 3.14.4. 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 Project Area, there is still a very small chance that it would hit a WTG.

Refer to the discussion of worldwide accidents in Section 3.14.

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

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 Area is clear of the obstacle limitation surfaces (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 four (4) reports of aircraft collisions with WTGs worldwide, which have resulted in a range of consequences, where aircraft occupants sustained minor injury in some cases and fatal injuries in others (see Section 8). Similarly, aircraft damage sustained ranged from minor to catastrophic. One (1) of these accidents resulted from structural failure of the aircraft before the collision with the WTG. Only two (2) relevant accidents occurred during the day, and only one (1) 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.

Untreated Likelihood	Possible

Current Treatments (without lighting)   • The Project Area is clear of the obstacle limitation surfaces (OLS) of any certified aerodrome.   • The Project Area is outside three (3) nm of the nearest runway threshold at nearby ALAs.   • Aircraft are restricted to a minimum height of 500 ft (152.4 m) AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. The proposed WTGs will be a maximum of 300 m (984 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 147.6 m (451 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).   • In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5,000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.   • At night, aircraft are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles (including terrain) which are within ten (10) nm of the aircraft in visual flight 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 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 more than 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 prior to construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically:	

Engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the WTG blades prior to the commencement of the subject aircraft operations within the Project Area. Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, which would involve notification to Airservices Australia.
Residual Risk With the implementation of the Recommended Treatments listed above, the likelihood of an aircraft collision with a WTG resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 - Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. In the circumstances, the level of risk under the proposed treatment plan is considered **as low as reasonably practicable (ALARP)**. **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of the Project.**

Residual Risk	7 - Tolerable

Table 10 Aircraft collision with wind monitoring tower (WMT)

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

Discussion

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

The Project includes the installation of up to seven (7) permanent WMTs up to 200 m AGL. Additionally, it is noted that two (2) temporary WMTs up to 110 m AGL have already been installed on site.

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

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

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

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

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

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

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

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

Untreated Likelihood	Possible

Current Treatments

- The proposed WMTs locations will be advised to CASA and Airservices Australia prior to construction.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built up areas. The highest permanent WMT could be at a height of up to 200 m (656 ft), which will be 47.6 m (156 ft) higher than the minimum height of 500 ft AGL for an aircraft flying at this height.
- In the event that descending cloud forces an aircraft lower than 152.4 m (500 ft) AGL, the minimum visibility of 5,000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of the tower.

- Aircraft are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- As the WMTs will be higher than 100 m AGL, there is a statutory requirement to report them to CASA and Airservices Australia prior to construction.

Level of Risk

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

Current Level of Risk	8 - Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Recommended Treatments

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

- Details of any WMTs when they are constructed should be advised to Airservices Australia.
- Consideration could be given to marking any wind monitoring towers according to the requirements set in MOS 139 Chapter 8 Division 10 Obstacle Markings (as modified by the guidance in NASF Guideline D); specifically:

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

- WMTs that are installed prior to WTG installation and WMTs that are not in close proximity to a WTG, should be fitted with a medium intensity steady red obstacle light at the top of the tower to ensure visibility in low light and deteriorated atmospheric conditions. Characteristics of medium-intensity lights are specified in MOS 139 Section 9.33:

  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.* • Ensure details of any additional WMTs at the Project Area have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction.	
Residual Risk With the additional Recommended Treatments listed above, the likelihood of an aircraft collision with a WMT resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. Under these circumstances, the level of risk under the proposed treatment plan is considered **ALARP.** **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the Project permanent WMTs that are in close proximity to a WTG without obstacle lighting on the WMTs.** **For temporary WMTs installed prior to WTG installation and WMTs that are not in close proximity to a WTG, there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision provided obstacle lighting is fitted to ensure visibility in low light and deteriorating atmospheric conditions.**	
Residual Risk	7 - Tolerable

Table 11 Harsh manoeuvring leading to controlled flight into terrain

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

Discussion

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

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

The Project is clear of the OLS of any aerodrome.

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

The proposed WTGs will be a maximum of 300 m (984 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 147.6 m (484 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL.

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

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

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

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

Assumed risk treatments

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

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

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

Untreated Likelihood	Unlikely

Current Treatments (without lighting)

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

• Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. • WTGs will be a maximum of 300 m (984 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 147.6 m (484 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 WMTs will be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart. • If cloud descends below the WTG hub, obstacle lighting would be obscured and therefore ineffective. • 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. • The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts. • Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the WTGs to CASA.

Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.	
Current Level of Risk	8 – Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Ensure details of the Project WTGs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction.	

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

Residual Risk	7 - Tolerable

Table 12 Effect of the Project on operating crew

Risk ID:	4. Effect of the Project on operating crew

Discussion

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

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

Consequence

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

Consequence	Minor

Untreated Likelihood

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

Untreated Likelihood	Possible

Current Treatments

- The Project is clear of the OLS of any aerodrome.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas.
- The WTGs and masts will be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart.
- WTGs will be a maximum of 300 m (984 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 147.6 m (484 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.
- 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 ten (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. • The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts. • Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the WTGs to CASA.	
Level of Risk The level of risk associated with a Possible likelihood of a 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 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 Area.	
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.**	
Residual Risk	5 – Tolerable

Table 13 Effect of obstacle lighting on neighbours

Risk ID:	5. **Effect of obstacle lighting on neighbours**

Discussion

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

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

Level of Risk

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

Current Level of Risk	8 - Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Recommended Treatments Not installing obstacle lighting would completely remove the source of the impact. As per the above safety risk assessment, the provision of lighting for the WTGs and permanent WMTs is not necessary to provide an acceptable level of safety.. 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 Area. 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

9. CONCLUSIONS

The key conclusions of this AIA are summarised as follows:

9.1. Planning considerations

The Project as proposed satisfies both the Hay Local Environmental Plan 2011 and Deniliquin Local Environmental Plan 2013, and it will not create incompatible intrusions or compromise the safety of existing airports and associated navigation and communication facilities. There are no relevant aviation safety considerations applicable to the Project under the Conargo Local Environmental Plan 2013.

9.2. Aviation Impact Statement

Based on the WTG layout and maximum blade tip height of up to 300 m AGL, the blade tip elevation of the highest WTG, which is WTG33, will not exceed 403 m AHD (1322.2 ft AMSL) and:

- There is one certified airport located within 30 nm (55.56 km) from the Project, Hay Airport (YHAY).
- Hay Airport (YHAY):
  - The WTGs will not impact on the OLS surfaces.
  - The WTGs will not impact on the circling areas.
  - The WTGs will impact on 25 nm MSA surfaces, which need to be raised by 700 ft to 2400 ft or sectorized for the wind farm area.
  - The WTGs will not impact PANS-OPS surfaces. However due to requirement of increasing the 25 nm MSA to 2400 ft the minimum altitudes in some segments would need to be increased.
- There is no aircraft landing area (ALA) identified within three (3) nm of the Project Area.
- A host landowner contacted by the proponent provided details of an unlisted private landing ground within the Project Area (Host ALA). The location of the several WTGs in close proximity to the Host ALA is likely to cause a hazard to safe flight operations there, both in terms of the size of the WTGs and the likely downwind turbulence created by them, over the ALA. The owner/operator of this ALA may consider these impacts as a limitation on the use of their airstrip and further consultation would be beneficial to understanding the potential extent of these impacts
- The WTGs will on impact the Grid LSALT, which need to be raised by 200 ft to 2400 ft
- The WTGs will impact on two air routes' LSALT:
  - Q60, which will need to be increased by 200 ft to 2400 ft.
  - W762, which will need to be increased by 200 ft to 2400 ft.
- The Project Area is located within Class G airspace and outside all controlled airspace, Prohibited Restricted and Danger areas.
- The WTGs will not impact on the aviation navigation facilities of nearby certified airports.
- The WTGs will not impact on the closest radar installations.

- There is no cumulative effect caused by other existing, approved or proposed wind farms in the vicinity of the Project Area.
- The WTGs must be reported to CASA and construction details provided to Airservices Australia.

9.3. Aircraft operator characteristics

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

Aircraft flying at night in visual conditions are permitted to descend or climb to or from an appropriate minimum altitude when within three (3) nm of the aerodrome.

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

WMTs remain the primary safety concern to aerial agricultural operators, who have expressed a general desire for these towers to be more visible.

9.4. 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 and WMT must be reported to CASA.
- CASA will review the proposed WTG and WMT development and make a recommendation for obstacle lighting if required.
- With respect to marking of WTGs, a white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- It is not mandatory to mark the WMT, however the following markings are recommended to be implemented in consideration of potential day VFR aerial work operations in accordance with NASF Guideline D:
    a. obstacle marking for at least the top 1/3 of the mast and be painted in alternating contrasting bands of colour
    b. marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires; and
    c. guy wire ground attachment points in contrasting colours to the surrounding ground/vegetation

9.5. Summary of risks

A summary of the level of residual risk associated with the Project with the Recommended Treatments implemented, is provided in Table 14.

Table 14 Summary of Residual Risks

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

10. RECOMMENDATIONS

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

Notification and reporting

1. Details of WTGs and WMTs exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. 'As constructed' details of WTG coordinates and elevation should be provided to Airservices Australia, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com
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 Project 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.

Marking of WTGs and WMT

6. The rotor blades, nacelle and the supporting tower of the WTGs should be painted white, typical of most WTGs operational in Australia. No additional marking measures are required for WTGs.
7. It is not mandatory to mark the WMTs, however the following markings are recommended to be implemented in consideration of potential day VFR aerial work operations in accordance with NASF Guideline D:
    a. obstacle marking for at least the top 1/3 of the mast and be painted in alternating contrasting bands of colour
    b. marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires; and
    c. guy wire ground attachment points in contrasting colours to the surrounding ground/vegetation

Lighting of WTGs and WMT

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

9. Aviation Projects considers that the WMTs will not require an obstacle light installed at the top to ensure aviation safety standards are met.

Micrositing

10. Providing the micrositing is within 100 m 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.

Triggers for review

11. Triggers for review of this risk assessment are provided for consideration:
    a. following any significant changes to the context in which the assessment was prepared, including the regulatory framework
    b. following any near miss, incident or accident associated with operations considered in this risk assessment.

Aerial firefighting

12. The developer or operator should ensure that:
    a. liaison with the relevant fire and land management agencies is ongoing and effective
    b. access is available to the Project Area by emergency services response for on-ground firefighting operations
    c. 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.

ANNEXURES

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

ANNEXURE 1 – REFERENCES

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

- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures, En Route Supplement Australia, dated 05 September 2024
- Airservices Australia, Designated Airspace Handbook dated 13 June 2024
- Civil Aviation Safety Authority, Civil Aviation Regulations 1988 (CAR)
- Civil Aviation Safety Authority, Civil Aviation Safety Regulations 1998 (CASR)
- Civil Aviation Safety Authority, Advisory Circular (AC) 91-10 v1.1: *Operations in the vicinity of non-controlled aerodromes*, dated November 2021
- Civil Aviation Safety Authority, Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design, version 1.8, dated August 2022
- Civil Aviation Safety Authority, *Part 139 (Aerodromes) Manual of Standards 2019*, dated 13 August 2020
- Civil Aviation Safety Authority, Advisory Circular 139.E-01 v1.0—Reporting of Tall Structures , dated December 2021
- Civil Aviation Safety Authority, Advisory Circular (AC) 139.E-05 v1.1 Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome (October 2022)
- Department of Infrastructure and Regional Development, 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
- Deniliquin Local Environmental Plan 2013
- Hay Local Environmental Plan 2011
- International Civil Aviation Organization (ICAO) Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS)
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes
- OzRunways, dated July 2024
- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*

ANNEXURE 2 – DEFINITIONS

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

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

ANNEXURE 3 – CASA REGULATORY REQUIREMENTS – LIGHTING AND MARKING

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

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

Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

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

Manual of Standards Part 139—Aerodromes

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

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

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

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

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

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

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

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

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

   b. *must be flashing white lights.*

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

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

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

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

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

   c. *all be synchronised to flash simultaneously; and*

   d. *be seen from every angle in azimuth.*

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

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

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

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

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

    a. *the surrounding ground (ground level); or*

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

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

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

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

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

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

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

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

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

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

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

International Civil Aviation Organisation

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

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

6.2.4 Wind turbines

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

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

Note 2. — See 4.3.1 and 4.3.2

Markings

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

Lighting

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

a) to identify the perimeter of the wind farm;

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Section 4.3 Objects outside the OLS states the following:

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

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

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

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

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

Light characteristics

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

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

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

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

1. *Low-intensity obstacle lights must have the following:*

    a. *fixed lights showing red;*

    b. *a horizontal beam spread that results in 360-degree coverage around the obstacle;*

    c. *a minimum intensity of 100 candela (cd);*

    d. *a vertical beam spread (to 50% of peak intensity) of 10 degrees;*

    e. *a vertical distribution with 50 cd minimum at +6 degrees and +10 degrees above the horizontal;*

    f. *not less than 10 cd at all elevation angles between –3 degrees and +90 degrees above the horizontal.*

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

2. *To indicate the following:*

    a. *taxiway obstacles;*

    b. *unserviceable areas of the movement area; low-intensity obstacle lights must have a peak intensity of at least 10 cd.*

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

1. *Medium-intensity obstacle lights must:*

a. be visible in all directions in azimuth; and

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

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

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

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

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

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

4. *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/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 tower of the WTGs should be painted a shade of white, unless otherwise indicated by an aeronautical study.

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

Wind monitoring towers

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

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

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

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

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

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

Overhead transmission lines

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

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

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

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

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

ANNEXURE 4 – RISK FRAMEWORK

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

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

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

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

Likelihood

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

Table 1 Likelihood Descriptors

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

Consequence

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

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

Table 2 Consequence Descriptors

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

Risk matrix

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

Table 3 Risk Matrix

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

Actions required

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

Table 4 Actions Required

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

ANNEXURE 5 – PROJECT TURBINE COORDINATES AND HEIGHTS

Reference file: 22110_WTG_Coords Check_Umwelt 220725_toAP.xlsx & 01. 22110_BayWa r.e._BWF_EIS_Appendix 3_WTG Locations_toAP.docx

Name	*Easting_m*	*Northing_m*	*Terrain elevation (m AHD)*	*WTG Height AGL (m)*	*Maximum Height (m AHD)*	*Maximum Height (ft AMSL)*
1	325889	6148937	98	300	398	1305.77
2	326621	6148848	99	300	399	1309.06
3	327356	6148753	99	300	399	1309.06
4	328097	6148676	99	300	399	1309.06
5	328822	6148578	99	300	399	1309.06
6	325002	6147624	97	300	397	1302.49
7	325904	6147385	97	300	397	1302.49
8	326714	6147263	98	300	398	1305.77
9	327508	6147213	98	300	398	1305.77
10	328287	6147117	98	300	398	1305.77
11	329052	6147057	99	300	399	1309.06
12	324858	6146391	95	300	395	1295.93
13	325661	6146001	96	300	396	1299.21
14	326426	6145898	96	300	396	1299.21
15	327196	6145809	96	300	396	1299.21
16	327969	6145722	97	300	397	1302.49
17	329561	6148507	98	300	398	1305.77
18	330337	6148443	99	300	399	1309.06
19	331092	6148351	99	300	399	1309.06
20	331860	6148259	99	300	399	1309.06
21	332638	6148164	99	300	399	1309.06
22	333377	6148025	98	300	398	1305.77
23	334009	6147654	99	300	399	1309.06
24	330013	6147080	100	300	400	1312.34

Name	Easting_m	Northing_m	Terrain elevation (m AHD)	WTG Height AGL (m)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
25	330718	6146885	100	300	400	1312.34
26	331444	6146713	101	300	401	1315.62
27	332160	6146513	101	300	401	1315.62
28	332979	6146412	101	300	401	1315.62
29	333255	6145600	101	300	401	1315.62
30	333650	6144874	101	300	401	1315.62
31	334218	6144486	101	300	401	1315.62
32	335106	6144410	102	300	402	1318.90
33	335945	6144403	103	300	403	1322.18
34	336878	6144289	100	300	400	1312.34
35	337620	6144253	99	300	399	1309.06
36	338166	6143415	100	300	400	1312.34
37	330484	6145212	99	300	399	1309.06
38	331389	6144310	99	300	399	1309.06
39	331958	6143950	99	300	399	1309.06
40	332573	6143605	100	300	400	1312.34
41	333203	6143254	99	300	399	1309.06
42	333996	6143197	101	300	401	1315.62
43	334738	6143017	101	300	401	1315.62
44	335401	6142826	101	300	401	1315.62
45	336300	6142676	102	300	402	1318.90
46	337097	6142644	102	300	402	1318.90
47	338567	6142708	100	300	400	1312.34
48	330358	6143911	97	300	397	1302.49
49	329297	6142739	95	300	395	1295.93
50	329614	6141976	95	300	395	1295.93
51	330438	6141998	96	300	396	1299.21
52	331232	6141964	96	300	396	1299.21
53	332074	6142021	97	300	397	1302.49

Name	Easting_m	Northing_m	Terrain elevation (m AHD)	WTG Height AGL (m)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
54	338236	6147166	99	300	399	1309.06
55	339117	6146967	99	300	399	1309.06
56	339766	6146640	100	300	400	1312.34
57	340686	6146893	100	300	400	1312.34
58	341453	6146650	100	300	400	1312.34
59	342148	6146393	100	300	400	1312.34
60	342897	6146193	100	300	400	1312.34
61	343616	6145990	101	300	401	1315.62
62	344659	6146058	101	300	401	1315.62
63	345336	6145774	101	300	401	1315.62
64	346161	6145800	102	300	402	1318.90
65	346946	6145723	102	300	402	1318.90
66	340361	6145442	100	300	400	1312.34
67	340982	6145076	100	300	400	1312.34
68	341674	6144832	100	300	400	1312.34
69	342363	6144583	100	300	400	1312.34
70	343079	6144384	100	300	400	1312.34
71	343821	6144248	101	300	401	1315.62
72	344218	6143469	101	300	401	1315.62
73	344612	6142711	101	300	401	1315.62
74	338036	6145708	99	300	399	1309.06
75	338729	6145093	99	300	399	1309.06
76	339261	6144544	100	300	400	1312.34
77	339662	6143830	100	300	400	1312.34
78	340263	6143433	100	300	400	1312.34
79	340899	6143133	100	300	400	1312.34
80	341634	6142930	101	300	401	1315.62
81	342373	6142780	101	300	401	1315.62
82	343154	6142720	101	300	401	1315.62

Name	Easting_m	Northing_m	Terrain elevation (m AHD)	WTG Height AGL (m)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
83	345937	6144257	101	300	401	1315.62
84	346710	6144163	102	300	402	1318.90
85	346469	6142723	102	300	402	1318.90
86	333915	6141396	99	300	399	1309.06
87	334609	6141159	99	300	399	1309.06
88	335335	6140979	99	300	399	1309.06
89	336148	6140789	100	300	400	1312.34
90	336854	6140574	101	300	401	1315.62
91	336854	6139248	99	300	399	1309.06
92	337366	6138797	99	300	399	1309.06
93	337864	6138304	99	300	399	1309.06
94	338360	6137720	100	300	400	1312.34
95	338929	6137258	101	300	401	1315.62
96	339487	6136774	100	300	400	1312.34
97	337995	6141127	101	300	401	1315.62
98	338519	6140442	101	300	401	1315.62
99	338964	6139799	101	300	401	1315.62
100	339423	6139177	101	300	401	1315.62
101	340050	6138780	101	300	401	1315.62
102	340547	6138194	102	300	402	1318.90
103	340804	6137269	101	300	401	1315.62
104	341349	6136760	101	300	401	1315.62
105	342044	6136474	101	300	401	1315.62
106	342885	6136323	101	300	401	1315.62
107	343677	6136268	101	300	401	1315.62
108	339868	6141477	101	300	401	1315.62
109	340376	6140918	101	300	401	1315.62
110	341589	6140106	101	300	401	1315.62
111	341734	6139061	101	300	401	1315.62

Name	Easting_m	Northing_m	Terrain elevation (m AHD)	WTG Height AGL (m)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
112	342195	6138414	101	300	401	1315.62
113	343210	6137839	101	300	401	1315.62
114	344115	6137894	101	300	401	1315.62
115	342819	6140857	101	300	401	1315.62
116	343677	6141097	101	300	401	1315.62
117	344468	6141163	102	300	402	1318.90
118	335945	6139634	99	300	399	1309.06
119	335070	6139607	98	300	398	1305.77
120	334255	6139707	98	300	398	1305.77
121	331546	6138756	97	300	397	1302.49
122	332501	6138720	97	300	397	1302.49
123	333337	6138777	97	300	397	1302.49
124	334008	6138237	98	300	398	1305.77
125	334565	6137780	98	300	398	1305.77
126	335301	6137507	98	300	398	1305.77
127	336052	6137197	99	300	399	1309.06
128	336601	6136533	99	300	399	1309.06
129	339184	6135332	100	300	400	1312.34
130	339948	6135225	100	300	400	1312.34
131	341801	6135058	101	300	401	1315.62
132	342496	6134558	101	300	401	1315.62
133	343500	6134920	101	300	401	1315.62
134	343096	6133419	101	300	401	1315.62
135	335819	6134506	98	300	398	1305.77
136	336684	6134609	98	300	398	1305.77
137	337383	6134382	99	300	399	1309.06
138	338064	6134119	99	300	399	1309.06
139	335679	6133080	98	300	398	1305.77
140	336388	6132686	98	300	398	1305.77

Name	Easting_m	Northing_m	Terrain elevation (m AHD)	WTG Height AGL (m)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
141	337141	6132568	98	300	398	1305.77
142	338122	6132991	99	300	399	1309.06
143	338604	6132397	99	300	399	1309.06

ANNEXURE 6 – WIND MONITORING TOWERS - COORDINATES AND HEIGHTS

Reference file: PROJDES_BayWa_PCV_231214_GDA20z55.shp & PROJDES_BayWa_ECG_231214_GDA20z55.shp

Mast	*X*	*Y*
ECG01	325152.38	6149059.76
ECG02	343375.68	6133151.07
PMM_151_152	334096.37	6137733.77
PMM_166_167	335931.09	6132696.37
PMM_080_081	329214.06	6142212.94
PMM_033_034	325170.33	6146052.82
PMM_097_098	346711.34	6146107.46

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