APPENDIX Q AVIATION IMPACT ASSESSMENT

AVIATION PROJECTS

March 2024

AVIATION IMPACT ASSESSMENT

THE PLAINS WIND FARM

Prepared for ERM

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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
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

Engie Australia and New Zealand (via its subsidiary International Power (Australia) Pty Ltd, (the Applicant) proposes to construct and operate The Plains Wind Farm (the Project), a renewable energy development located south of Hay in the Riverina region of New South Wales (NSW).

The Project is part of a hybrid renewable energy development (The Plain Renewable Energy Park) consisting of a wind farm, solar farm, and energy storage, including battery and deep storage. The Plains Wind Farm is seeking State Significant Development (SSD) Consent for the Project under Division 4.7, Part 4 of the *Environmental Planning and Assessment Act 1979 (EP&A Act).*

The Project is located to the east and west of the Cobb Highway approximately 15 km south of Hay in southern NSW.

ERM has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) for the Project to support the development application and formally consult with aviation agencies.

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

- NSW DPE Planning Secretary's Environmental Assessment Requirements (SEARS) number SSD-50629707
- Civil Aviation Safety Regulations 1998 and associated Manuals of Standards (MOS) 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 WTGs and/or WMTs.

Project description

The Plains Wind Farm includes the following:

- Up to 188 wind turbine generators (WTGs) and a maximum tip height of 270 m above ground level (AGL). The highest WTG, EE15 has an overall height of 364.5 m AHD / 1195.78 ft AMSL.
- Ancillary infrastructure including access tracks, road upgrades, underground and overhead electricity cabling, transmission lines.
- Up to 10 WMTs located within the Project site, with a maximum height of 150 m.

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.

Certified airports

2. The Project is located within 30 nm (55.56 km) of one Certified airport – Hay Airport (YHAY)
3. The Project will infringe the Hay Airport Procedures for Air Navigation Services - Aircraft Operations' (PANS-OPS) surface related to 10nm and 25 nm Minimum Sector Altitude (MSA)
4. The Project is located beyond the horizontal extent of circling areas at Hay Airport
5. Hay Airport's Required Navigation Performance (RNP) RWY 04 PANS-OPS surfaces will be infringed by WTGs, requiring amendment to the minimum heights in the Initial and Intermediate segments of this instrument approach procedure. The amendments will not affect the safe and efficient operation of flight operations using these approaches.

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 3 nm from all ALAs.

Air Routes and Lowest Safe Altitude (LSALT)

8. The WTGs will infringe the Grid Lowest Safe Altitude (LSALT), which will need to be increased to accommodate the Project. The increase will not create an adverse impact to flight operations
9. 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

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

Aviation Navigation Facilities

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

ATC Radar

12. The Project site is located outside of the area of interest for assessment of potential on surveillance radar and will not impact any ATC radars.

Aviation Impact Statement (AIS)

Based on the proposed Project WTG layout and maximum blade tip height of 270 m AGL, the highest wind turbine (WTG EE115) will not exceed 364.5 m (1195.78 ft AMSL).

The Project site WTGs:

- Would not infringe any OLS surfaces
- Would not infringe any circling areas
- Would infringe the Hay Airport 25 nm and 10 nm MSA surfaces but can be mitigated
- Would infringe the Hay Airport RNP RWY 04 PANS-OPS surface but can be mitigated
- Would not infringe the Hay Airport RNP RWY 22
- Would not have an impact on operations of nearby ALAs
- Would infringe the Grid LSALT but can be mitigated
- Would infringe the following air route LSALT – Q60, H247 and W466, but can be mitigated
- Would be outside the clearance zones associated with civil aviation navigation aids and communication facilities.
- Would be located outside of controlled airspace (wholly within Class G airspace) and not located in any Prohibited, Restricted or Danger areas.
- Would not impact on the closest ATC radar installations
- Must be reported to CASA and construction details provided to Airservices.

Obstacle lighting risk assessment

- Aviation Projects has undertaken a safety risk assessment of the Project and concludes that WTGs and WMTs would not require obstacle lighting to maintain an acceptable level of safety to aircraft
- However, the WMTs that are installed prior to WTG installation and WMTs that are not in close proximity to a WTG will require obstacle lighting to maintain an acceptable level of safety.
- Over the 12-year period between 2010-2022, no aircraft collided with a WTG or a WMT in Australia
- There is no regulatory requirement to mark or light power poles or overhead transmission lines for this Project.

Consultation

An appropriate and justified level of consultation was undertaken with relevant parties. Refer to Section 5 for details of the stakeholders and a consultation summary.

Summary of key recommendations

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

Notification and reporting

1. 'As constructed' details of WTG and WMT exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. 'As constructed' details of WTG and WMT coordinates and elevation should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
    a. The planned operational timeframe and maximum height of the crane; and
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
4. Details of the wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations.
5. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs, WMTs and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Marking of WTGs

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.

Lighting of WTGs

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

Marking of wind monitoring towers

8. Consideration should be given to marking the temporary and permanent WMTs according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D). Specifically:
    a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires
    b. paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast
    c. ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation.

Lighting of WMTs

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

Micrositing

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

Overhead transmission line

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

Triggers for review

12. Triggers for review of this risk assessment are provided for consideration:
    a. prior to construction to ensure the regulatory framework has not changed
    b. following any significant changes to the context in which the assessment was prepared, including the regulatory framework
    c. following any near miss, incident or accident associated with operations considered in this risk assessment.

AVIATION PROJECTS

1. INTRODUCTION

1.1. Situation

ERM is assisting Engie Australia to secure approvals to develop The Plains Wind Farm (the Project), located approximately 13 km south of Hay Airport in New South Wales.

ERM has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) for the Project to support the proposed application and formally consult with aviation agencies.

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 Applicant 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 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
- NSW DPE SSD SEARS (SSD-50629707)
- Civil Aviation Safety Authority (CASA) MOS Part 139.
- Specific requirements as advised by Airservices Australia.

1.3. Methodology

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

- Conduct a site visit to properly investigate aviation safety aspects of the proposed Project
- 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 incorporating responses received from stakeholders.

1.4. Aviation Impact Statement (AIS)

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

Aerodromes:

- Specify all certified aerodromes that are located within 30 nm (55.6 km) of the Project site
- Nominate all instrument approach 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 site 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 site is located.

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

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

- The Plains - Project Disturbance Footprint and Explanation.pdf
- Wind Farm Project Description_100523
- WTG_Layout20230511_LiDAR_Elevation.kmz
- WTGs_LiDAR_Elevations_20230511.xlsx
- WTG Layout Rev13 188WTGs 20230925 Elevation Data.xlsx
- Wind Farm Layout 20230925.kmz

2. BACKGROUND

2.1. Site overview

The Project site boundary is located approximately 15 km south of Hay Airport in New South Wales.

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

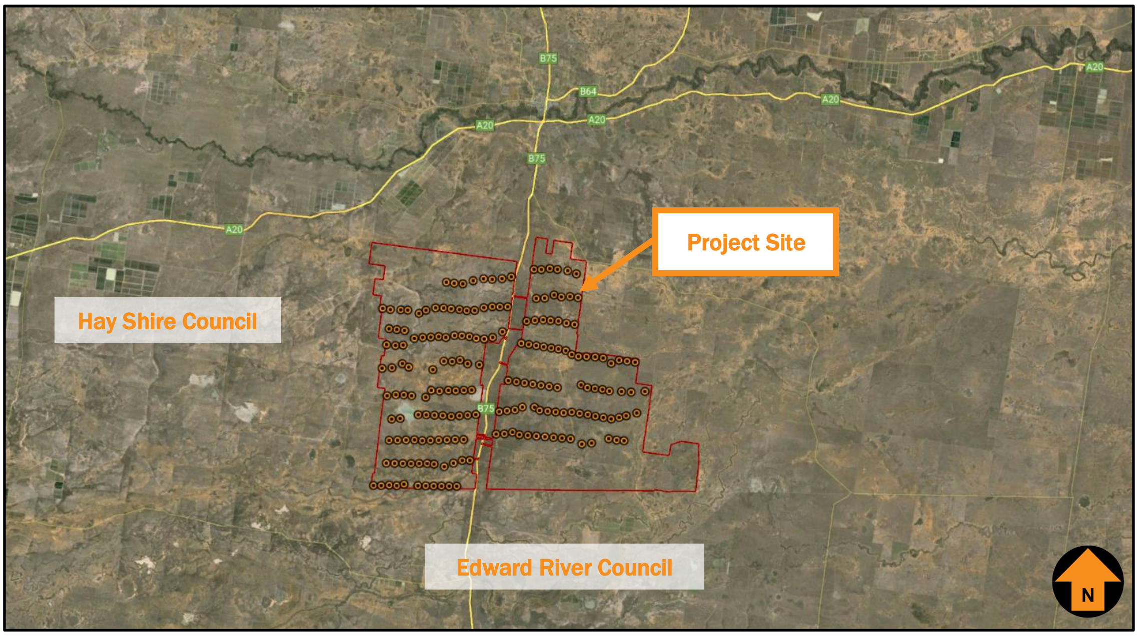

Figure 1 Project site overview

2.2. Project Description

The Project involves the construction, operation, maintenance and decommissioning of The Plains Wind Farm, including a final layout of up to 188 wind turbine generators (WTGs) providing a generating capacity of approximately 1,350 MW with associated electrical and ancillary infrastructure.

WTGs will have blade lengths of up to approximately 90 m, with maximum tip heights of 270 m AGL.

Based on the proposed Project WTG layout and maximum blade tip height of 270 m AGL, the highest wind turbine (WTG EE115) will not exceed 364.5 m (1195.78 ft AMSL).

3. EXTERNAL CONTEXT

3.1. National Airports Safeguarding Framework

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

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

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

3.2. Hay Shire Council

The Project is within the Hay Local Government Area (LGA). Hay Shire Council published the Hay Local Environmental Plan 2011, which includes guidelines and performance outcomes for airspace operations 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 Project is adjacent to the Edward River LGA. The Edward River Council published Deniliquin Local Environmental Plan 2013 includes guidelines and performance outcomes for airspace operations to ensure new developments do not create incompatible intrusions or compromise the safety of existing airports and associated navigation facilities.

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. Aircraft operations at non-controlled aerodromes

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

A conventional circuit pattern and heights are provided in AC 91-10 v1.1. The standard circuit consists of a series of flight paths known as legs when departing, arrival or when conducting circuit practice.

Illustrations of the standard aerodrome traffic circuit procedures provided in AC 91-10 v1.1. are shown in Figure 2 and Figure 3.

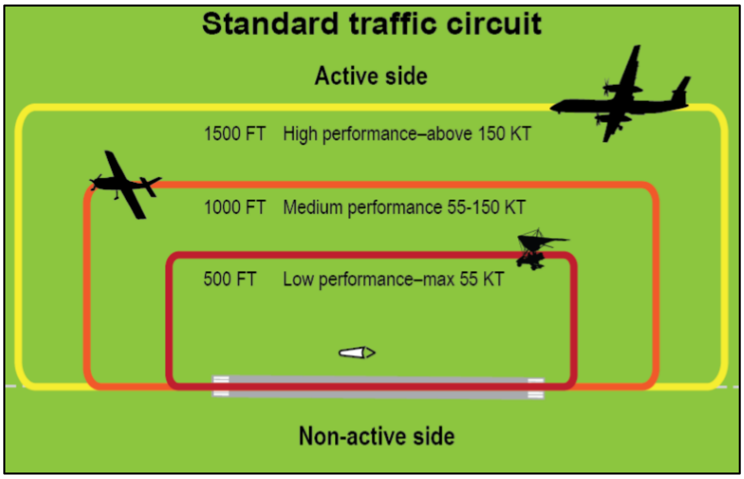

Figure 2 Standard traffic circuit altitudes

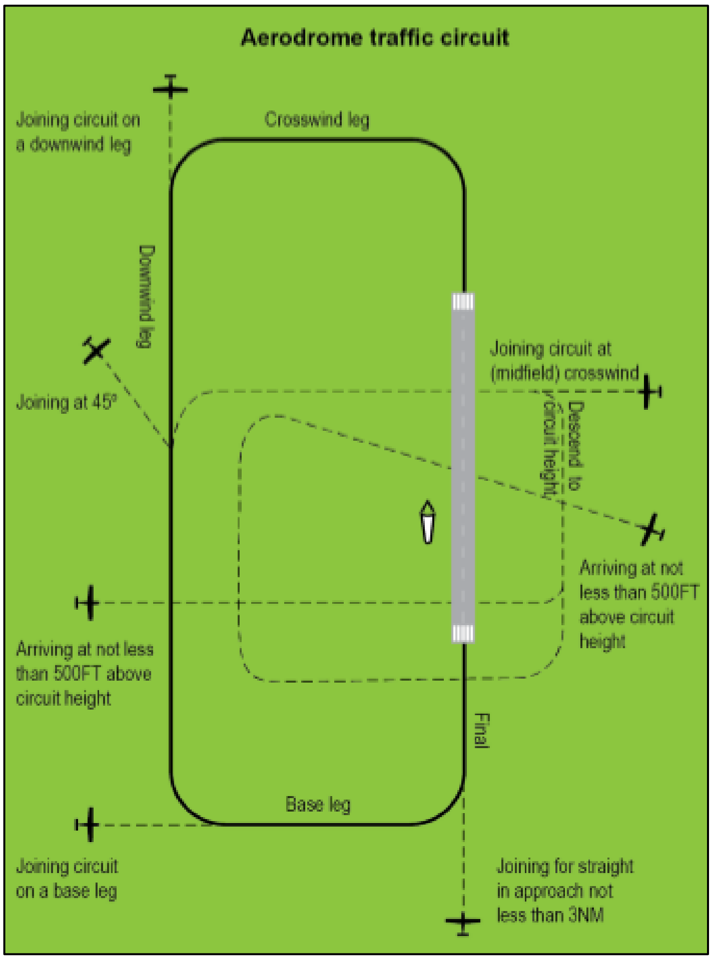

Figure 3 Aerodrome traffic circuit legs

The following CASA publications inform pilots of their obligations at non-certified aerodromes (ALA).

3.4.1. Advisory Circular (AC) 91-02 V1.1, Guidelines for aeroplanes with MTOW not exceeding 5700 kg – suitable places to take off and land, dated November 2021

Purpose

This AC provides guidance to assist pilots when making a determination about the suitability of a place for an aeroplane to safely take off and land. It provides an overview of the pilot's responsibilities and discusses some, but not all, circumstances, including prevailing weather conditions, that are recommended to be considered. It also provides 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 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.

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).

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.

3.4.2. AC 91-10 v1.1, Operations in the vicinity of non-controlled aerodromes, date 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

4.1.1 Subdivision D.4.6 of CASR Part 91 (prescribes the requirements for operating in the vicinity of a non-controlled aerodrome. Prior to flight, pilots should consult the current ERSA and NOTAMs to ascertain whether carriage of radio is required, special circuit procedures apply or, in the case of NOTAMs, whether the information contained within the ERSA has been modified.

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.

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 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.*

3.5. Rules of flight

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

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

Civil Aviation Safety Regulation (1998) 91.267 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), except during take-off and landing phases of flight.

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 Such as authorised .

3.5.2. 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.

3.5.3. Flight under Instrument Flight Rules (Day or Night) (IFR)

According to CASR Part 91, flight under the instrument flight rules (IFR) requires an aircraft to be operated at a height clear of obstacles that is calculated according to an approved method. The minimum heights are described as PANS-OPS surfaces for each segment of the IFR flight operation.

3.6. Aircraft operator characteristics

Flying training may be conducted under either the IFR or visual flying rules (VFR). Other general aviation operations such as ambulance flights and charter flights operate under either IFR or VFR are also conducted at various aerodromes in the area.

3.7. Passenger transport operations

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

3.8. Private operations

Private operations are generally conducted under day or night VFR, with some IFR. Flight under day VFR is conducted above 500 ft AGL in areas outside city and township built-up areas.

Generally private travel flights between aerodromes are conducted at a much higher altitude to cater for fuel efficiency, comfort (away from low level turbulence) and to recognise navigation features along the route taken.

3.9. Military operations

There may be some high-speed low-level military jet aircraft, transport and helicopter operations conducted in the area.

Military operations can be conducted under separate but compatible regulations and standards, including obstacle separation requirements.

Low level military flight operations require a considerable pre-flight assessment of the planned route or operation to enable aircrew to be aware of the terrain and obstacle environment that could create a hazard to the operation.

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

3.10. Aerial application operations

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

Aerial application operations are conducted in the area.

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.

3.10.1. Aerial Agricultural 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.

3.10.2. Local aerial application operators

Based on previous studies for other wind farm Projects undertaken by Aviation Projects, and the results of consultation with AAAA and local aerial application operators, it is reasonable to conclude that safe aerial application operations would be possible on properties within the Project site and on neighbouring properties, subject to final WTG locations and by implementing recommendations provided in this report at Section 11.

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

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

3.11. Emergency services

3.11.1. Royal Flying Doctor Service

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

Aircraft arriving or departing from Hay Airport are able to conduct their flights under the IFR using the two published instrument approach procedures.

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

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

3.11.2. Aerial firefighting

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

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.*

4. INTERNAL CONTEXT

4.1. Wind farm site description

The Plains Wind Farm site boundary is located approximately 15 km south of Hay in New Sales Wales, Australia.

The Project site is to comprise of up to 188 WTGs. The maximum blade tip height of the proposed WTGs will be 270 m above ground level (AGL).

The ground elevation for the highest WTG location (WTG EE15) is 94.48 m AHD which with a 270 m WTG height, results in a maximum overall height of 364.5 m AHD / 1195.78 ft AMSL.

Figure 4 illustrates the Project layout identifying the highest WTG location, WTG EE15 (source: ERM, Google Earth).

Figure 4 Project layout and highest WTG location

'Micrositing' of WTGs means an alteration to the siting of a WTG by not more than 100 m and any consequential changes to access tracks and internal power cable routes. The potential micrositing of the WTGs has been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level is within 100 m of the nominal WTG position. The micrositing 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

It is proposed to install up to 10 new wind monitoring towers (WMTs) The location of WMTs are indicated in Figure 5 (Source: ERM, Google Earth).

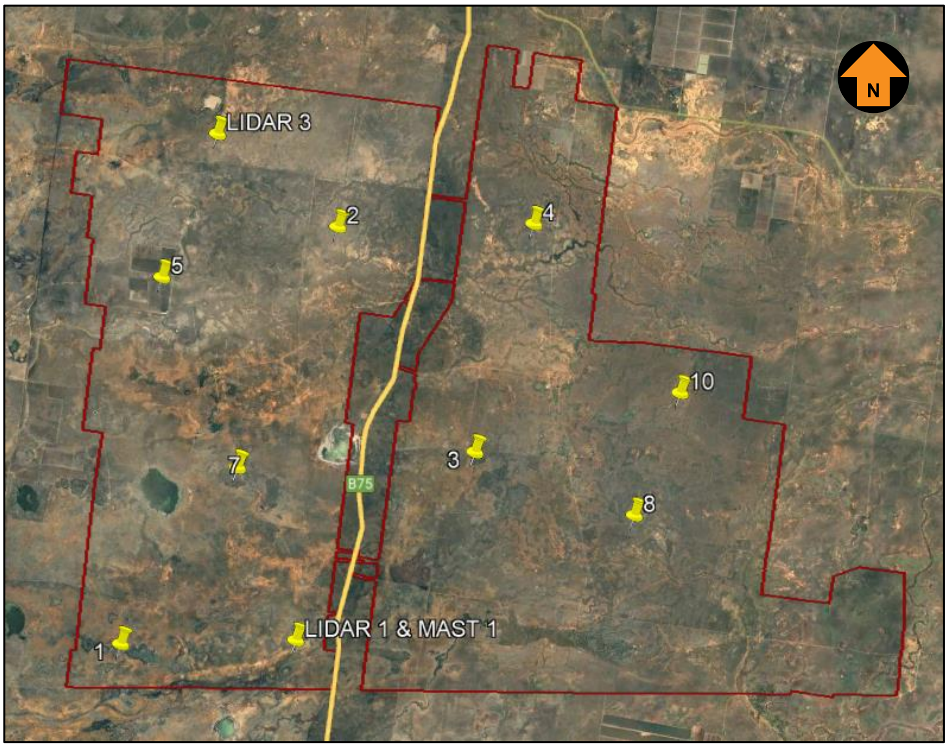

Figure 5 WMT Locations

Details of the proposed WMTs are provided in Table 1, (source: WMT report, dated 20 February 2023).

Table 1 WMT locations and heights

Mast	*Easting*	*Northing*	*Ground elevation m AHD*	*Mast Height m (ft) AMSL*
0	308945.0215	6152739.445	95 m	245 m (804 ft)
1	287431.6323	6142596.691	84 m	234 m (768 ft)
2	295535.8953	6158882.179	90 m	240 m (788 ft)
3	301030.0002	6150289.393	87 m	237 m (778 ft)
4	303139.6039	6159156.249	90 m	240 m (788 ft)
5	288749.8911	6156803.948	85 m	235 m (771 ft)
LiDAR 1 & MAST 1	294228.5566	6142880.561	86 m	236 m (774 ft)
7	291827.0947	6149512.753	86 m	236 m (774 ft)
8	307269.0517	6147975.15	89 m	239 m (785 ft)
LIDAR 3	290788.7061	6162385.813	91 m	241 m (791 ft)

4.3. Internal transmission

Electrical infrastructure consists of a 330 kV internal transmission line shown in Figure 6 (source: ERM).

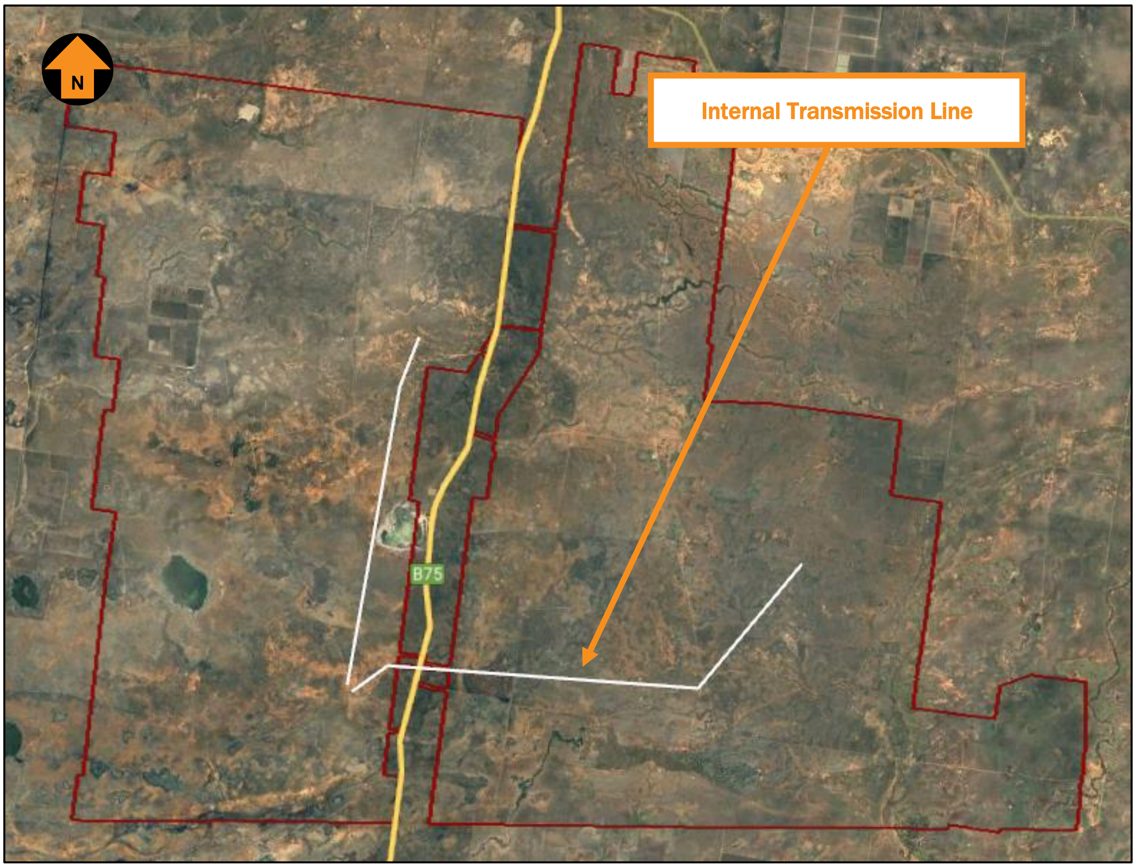

Figure 6 Electrical reticulation and transmission lines within the Project site.

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. Royal Flying Doctor Service
6. Aerial operators

Aviation Projects will conduct the initial consultations and provide details and results of the consultation activities in Table 2.

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

Table 2 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices				
Department of Defence				
Hay Shire Council				
Edward River Council				
Royal Flying Doctor Service				
Aerial Operators				

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

The Project area is located within 30 nm (55.56 km) of one certified airport – Hay Airport (YHAY).

The location of the Project site relative to Hay (YHAY), Griffith (YGTH) and Deniliquin (YDLQ) Airports is shown in Figure 7 (Source: ERM).

The red circle around each airport represents a distance of 30 nm from the aerodrome reference point of each airport.

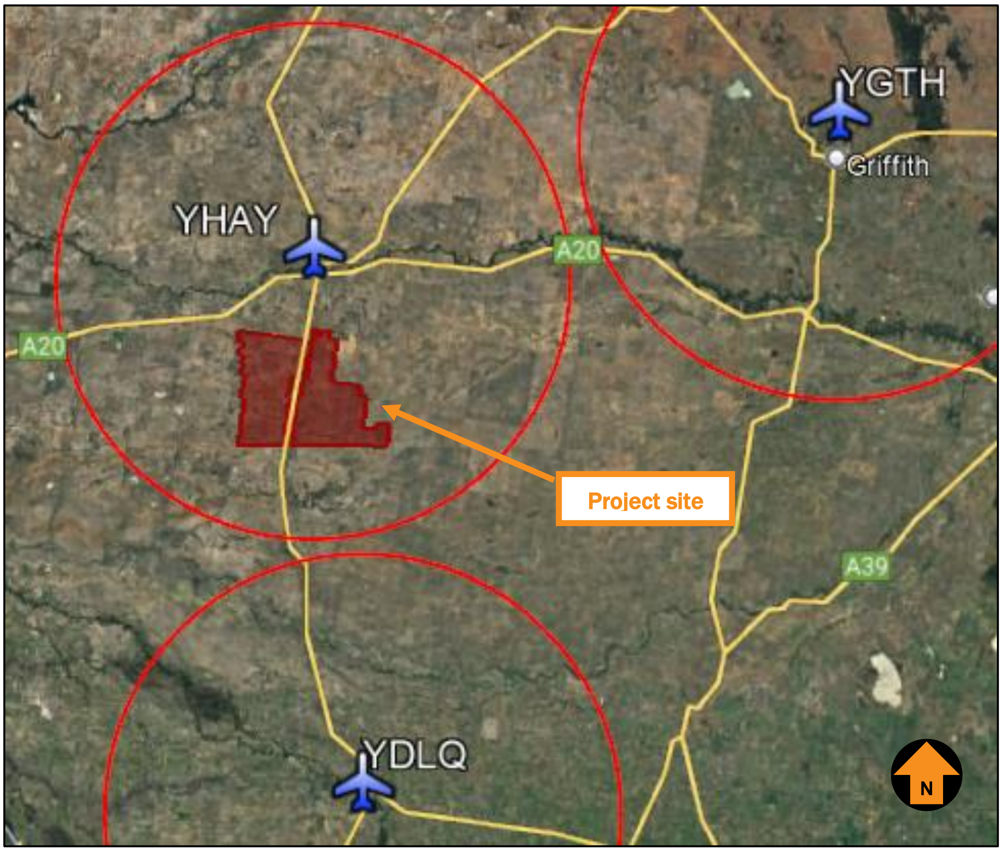

Figure 7 Location of Certified Airports in relation to Project Area

6.2.1. Hay Airport

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 21 March 2024).

Hay Airport has two runways:

- runway 04/22 is an asphalt runway 1463 x 30 m and runway strip 90 m
- runway 15/33 is an unrated red sandy clay runway 1140 m x 30 m and runway strip 90 m.

Figure 8 shows the runway layout of Hay Airport (source: AsA, Aerodrome Chart, 15 August 2019).

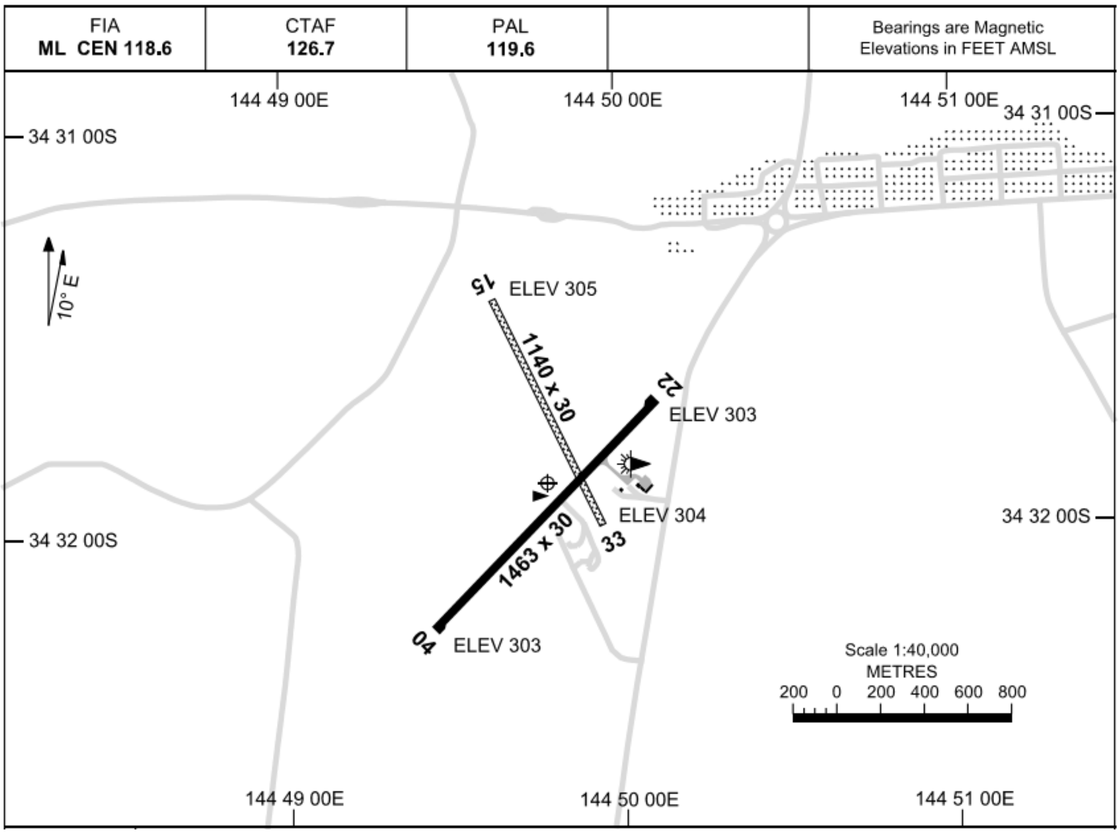

Figure 8 Hay Airport (YHAY) runway layout

Hay Airport's 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.

6.2.2. Instrument approach procedures

A check of AIP via the Airservices Australia website showed that Hay Airport is served by non-precision instrument flight procedures (source: AsA, effective 21 March 2024).

Table 3 identifies the aerodrome and procedure charts for Hay Airport, designed by Airservices Australia (AsA) as indicated.

Table 3 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)

6.2.3. MSA surfaces

The minimum sector altitudes (MSA) is applicable for each instrument approach procedure at Hay Airport. An image of the MSA published for Hay Airport is shown in Figure 9 (source: AsA, 15 June 2023).

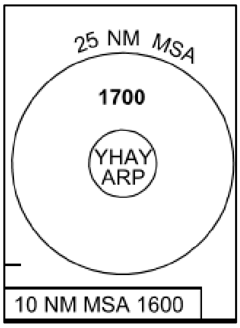

Figure 9 MSA at Hay Airport

The MOS 173 Standards Applicable to Instrument Flight Procedure Design (MOS 173), requires that a minimum obstacle clearance (MOC) of 300 m / 984 ft above the highest terrain or obstacle within the MSA areas.

Obstacles within 15 nm (10 nm MSA + 5 nm buffer) and within 30 nm (25 nm MSA + 5 nm buffer) of the Hay Airport's ARP define the height at which an IFR aircraft can fly when within 10 nm and 25 nm and when weather conditions do not allow the pilot to see the ground.

Sections of the proposed Project are within the 25 nm MSA and the 10 nm MSA areas of Hay Airport (as depicted in Figure 10). The red circles represent distances of 15 and 30 nm from the aerodrome reference point of Hay airport.

The 10 nm MSA has an elevation of 487.7 m AHD / 1600 ft AMSL with a PANS-OPS surface elevation of 187.7 m AHD / 616 ft AMSL. WTG EE15 at a maximum elevation of 364.5 m AHD /1195.78 ft AMSL, infringes the 10 nm MSA by 176.8 m / 579.78 ft.

The 25 nm MSA has an elevation of 518.1 m AHD / 1700 ft AMSL with a PANS-OPS surface elevation of 218.1 m AHD / 716 ft AMSL. WTG EE15 infringes the 25 nm MSA by 146.4 m / 479.78 ft.

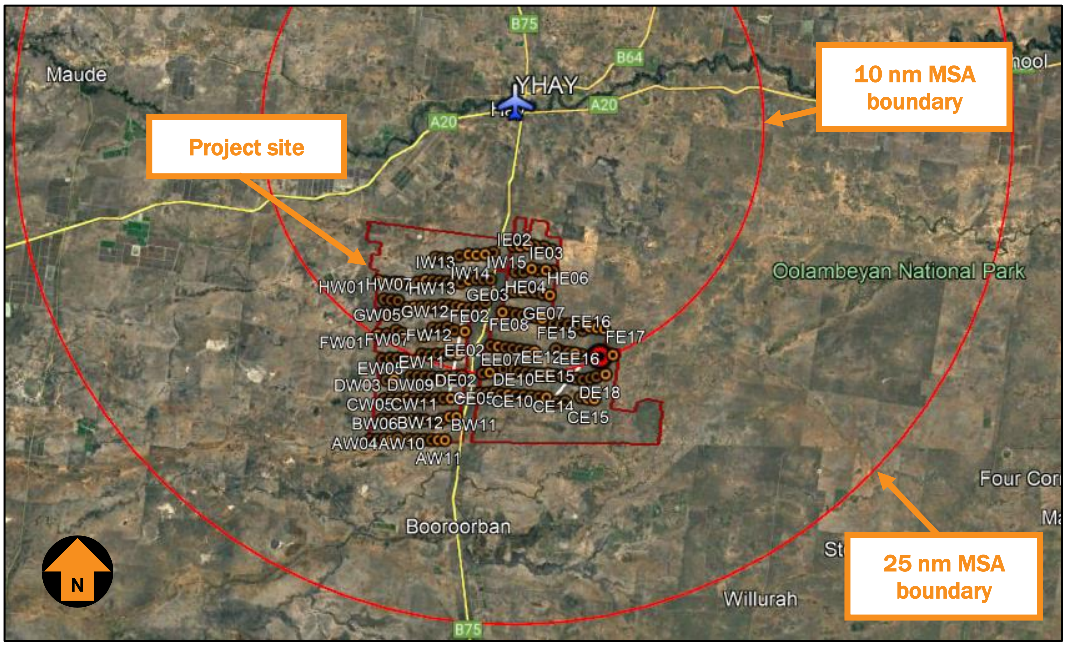

Figure 10 Hay Airport MSA

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

Table 4 Hay Airport MSA Impact analysis

MSA	Minimum altitude	MOC	Impact on airspace design	Potential solution	Impact on aircraft ops
10 nm	1600ft AMSL	616 ft AMSL	EE15 1195.78 ft infringes the 10 nm MSA by 579.78 ft	Increase 10 nm MSA by 600 ft to 2200 ft	Minor
25 nm	1700 ft AMSL	716 ft AMSL	EE15 1195.78 ft infringes the 10 nm MSA by 479.78 ft	Increase 25 nm MSA by 500 ft to 2200 ft	Minor

The 10 nm MSA for Hay Airport would need to be increased by 600ft to 2200ft, and the 25nm MSA would need to be increased by 500ft to 2200ft.

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.

6.2.4. IFR Circling areas

A circling approach is an extension of an instrument approach to the specified circling minimum descent altitude (MDA) 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.

Both runways at Hay have runway aligned approach procedures so the requirement to circle to the other runway is seldom required.

Circling areas are established by the instrument flight procedure designer based on International Civil Aviation Organization (ICAO) specifications and 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 Hay Airport instrument flight procedure's is Category C.

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

- Category A – 1.68 nm / 3.12 km
- Category B – 2.66 nm / 4.90 km
- Category C – 4.20 nm / 7.85 km

The Project is located approximately 12.7 km from the Runway 04 threshold and is therefore beyond the circling area and would not impact circling areas established for instrument approach procedures.

6.2.5. PANS-OPS Surfaces

A detailed assessment of the PANS-OPS surfaces associated with the published instrument approach procedures is outlined below.

The following tables detail the assessment for each instrument approach procedure.

RNP RWY 04

The RNP RWY 04 instrument approach procedure is aligned with Runway 04 and brings IFR aircraft from the south via Initial Approach fixes at HXXSA, HXXSB and HXXSC with a holding pattern at HXXSB.

Table 5 Hay Airport (YHAY) RNP RWY 04 PANS-OPS Assessment

Instrument Approach Procedure Title - Segment	*Minimum Altitude over Project (ft AMSL)*	*PANS-OPS Surface (ft AMSL)*	*Highest WTG in Segment*	*Infringement to PANS-OPS surface*	*Potential solution*	*Impact on aircraft ops*
RNP RWY 04 – RH Initial	1700	716	FW10 1175.62 ft	460 ft	Increase Initial segment Min ALT by 500 ft to 2200 ft	Minor. Approach still usable and efficient
RNP RWY 04 - Intermediate	1700	1208	IW09 1172.89 ft	Nil	Nil	Nil
Holding @HXXSB	2000	1016	EE15 1195.78 ft	180 ft	Increase Holding Min ALT by 200 ft to 2200 ft	Minor. Approach still usable and efficient.

The increase to the PANS-OPS segments of this approach is commensurate with the increases required by the 25 nm MSA increase to 2200 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. Descent from 2200 ft would occur at approximately 1.9 nm prior to HXXSF rather than 0.2 nm prior to HXXSF currently published.

The final missed approach altitude would also need to be increased to 2200 ft without impact to the RNP RWY 04 approach procedure.

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

Figure 11 details the Hay Airport RNP RWY 04 instrument approach chart. The altitudes that would need to be amended to accommodate the Project are circled in orange.

The wind farm would be depicted on the plan view of this chart in the correct location for pilot reference.

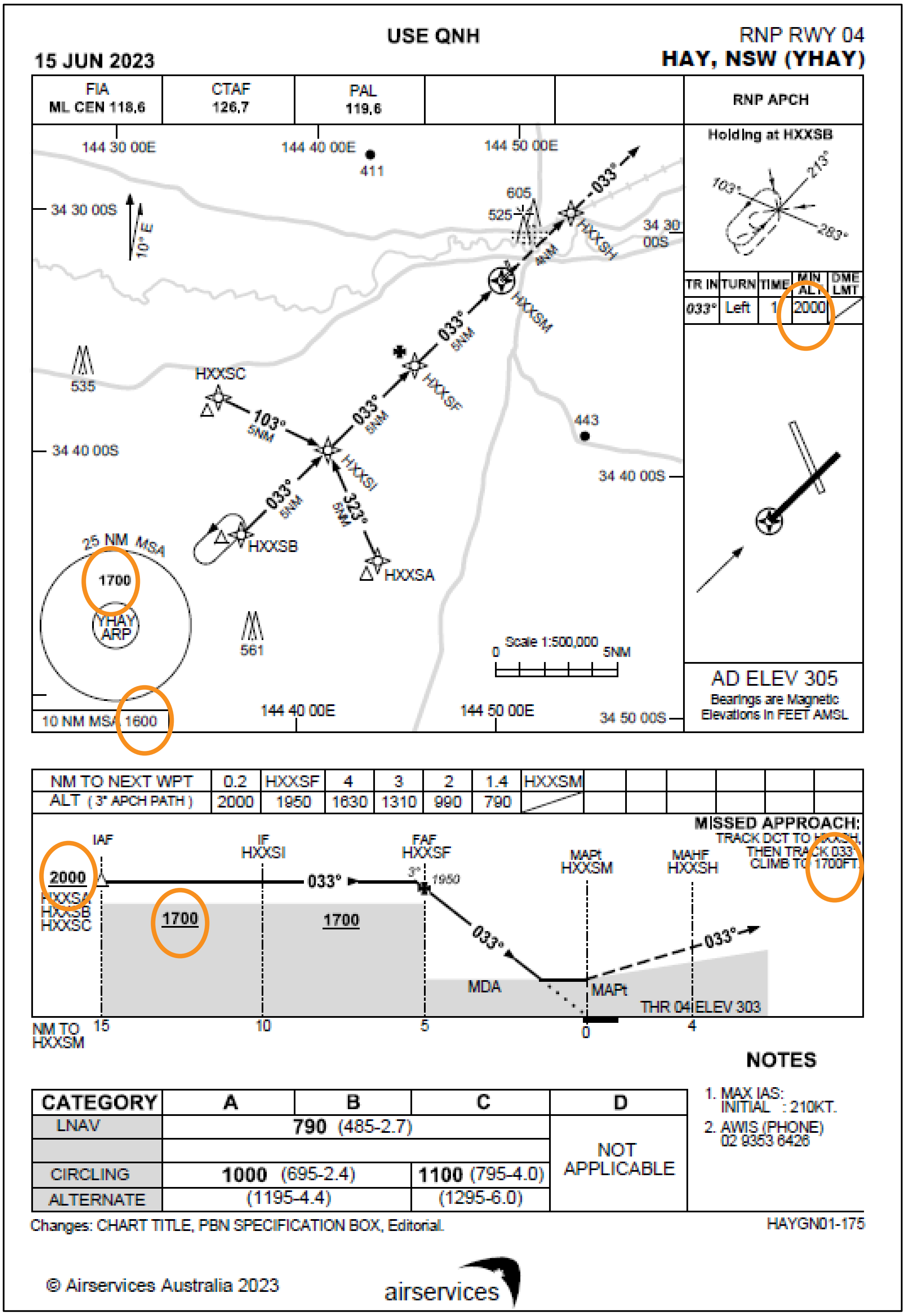

Figure 11 Hay Airport (YHAY) RNP RWY 04

RNP RWY 22

The RNP RWY 22 instrument approach procedure is aligned with Runway 22 and brings IFR aircraft from the north via Initial Approach fixes at HXXND, HXXBE and HXXNG with a holding pattern at HXXNE.

Table 6 Hay Airport (YHAY) RNP RWY 22 PANS-OPS Assessment

Instrument Approach Procedure Title - Segment	*Minimum Altitude over Project (ft AMSL)*	*PANS-OPS Surface (ft AMSL)*	*Highest WTG/WMT in Segment*	*Infringement to PANS-OPS surface*	*Potential solution*	*Impact on aircraft ops*
RNP RWY 22 – All approach segments	Various	N/A	Nil	N/A	Nil	Nil.
RNP RWY 22 – Missed Approach	> 2080	>1919	LIDAR 3 791 ft	Nil	Nil	Nil

There are no WTGs located within the missed approach segment of the Hay Airport RNP RWY 22 instrument approach procedure.

The Project would not affect the RNP GNSS RWY 22 procedure, however due to requirement of increasing the 25 nm MSA to 2200 ft the minimum altitudes in some segments would need to be increased.

Figure 12 details the Hay Airport RNP RWY 22 instrument approach chart. The altitudes that would need to be amended to accommodate the Project are circled in orange.

The wind farm 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 2200 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.

Descent from 2200 ft would occur at approximately 1.9 nm prior to HXXSF rather than 0.2 nm prior to HXXSF currently published.

The final missed approach altitude would also need to be increased to 2200 ft without impact to the RNP RWY 22 approach procedure.

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

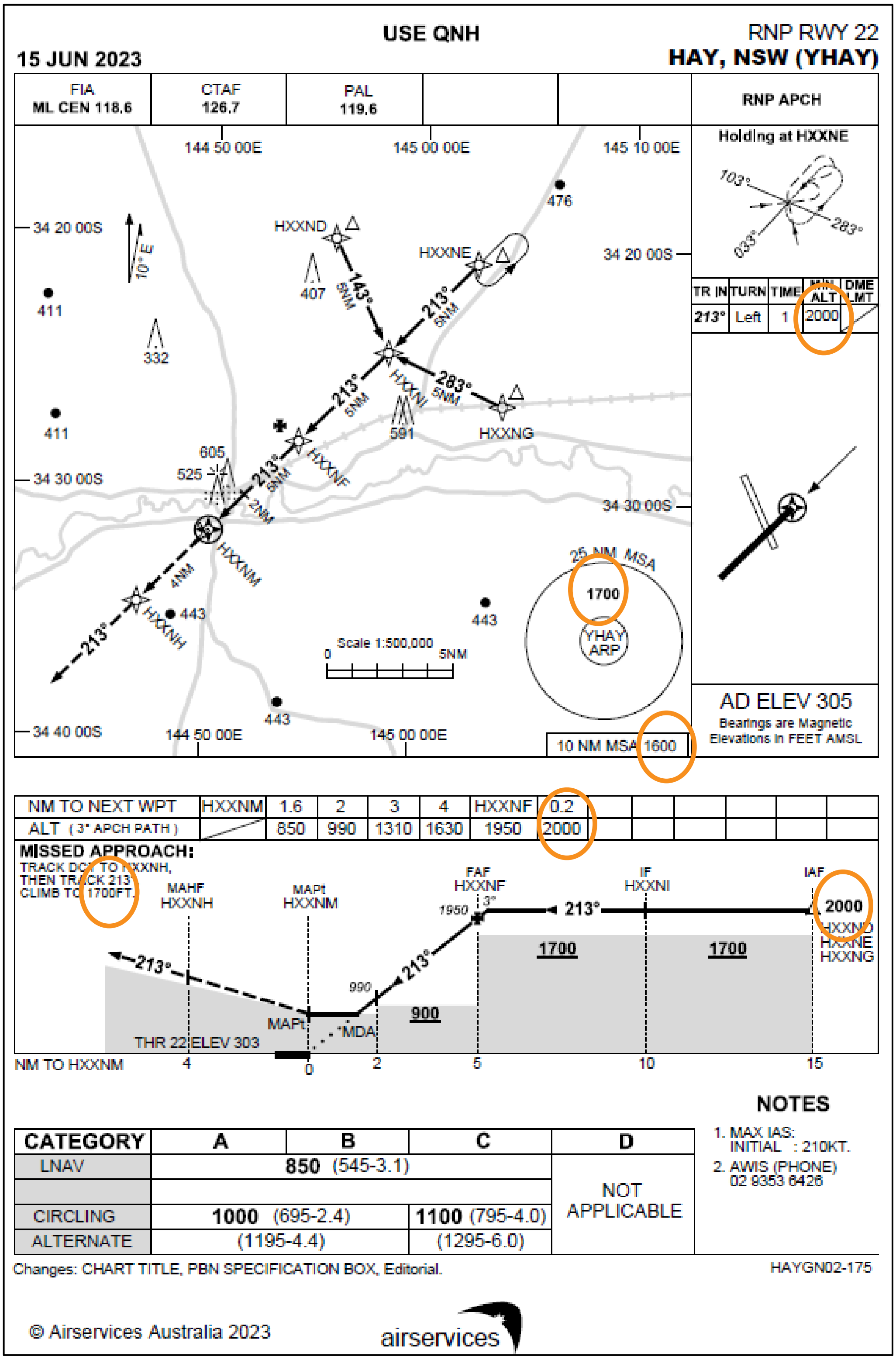

Figure 12 Hay Airport (YHAY) RNP RWY 22 instrument approach chart

6.3. Obstacle Limitation Surfaces

OLS are established for each runway at Hay Airport.

For the existing Code 3 non-precision runways, the maximum lateral extent of the OLS is up to 5.5 km radius for the conical surface and 15km from each runway threshold for the take-off climb surfaces and the approach surfaces.

The closest WTGs in the Project area to Hay Airport is located beyond the horizontal extent of the obstacle limitation surfaces for the proposed runway extension, as shown in Figure 13 (Source: Google Earth)

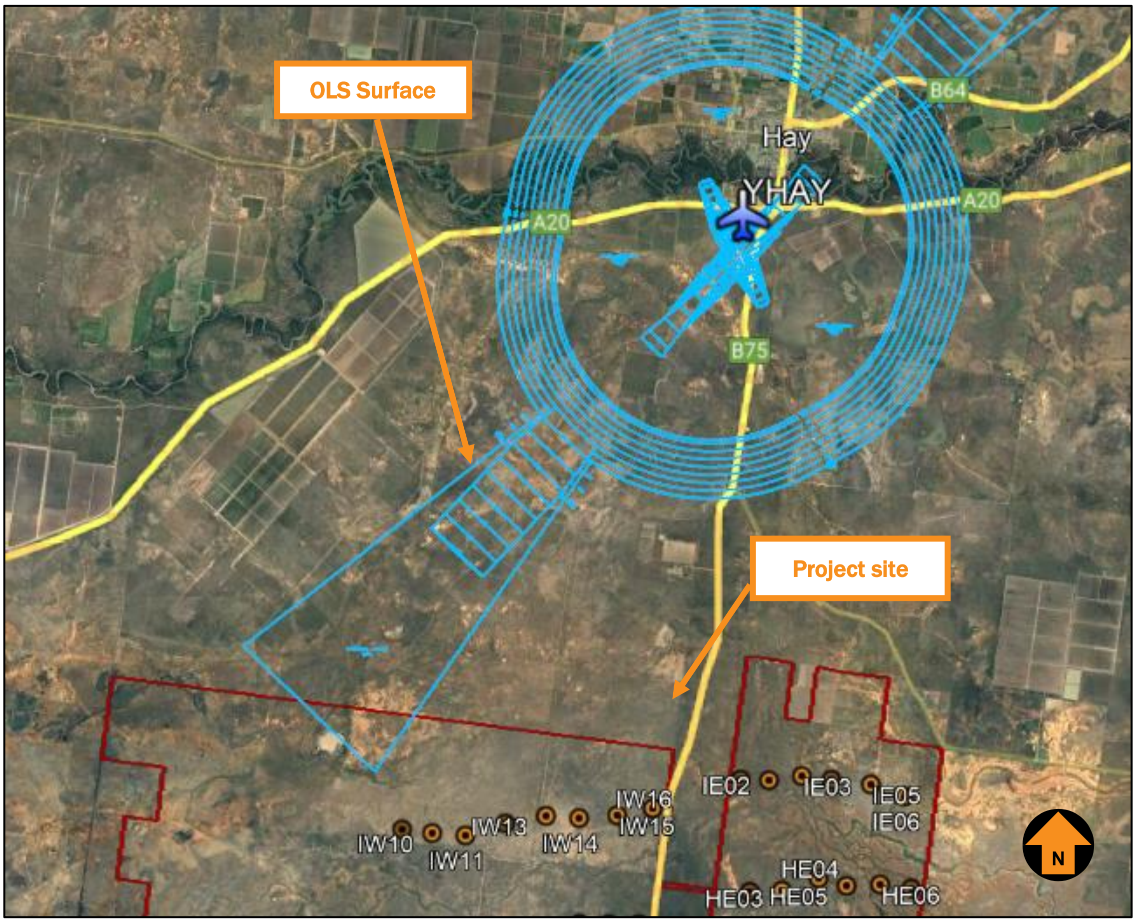

Figure 13 Hay's OLS surface in relation to WTGs

Based on Hay Aerodrome Master Plan 2022, the Runway 04/22 will be extended to 2300 m and upgraded to a Code 4 non-precision instrument runway, as shown in Figure 14. (Source: Hay Aerodrome Master Plan 2022).

The closest WTGs in the Project area to Hay Airport are located beyond the horizontal extent of the obstacle limitation surfaces of the future proposed extended runway.

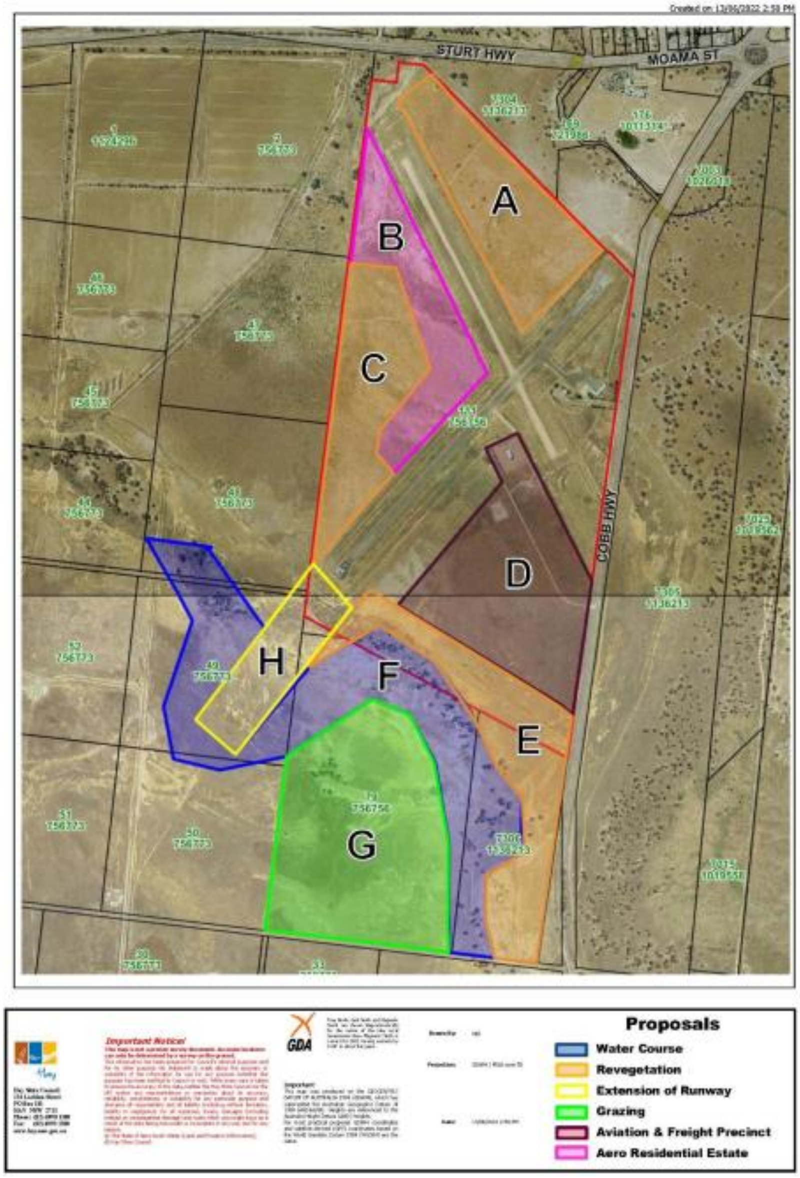

Figure 14 Hay Aerodrome runway extension plan

6.4. 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:

- 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 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 15 shows the location of nearby ALAs relative to the Project site and a nominal 3 nm buffer from the closer ALAs (source: ERM).

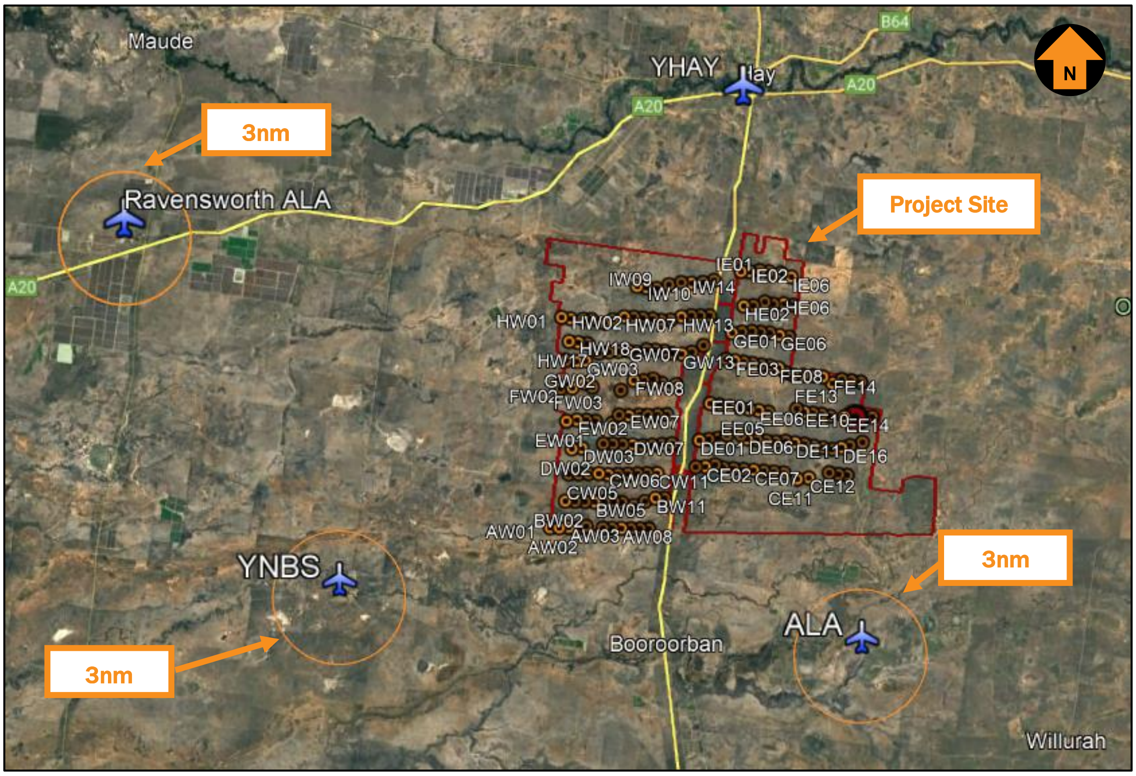

Figure 15 ALAs in the vicinity of the Project site

Ravensworth aerodrome (YRWH), North Bundy Station (YNBS) and an unnamed ALA 1 are the closest in relation to the Project.

No WTGs are located within a radius of 3 nm of closest runway.

Aircraft operations at these ALA will not be impacted by the WTGs.

6.5. 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 is 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 180 m rotor diameter has been used. Based on the NASF Guideline, the effects of wake turbulence could be noticeable at 2880 m from the WTGs.

Aviation Projects, through research, has determined that any adverse turbulence would most likely be confined to within 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 180 m rotor diameter, this area would therefore extend to a distance of 1800 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 10 times (1800 m) (green) and 16 times (2880 m) (red) around the relevant boundary WTGs in relation to nearby ALAs (sources: ERM, Google Earth).

There is no impact to nearby ALAs.

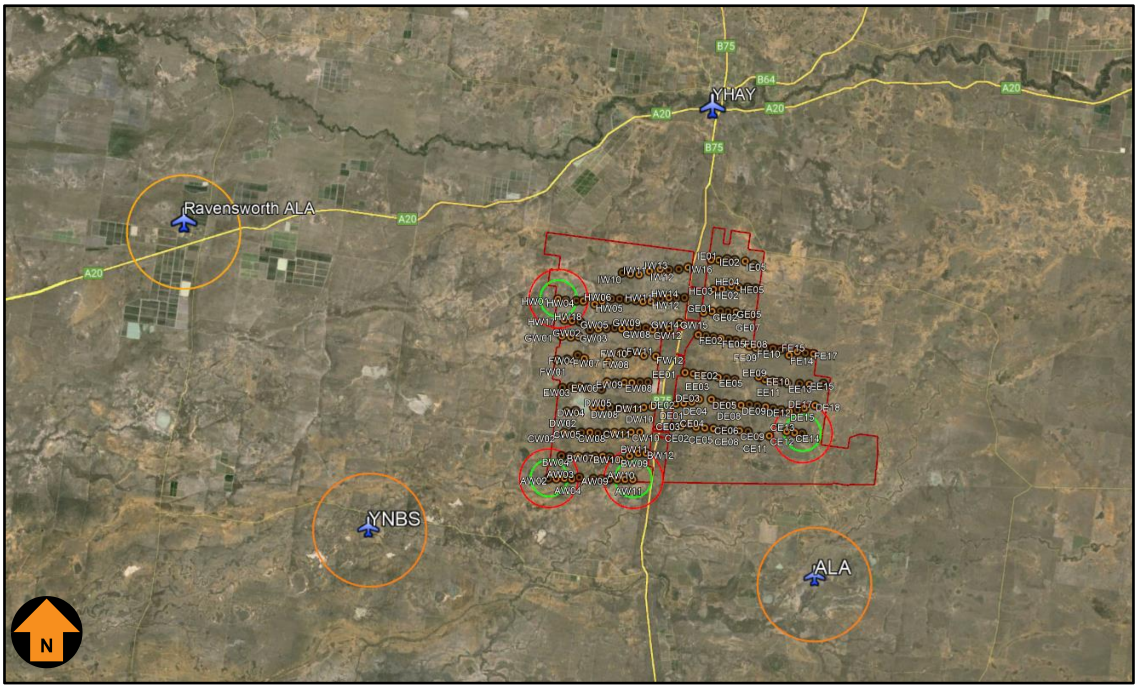

Figure 16 Possible extent of Wake Turbulence from WTGs in relation to ALAs

6.6. 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.

6.6.1. Grid LSALT

The Project site is located within the Grid LSALT of 1700 ft AMSL with a protection surface of 700 ft AMSL.

Figure 17 shows the grid LSALTs in proximity to the Project site (source: ERC Low National, OzRunways, March, 2024, Google Earth).

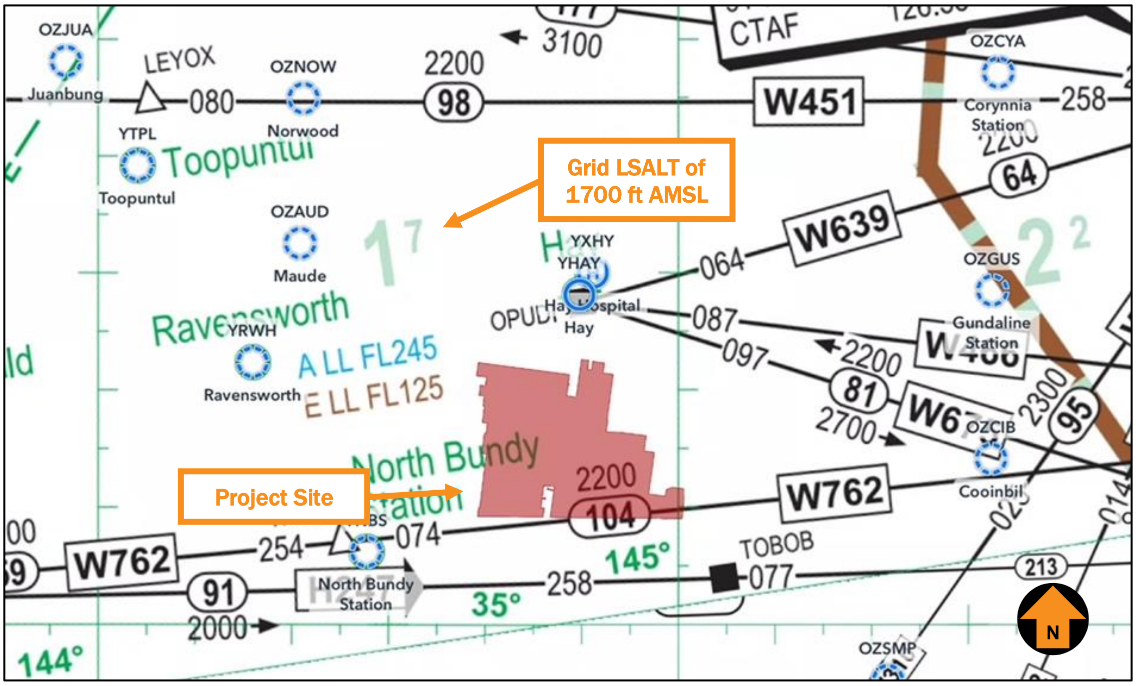

Figure 17 Air Route and Grid LSALTs in proximity to the Project site

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

The highest WTG (EE15, at 364.5 m AHD / 1195.78 ft AMSL) infringes the 700 ft protection surface by 495.78 ft, requiring the Grid LSALT to be raised by 500 ft to 2200 ft.

Airservices Australia will be provided with this AIA and can then assess this proposed change and amend aeronautical charts relevant to the Project as appropriate.

Table 7 Grid ISALT impact analysis

Grid ISALT	*Protection Surface*	*Highest WTG*	*Impact on Grid LSALT*	*Potential solution*	*Impact on aircraft ops*
1700 ft AMSL	700 ft AMSL	EE15 1195.78 ft AMSL	495.78 ft infringement	Raised by 500 ft	Minor.

6.6.2. Air Route LSALTs

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

There are several air routes within 7 nm of the Project Site shown below in Table 8 (source: ERC Low National, Google Earth).

An impact analysis of the surrounding air routes is provided in Table 8.

Table 8 Air route impact analysis

Air route	Waypoint pair	Route LSALT	Protection Surface	Impact on airspace design	Potential solution	Impact on aircraft ops
Q60	TOBOB to MAXEM	Grid 1700 ft AMSL	700 ft AMSL	Highest WTG will exceed by 488.5 ft	LSALT raised by 500 ft	N/A
H247	NATYA to TOBOB	2000 ft AMSL	1000 ft AMSL	Highest WTG will exceed by 167.8 ft	LSALT raised by 200 ft	N/A
W762	TREST to VINOP	2200 ft AMSL	1200 ft AMSL	Nil	Nil	N/A
W639	OPUDI to BORLI	2200 ft AMSL	1200 ft AMSL	Nil	Nil	N/A
W466	OPUDI to VINOP	2100 ft AMSL	1100 ft AMSL	Highest WTG will exceed by 95.8 ft	LSALT raised by 100 ft	N/A
W675	OPUDI to RUNDA	2200 ft AMSL	1200 ft AMSL	Nil	Nil	N/A

6.7. Airspace Protection

The Project Site is located outside of controlled airspace (wholly within Class G airspace) and is not located within in any Special Use Airspace.

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

6.8. Aviation navigation facilities

The nearest aviation navigation aid is located at Griffith Airport, approximately 64 nm northeast of the Project.

The Project WTGs are located sufficient distance away from aviation facilities and will not have an impact.

6.9. ATC Radar installations

Airservices Australia requires an assessment of the potential for the WTGs to affect radar line of sight.

The closest radar facility to the Project site is the Mount Bobbara Route Surveillance Radar (RSR), which is located approximately 334 km to the south-east.

The Project site are outside the range of the Mount Bobbara RSR and will not impact this facility.

6.10. AIS Summary

Based on the proposed Project WTG layout and maximum blade tip height of 270 m AGL, the highest wind turbine (WTG EE115) will not exceed 364.5 m (1195.78 ft AMSL).

The Project site WTGs:

- Would not infringe any OLS surfaces
- Would not infringe any circling areas
- Would infringe the Hay Airport's 25 nm and 10 nm MSA surfaces but can be mitigated
- Would infringe the Hay Airport RNP RWY 04 PANS-OPS surface but can be mitigated
- Would not infringe the Hay Airport RNP RWY 22
- Would not have an impact on operations of nearby ALAs
- Would infringe the Grid LSALT but can be mitigated
- Would infringe the following air route LSALT – Q60, H247 and W466, but can be mitigated
- Would be outside the clearance zones associated with civil aviation navigation aids and communication facilities.
- Would be located outside of controlled airspace (wholly within Class G airspace) and not located in any Prohibited, Restricted or Danger areas.
- The WTGs will not impact on the closest ATC radar installations
- The WTGs must be reported to CASA and construction details provided to Airservices.
- Would be outside the clearance zones associated with civil aviation navigation aids and communication facilities.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 9 it is concluded that aviation lighting is likely to not be required for WTGs.

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

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

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

7.1. Wind monitoring towers (WMTs)

Given that aerial operators might use the airspace within the Project site and that it is expected that WMTs will be constructed prior to WTGs, the WMTs may be free-standing and not surrounded by any other obstacles.

Therefore, the proposed temporary and permanent WMTs should be marked with red/white/red bands as per the NASF Guideline D.

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

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

> *8.109 Obstacles and hazardous obstacles*
>
> *(1) The following objects or structures at an aerodrome are obstacles and must be marked in accordance with this Division unless CASA determines otherwise under subsections (3) and (5):*
>
> > *any fixed object or structure, whether temporary or permanent in nature, extending above the obstacle limitation surfaces. Note an ILS building is an example of a fixed object;*
> >
> > *any object or structure on or above the movement area that is removable and is not immediately removed.*
>
> *8.110 Marking of hazardous obstacles*
>
> *(5) long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that:*
>
> > *(a) the darker colour is at the top; and*
> >
> > *(b) the bands:*
> >
> > > *i. are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and*
> > >
> > > *ii. have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of:*
> > >
> > > > *(A) 1/7 of the height of the structure; or*
> > > >
> > > > *(B) 30 m.*

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

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

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

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

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

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

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

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

1) *Medium-intensity obstacle lights must:*
   a) *be visible in all directions in azimuth; and*
   b) *if flashing — have a flash frequency of between 20 and 60 flashes per minute.*
2) *The peak effective intensity of medium-intensity obstacle lights must be 2 000 ☐ 25% cd with a vertical distribution as follows:*
   a) *for* ***vertical beam spread*** *— a minimum of 3 degrees;*
   b) *at -1 degree elevation — a minimum of 50% of the lower tolerance value of the peak intensity;*
   c) *at 0 degrees elevation — a minimum of 100% of the lower tolerance value of the peak intensity.*
3) *For subsection (2),* ***vertical beam spread*** *means the angle between 2 directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity.*
4) *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m² or greater.*

7.2. Overhead transmission line

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

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

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

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

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

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

8. 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.

8.1. 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.

8.2. 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.

8.3. 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 9 (source: ATSB).

Table 9 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 18 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.

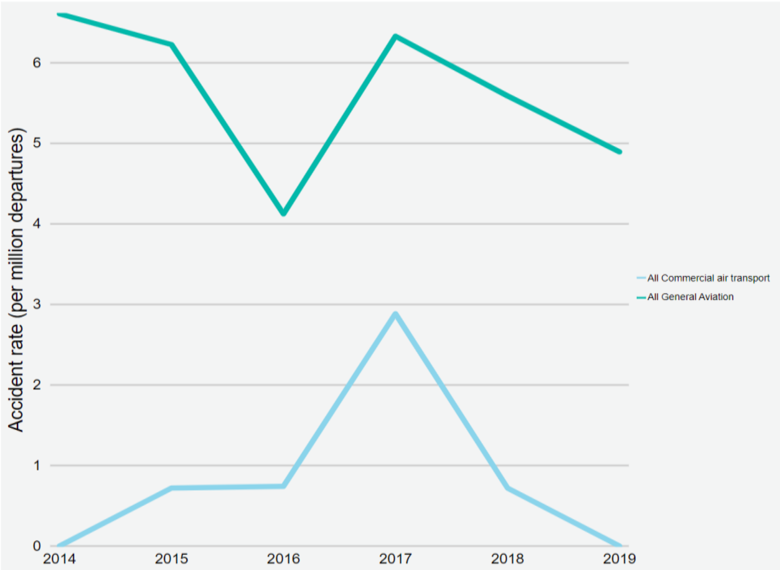

Figure 18 Fatal Accident Rate (per million departures) by Operation Type

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

In 2019, there were 1,760,000 landings, and 1,320,000 hours flown by VH-registered general aviation aircraft in Australia, with 8 fatal accidents and 17 fatalities. Based on these results, in 2019 there were 4.9 fatal accidents per million departures and 6.4 fatal accidents per million hours flown. A summary of fatal accidents from 2010-2019 by GA sub-category is provided in Table 10 (source: ATSB).

Table 10 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.

8.4. Worldwide accidents involving wind farms

Worldwide since aviation accident statistics have been recorded, there have been a total of 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 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 4 recorded aviation accidents involving a wind farm are summarised as follows:

- One accident, which resulted in 2 fatalities, occurred in Palm Springs in 2001. This accident involved a wind farm but was not caused by the wind farm. The cause of the accident was the inflight separation of the majority of the right canard and all of the right elevator resulting from a failure of the builder to balance the elevators per the kit manufacturer's instructions. The accident occurred above a wind farm, and the aircraft struck a WTG on its descent and therefore the cause of the accident was not attributable to the wind farm and not applicable to this AIA.
- Two accidents involving collision with a WTG were during the day, as follows:
    - One accident occurred in Melle, Germany in 2017 as the result of a collision with a WTG mounted on a steel lattice tower at a very low altitude during the day with good visibility and no cloud. The accident resulted in one fatality. If the tower was solid and painted white, as is standard on contemporary wind farms, then it more than likely would have been more visible than if it were to be equipped with an obstacle light which in all likelihood would not have been operating during daylight with good visibility conditions.
    - One accident occurred in Plouguin, France in 2008 when the pilot decided to descend below cloud in an attempt to find the destination aerodrome. The aircraft was flying in conditions of significantly reduced horizontal visibility in fog where the top of the WTGs were obscured by cloud. The WTGs became visible too late for avoidance manoeuvring and the aircraft made contact with two WTGs. The aircraft was damaged but landed safely. No fatalities were recorded.
    - In both of the above cases, it is difficult to conclude that obstacle lighting would have prevented the accidents.
- One fatal accident, near Highmore, South Dakota in 2014 occurred at night in Instrument Meteorological Conditions (IMC).

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

A summary of the 4 accidents is provided in Table 11.

Table 11 Summary of accidents involving collision with a WTG

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

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

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

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

9. 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.**

9.1. Risk Identification

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

Based on an extensive review of accident statistics data (see summary in Section 8 above) and stakeholders who were consulted during the preparation of this AIA (see Section 0), 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 risk events identified here are assessed in detail in the following section.

9.2. 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 12 through to Table 16.

Table 12 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 4 reported occurrences worldwide of aircraft collisions with a component of a WTG structure since the year 2000 as discussed in Section8. These reports show a range of situations where pilots were conducting various flying operations at low level and in the vicinity of wind farms in both IMC and VMC. No reports of aircraft collisions with wind farms in Australia have been found.

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

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

Refer to the discussion of worldwide accidents in Section8.

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

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

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

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

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

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 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 of these accidents resulted from structural failure of the aircraft before the collision with the WTG. Only two relevant accidents occurred during the day, and only one resulted in a single fatality. It is assessed that collision with a WTG resulting in multiple fatalities and damage beyond repair is unlikely to occur.

Untreated Likelihood	Unlikely

Current Treatments (without lighting) • The Project site is clear of the obstacle limitation surfaces (OLS) of any certified aerodrome. • The Project site outside 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 270 m (886 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 117.6 m (386 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 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 above 100 m AGL, there is a statutory requirement to report the WTGs to CASA and notified to Airservices Australia prior to construction.
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8 (Unacceptable).

Current Level of Risk	8 - Unacceptable

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

Risk Decision	Unacceptable

Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Details of the Project should be communicated to local and regional aircraft prior to construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically:

• Engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the WTG blades prior to the commencement of the subject aircraft operations within the Project site. • Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, which would involve notification to Airservices Australia.
Residual Risk With the implementation of the Recommended Treatments listed above, the likelihood of an aircraft collision with a WTG resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 - Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. 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 13 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.

It is proposed to install 10 new WMTs with a maximum height of 150 m (492 ft) AGL in height.

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 wind farm.

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

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

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

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

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

Untreated Likelihood	Possible

Current Treatments

- The temporary and permanent WMT 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 150 m (492 ft), which will be 2 m (8 ft) below the minimum height of 500 ft AGL for an aircraft flying at this height.
- In the event that descending cloud forces an aircraft lower than 152.4 m (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. • If 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 (Temporary WMTs) and WMTs that are not in close proximity to a WTG, should be fitted with a medium intensity steady red obstacle light at the top of the tower to ensure visibility in low light and deteriorated atmospheric conditions. Characteristics of medium-intensity lights are specified in MOS 139 Section 9.33: *5) Medium-intensity obstacle lights must:* *c) be visible in all directions in azimuth; and* *d) if flashing — have a flash frequency of between 20 and 60 flashes per minute.*		

6) *The peak effective intensity of medium-intensity obstacle lights must be 2 000 ± 25% cd with a vertical distribution as follows:* d) *for* **vertical beam spread** *— a minimum of 3 degrees;* e) *at -1 degree elevation — a minimum of 50% of the lower tolerance value of the peak intensity;* f) *at 0 degrees elevation — a minimum of 100% of the lower tolerance value of the peak intensity.* 7) *For subsection (2),* **vertical beam spread** *means the angle between 2 directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity.* 8) *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m² or greater.* • Ensure details of any additional WMTs at the Project site have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction.
Residual Risk With the additional Recommended Treatments listed above, the likelihood of an aircraft collision with a WMT resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. Under these circumstances, the level of risk under the proposed treatment plan is considered **ALARP.** **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the Project 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 14 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 270 m (886 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 117.6 m (386 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 270 m (886ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 117.6 m (386 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs. • The WTGs and masts will be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart. • If cloud descends below the WTG hub, obstacle lighting would be obscured and therefore ineffective. • 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 site.		
Residual Risk With the additional recommended treatments, the likelihood of ground collision resulting from manoeuvring to avoid a wind turbine resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. In the circumstances, the level of risk under the proposed treatment plan is considered **ALARP**. **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a wind turbine, without obstacle lighting on the turbines of the Project.**		
	Residual Risk	7 - Tolerable

Table 15 Effect of the Project on operating crew

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

Discussion

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

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

Consequence

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

Consequence	Minor

Untreated Likelihood

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

Untreated Likelihood	Possible

Current Treatments

- The Project is clear of the OLS of any aerodrome.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas.
- The WTGs and masts will be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart.
- WTGs will be a maximum of 270 m (886 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 117.6 m (386 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 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 WMTs installed prior to WTG installation and those that are not in relatively close proximity to a WTG should be lit to ensure they are visible in low light and deteriorating atmospheric conditions. (see Risk ID: 2) The following additional treatments will provide an additional margin of safety: - Ensure details of the Project WTGs and WMTs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction. - Although there is no requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for such aircraft operations in the vicinity of the Project site.	
Residual Risk Notwithstanding the current level of risk is considered **Tolerable,** the additional Recommended Treatments listed above will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **Tolerable.** **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew, without obstacle lighting on the Project WTGs and Permanent WMTs in close proximity to a WTG, and with obstacle lighting for temporary WMTs installed prior to WTG installation and WMTs that are not in close proximity to a WTG.**	
Residual Risk	5 – Tolerable

Table 16 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. For temporary WMTs installed prior to WTG installation and WMTs that are not in close proximity to a WTG, obstacle lighting is recommended to ensure visibility in low light and deteriorating atmospheric conditions. If CASA or a planning authority decide that obstacle lighting is required there are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours, including: • reducing the number of WTGs with obstacle lights • specifying an obstacle light that minimises light intensity at ground level • specifying an obstacle light that matches light intensity to meteorological visibility • mitigating light glare from obstacle lighting through measures such as baffling. These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to residents within and around the Project site. Consideration may be given to activating the obstacle lighting via a pilot activated lighting system. An option is to consider using Aircraft Detection Lighting Systems (referred in the United States Federal Aviation Administration Advisory Circular AC70/7460-1L CHG1 – *Obstruction Marking and Lighting*). Such a system would only activate the lights when an aircraft is detected in the near vicinity and deactivate the lighting once the aircraft has passed. This technology reduces the impact of night lighting on nearby communities and migratory birds and extends the life expectancy of obstruction lights.
Residual Risk Not installing obstacle lights would clearly be an acceptable outcome to those potentially affected by visual impact. If lighting is required, consideration of visual impact in the lighting design should enable installation of lighting that reduces the impact to neighbours. The likelihood of a **Moderate** consequence remains **Likely**, with a resulting risk level of **7 – Tolerable**. **It is our assessment that visual impact from obstacle lights can be negated if they are not installed.** If obstacle lights are to be installed, they can be designed so that there is an acceptable risk of visual impact to neighbours.

Residual Risk	7 - Tolerable

10. CONCLUSIONS

The key conclusions of this AIA are summarised as follows:

10.1. 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.

10.2. Aviation Impact Statement

Based on the proposed Project WTG layout and maximum blade tip height of 270 m AGL, the highest wind turbine (WTG EE115) will not exceed 364.5 m (1195.78 ft AMSL).

The Project site WTGs:

- Would not infringe any OLS surfaces
- Would not infringe any circling areas
- Would infringe the Hay Airport's 25 nm and 10 nm MSA surfaces but can be mitigated
- Would infringe the Hay Airport RNP RWY 04 PANS-OPS surface but can be mitigated
- Would not infringe the Hay Airport RNP RWY 22
- Would not have an impact on operations of nearby ALAs
- Would infringe the Grid LSALT but can be mitigated
- Would infringe the following air route LSALT – Q60, H247and W466, but can be mitigated
- Would be outside the clearance zones associated with civil aviation navigation aids and communication facilities.
- Would be located outside of controlled airspace (wholly within Class G airspace) and not located in any Prohibited, Restricted or Danger areas.
- Would not impact on the closest ATC radar installations
- Must be reported to CASA and construction details provided to Airservices.

10.3. Aircraft operator characteristics

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

Aircraft flying at night in visual conditions are permitted to descend or climb to or from an appropriate minimum altitude when within 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.

10.4. Hazard marking and lighting

The following conclusions apply to hazard marking and lighting:

- With respect to CASR Part 139 Division 139.E.1 Notifying potential hazards 139.165, the proposed WTGs and WMTs must be reported to CASA. WTGs and WMTs must be marked in accordance with Part 139 MOS 2019 Chapter 8 Division 10 section 8.110
- 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 resident
- Temporary and permanent WMTs should be marked according to the requirements set out in Manual of Standards (MOS) 139 Section 8.10 (as modified by the guidance in NASF Guideline D). Aviation marker balls and painting the top 1/3 of WMTs structures in red and white bands is considered to be an acceptable mitigation strategy.
- WMTs that are installed prior to WTG installation, and WMTs that are not in close proximity to a WTG, will require obstacle lighting to maintain an acceptable level of safety. These WMTs should be lit with medium intensity steady red obstacle lighting at the top of the WMT mast. Characteristics of medium intensity obstacle lighting in MOS 139, Section 9.33.

10.5. Summary of risks

A summary of the level of residual risk associated with the Project with the Recommended Treatments implemented, is provided in Table 17.

Table 17 Summary of Residual Risks

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

11. RECOMMENDATIONS

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

Notification and reporting

1. 'As constructed' details of WTG and WMT exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. 'As constructed' details of WTG and WMT coordinates and elevation should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
    a. The planned operational timeframe and maximum height of the crane; and
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
4. Details of the wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations.
5. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs, WMTs and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Marking of WTGs

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.

Lighting of WTGs

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

Marking of wind monitoring towers

8. Consideration should be given to marking the temporary and permanent WMTs according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D). Specifically:
    a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires
    b. paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast
    c. ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation.

Lighting of WMTs

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

Micrositing

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

Overhead transmission line

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

Triggers for review

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

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

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

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

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 21 March 2024
- Hay Local Environmental Plan 2011
- Deniliquin Local Environmental Plan 2013
- 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 1.5, dated March 2016
- Civil Aviation Safety Authority, *Part 139 (Aerodromes) Manual of Standards 2019*, dated 5 September 2019
- Civil Aviation Safety Authority, Advisory Circular 139.E-01 v1.0—Reporting of Tall Structures , dated December 2021
- Civil Aviation Safety Authority, Advisory Circular (AC) 139.E-05 v1.0 Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome
- Department of State Development, Infrastructure and Planning, QLD State Government, Development Assessment mapping system and State Planning Policy Planning interactive mapping system
- Department of State Development, Infrastructure and Planning, QLD State Government, State Development Assessment Provisions (SDAP), State Code 23: Wind Farm Development and State Code 23: Wind farm development Planning Guideline (June 2018), SDAP version 3.0, date of commencement 04 February 2022
- Department of Infrastructure and Regional Development, Australian Government, National Airport Safeguarding Framework, Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*, dated June 2013
- 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 March 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/m^2 or greater.*

Visual impact of night lighting

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

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

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

Marking of WTGs

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

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

Wind monitoring towers

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

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

8.110 Marking of Hazardous Obstacles

(5) As illustrated in Figure 8.110 (5), long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that the darker colour is at the top; and the bands are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of: 1/7 of the height of the structure; or 30 m.

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

(8) The objects mentioned in subsection (7) must:
(a) be approximately equivalent in size to a cube with 600 mm sides; and
(b) be spaced 30 m apart along the length of the wire or cable.

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

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

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

Overhead transmission lines

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

8.110 Marking of hazardous obstacles

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

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

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

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

ANNEXURE 4 – RISK FRAMEWORK

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

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

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

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

Likelihood

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

Table 1 Likelihood Descriptors

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

Consequence

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

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

Table 2 Consequence Descriptors

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

Risk matrix

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

Table 3 Risk Matrix

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

Actions required

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

Table 4 Actions Required

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

ANNEXURE 5 – PROJECT TURBINE COORDINATES AND HEIGHTS

Reference file: WTG Layout Rev13 188WTGs 20230925 Elevation Data.xlsx

Name	*X*	*Y*	*Terrain elevation (m AHD)*	*WTG Height AGL (m)*	*Maximum Height (m AHD)*	*Maximum Height (ft AMSL)*
AW01	285826	6141727	83.72	270	353.72	1160.51
AW02	286596	6141739	84.17	270	354.17	1161.97
AW03	287396	6141800	84.34	270	354.34	1162.53
AW04	288136	6141765	84.53	270	354.53	1163.16
AW05	288854.6192	6141918.517	85.05	270	355.05	1164.87
AW06	290240	6141807	84.92	270	354.92	1164.44
AW07	291020	6141811	85.08	270	355.08	1164.97
AW08	291800	6141816	85.42	270	355.42	1166.08
AW09	292580	6141820	85.81	270	355.81	1167.35
AW10	293346	6141830	85.91	270	355.91	1167.68
AW11	294096	6141835	85.93	270	355.93	1167.76
BW02	287054	6143972	84.76	270	354.76	1163.92
BW03	287874	6143970	84.85	270	354.85	1164.21
BW04	288694	6143968	85.15	270	355.15	1165.18
BW05	289514	6143966	85.78	270	355.78	1167.26
BW06	290324	6143998	85.92	270	355.92	1167.71
BW07	291110	6144024	86.02	270	356.02	1168.03
BW08	291794.7259	6143976.496	86.01	270	356.01	1168.00
BW09	292808	6143754	85.83	270	355.83	1167.43
BW10	293723.2618	6144117.342	86.15	270	356.15	1168.46
BW11	294583.3787	6144400.343	86.67	270	356.67	1170.17
BW12	295341	6144425	86.79	270	356.79	1170.58
CE01	297894	6147075	87.91	270	357.91	1174.25
CE02	298705	6147118	87.96	270	357.96	1174.42
CE03	299515.8223	6147303.831	88.03	270	358.03	1174.63

Name	X	Y	Terrain elevation (m AHD)	WTG Height AGL (m)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
CE04	300196	6147067	88.21	270	358.21	1175.24
CE05	301044	6147018	88.43	270	358.43	1175.95
CE06	301893	6146969	88.74	270	358.74	1176.95
CE07	302742	6146920	89.43	270	359.43	1179.23
CE08	303590	6146870	90.22	270	360.22	1181.82
CE09	304439	6146821	89.93	270	359.93	1180.86
CE10	305287	6146772	90.06	270	360.06	1181.31
CE11	306416	6146274	90.05	270	360.05	1181.27
CE12	307379	6146395	90.66	270	360.66	1183.26
CE13	309069.3013	6146863.631	91.64	270	361.64	1186.49
CE14	309857.0016	6146748.597	92.24	270	362.24	1188.45
CE15	310588.1227	6146700.64	92.12	270	362.12	1188.05
CW02	287282	6146230	84.60	270	354.60	1163.37
CW03	288122	6146265	84.73	270	354.73	1163.81
CW04	288961	6146300	84.91	270	354.91	1164.40
CW05	289800	6146334	85.44	270	355.44	1166.13
CW06	290571	6146269	86.11	270	356.11	1168.34
CW07	291389	6146312	86.30	270	356.30	1168.97
CW08	292208	6146355	87.73	270	357.73	1173.67
CW09	293027	6146397	86.76	270	356.76	1170.47
CW10	293837	6146448	86.91	270	356.91	1170.97
CW11	294676.265	6146464.878	87.18	270	357.18	1171.84
DE01	298150	6149305	88.11	270	358.11	1174.91
DE02	298923	6149408	89.31	270	359.31	1178.83
DE03	299703	6149510	89.05	270	359.05	1177.97
DE04	300431.7513	6149808.024	89.26	270	359.26	1178.67
DE05	301629.904	6149824.877	89.38	270	359.38	1179.07
DE06	302164	6149516	89.40	270	359.40	1179.14
DE07	302957	6149452	89.39	270	359.39	1179.09

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Name	*X*	*Y*	*Terrain elevation (m AHD)*	*WTG Height AGL (m)*	*Maximum Height (m AHD)*	*Maximum Height (ft AMSL)*
DE08	303749	6149389	90.50	270	360.50	1182.75
DE09	304542	6149325	91.01	270	361.01	1184.41
DE10	305349	6149409	90.85	270	360.85	1183.88
DE11	306135	6149292	90.69	270	360.69	1183.37
DE12	306941	6149209	90.58	270	360.58	1183.02
DE13	307708	6149058	91.01	270	361.01	1184.40
DE14	308495	6148941	91.39	270	361.39	1185.65
DE15	309281	6148824	91.57	270	361.57	1186.24
DE16	310066.6198	6148983.35	92.60	270	362.60	1189.62
DE17	310753.9453	6149170.562	93.02	270	363.02	1191.02
DE18	311799.7208	6149465.242	93.58	270	363.58	1192.86
DW02	287491	6148336	83.66	270	353.66	1160.29
DW03	288337	6148420	83.56	270	353.56	1159.98
DW04	290114.6805	6148826.912	85.41	270	355.41	1166.05
DW05	290913	6148834	86.12	270	356.12	1168.38
DW06	291732	6148816	85.97	270	355.97	1167.88
DW07	292552	6148797	85.85	270	355.85	1167.49
DW08	293393	6148734	85.84	270	355.84	1167.46
DW09	294209	6148812	86.07	270	356.07	1168.22
DW10	295026	6148890	86.61	270	356.61	1169.96
DW11	295842	6148968	87.61	270	357.61	1173.25
EE01	298981	6152391	90.25	270	360.25	1181.93
EE02	299795	6152293	90.24	270	360.24	1181.88
EE03	300609	6152195	91.31	270	361.31	1185.38
EE04	301423	6152096	90.48	270	360.48	1182.68
EE05	302238	6151998	90.30	270	360.30	1182.10
EE06	303052	6151899	90.74	270	360.74	1183.53
EE07	303866	6151801	90.78	270	360.78	1183.67
EE09	306217	6152128	92.11	270	362.11	1188.01

Name	X	Y	Terrain elevation (m AHD)	WTG Height AGL (m)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
EE10	306851	6151863	92.03	270	362.03	1187.78
EE11	307585	6151796	92.22	270	362.22	1188.40
EE12	308338	6151721	92.64	270	362.64	1189.77
EE13	309032	6151577	93.09	270	363.09	1191.23
EE14	310234	6151557	93.63	270	363.63	1193.02
EE15	311193	6151515	94.48	270	364.48	1195.78
EE16	312561.3229	6151613.202	93.41	270	363.41	1192.29
EW01	286988	6150635	83.75	270	353.75	1160.59
EW02	287855	6150748	84.72	270	354.72	1163.78
EW03	288652	6150757	84.39	270	354.39	1162.69
EW04	289422	6150690	84.92	270	354.92	1164.43
EW05	290825.4546	6150572.778	85.86	270	355.86	1167.52
EW06	291370.7457	6151260.318	86.43	270	356.43	1169.40
EW07	292184	6151207	86.65	270	356.65	1170.12
EW08	293056	6151299	86.91	270	356.91	1170.95
EW09	293790	6151286	87.17	270	357.17	1171.81
EW10	294596	6151343	87.71	270	357.71	1173.59
EW11	295374	6151379	88.27	270	358.27	1175.44
FE02	300200	6156108	90.93	270	360.93	1184.16
FE03	300944	6156008	91.18	270	361.18	1184.97
FE04	301687	6155909	91.76	270	361.76	1186.87
FE05	302430	6155809	92.02	270	362.02	1187.71
FE06	303174	6155709	92.24	270	362.24	1188.46
FE07	303893	6155632	92.33	270	362.33	1188.74
FE08	304628	6155478	92.41	270	362.41	1189.00
FE09	305221.2808	6155112.204	92.58	270	362.58	1189.58
FE10	305889	6154928	92.68	270	362.68	1189.89
FE11	306689	6154925	92.80	270	362.80	1190.29
FE12	307552	6154916	93.66	270	363.66	1193.11

Name	*X*	*Y*	*Terrain elevation (m AHD)*	*WTG Height AGL (m)*	*Maximum Height (m AHD)*	*Maximum Height (ft AMSL)*
FE13	308347	6154829	93.78	270	363.78	1193.51
FE14	309151.9481	6154318.843	93.60	270	363.60	1192.91
FE15	309938	6154655	93.23	270	363.23	1191.70
FE16	310733	6154568	93.61	270	363.61	1192.95
FE17	311528	6154481	93.91	270	363.91	1193.91
FW01	286436	6153339	85.20	270	355.20	1165.35
FW02	287409	6153411	85.76	270	355.76	1167.18
FW03	288431.5574	6153839.963	86.02	270	356.02	1168.03
FW04	289078	6153520	86.31	270	356.31	1169.00
FW07	291471.4909	6153315.065	87.12	270	357.12	1171.65
FW08	292549	6154173	87.36	270	357.36	1172.44
FW09	293372	6154161	87.88	270	357.88	1174.13
FW10	294150.533	6154318.066	88.33	270	358.33	1175.62
FW11	294908	6153969	88.36	270	358.36	1175.73
FW12	296086	6153901	89.45	270	359.45	1179.31
GE01	300676	6158306	90.61	270	360.61	1183.10
GE02	301496	6158406	91.37	270	361.37	1185.58
GE03	302322	6158479	91.97	270	361.97	1187.57
GE04	303055	6158427	92.13	270	362.13	1188.07
GE05	303833	6158389	92.13	270	362.13	1188.09
GE06	304637	6158195	92.03	270	362.03	1187.76
GE07	305438	6158083	92.34	270	362.34	1188.78
GW01	286826.5357	6155690.667	84.85	270	354.85	1164.21
GW02	287710.803	6155619.415	85.02	270	355.02	1164.78
GW03	288472	6155680	85.31	270	355.31	1165.71
GW04	289564	6156361	85.62	270	355.62	1166.74
GW05	290404	6156469	85.76	270	355.76	1167.19
GW06	291203	6156523	86.13	270	356.13	1168.42
GW07	291985	6156602	86.58	270	356.58	1169.90

Name	X	Y	Terrain elevation (m AHD)	WTG Height AGL (m)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
GW08	292696	6156525	87.20	270	357.20	1171.93
GW09	293548	6156742	87.21	270	357.21	1171.93
GW10	294286.0119	6156729.962	87.73	270	357.73	1173.65
GW11	295037	6156658	88.46	270	358.46	1176.04
GW12	295716	6156492	88.91	270	358.91	1177.51
GW13	296503.3171	6156452.959	90.03	270	360.03	1181.19
GW14	297342.1343	6156622.782	89.76	270	359.76	1180.31
GW15	298304	6157211	90.42	270	360.42	1182.49
HE02	301591	6160576	92.07	270	362.07	1187.90
HE03	302414	6160624	92.50	270	362.50	1189.30
HE04	303347	6160959	91.73	270	361.73	1186.77
HE05	304069	6160782	91.85	270	361.85	1187.16
HE06	304933	6160833	92.06	270	362.06	1187.87
HE07	305732	6160744	92.16	270	362.16	1188.19
HW01	286371.09	6159261.053	84.93	270	354.93	1164.48
HW02	287126.1541	6159170.865	85.35	270	355.35	1165.83
HW03	288167.0774	6159160.794	85.03	270	355.03	1164.80
HW04	288860.9873	6159149.669	85.28	270	355.28	1165.61
HW05	289980.522	6158850.424	85.69	270	355.69	1166.95
HW06	290663	6159173	85.93	270	355.93	1167.76
HW07	291614	6159429	86.18	270	356.18	1168.55
HW08	292407	6159429	86.70	270	356.70	1170.29
HW09	293162	6159366	87.36	270	357.36	1172.45
HW10	293985	6159319	87.66	270	357.66	1173.41
HW11	294707	6159222	87.75	270	357.75	1173.70
HW12	295488	6159262	89.17	270	359.17	1178.37
HW13	296405	6159551	88.79	270	358.79	1177.12
HW14	297235	6159667	89.27	270	359.27	1178.70
HW15	297989	6159672	89.37	270	359.37	1179.04

Name	*X*	*Y*	*Terrain elevation (m AHD)*	*WTG Height AGL (m)*	*Maximum Height (m AHD)*	*Maximum Height (ft AMSL)*
HW16	298759	6159692	89.83	270	359.83	1180.55
HW17	287043.1437	6157273.104	84.94	270	354.94	1164.49
HW18	287809.335	6157201.835	85.13	270	355.13	1165.13
HW19	288583.0922	6157123.793	85.33	270	355.33	1165.77
IE01	301295.3025	6163439.286	91.89	270	361.89	1187.29
IE02	302024.4441	6163435.643	91.57	270	361.57	1186.25
IE03	302865.1918	6163563.123	92.00	270	362.00	1187.68
IE04	303622.5059	6163485.898	91.87	270	361.87	1187.23
IE05	304641.1199	6163381.95	92.16	270	362.16	1188.19
IE06	305511.9808	6163091.247	93.15	270	363.15	1191.42
IW09	292634	6161989	87.50	270	357.50	1172.89
IW10	293407	6161907	87.65	270	357.65	1173.40
IW11	294262	6161867	88.26	270	358.26	1175.38
IW12	295283	6162196	88.89	270	358.89	1177.47
IW13	296321	6162407	89.27	270	359.27	1178.71
IW14	297169	6162368	89.44	270	359.44	1179.27
IW15	298148	6162462	89.63	270	359.63	1179.90
IW16	299055	6162656	89.78	270	359.78	1180.39

ANNEXURE 6 – WIND MONITORING TOWERS - COORDINATES AND HEIGHTS

Reference file: ThePlains_WSPMonitoringLocations_RevB_UTM55S.csv.

Mast	*Easting*	*Northing*	*Ground elevation m AHD*	*Mast Height m (ft) AMSL*
0	308945.0215	6152739.445	95 m	245 m (804 ft)
1	287431.6323	6142596.691	84 m	234 m (768 ft)
2	295535.8953	6158882.179	90 m	240 m (788 ft)
3	301030.0002	6150289.393	87 m	237 m (778 ft)
4	303139.6039	6159156.249	90 m	240 m (788 ft)
5	288749.8911	6156803.948	85 m	235 m (771 ft)
LiDAR 1 & MAST 1	294228.5566	6142880.561	86 m	236 m (774 ft)
7	291827.0947	6149512.753	86 m	236 m (774 ft)
8	307269.0517	6147975.15	89 m	239 m (785 ft)
LIDAR 3	290788.7061	6162385.813	91 m	241 m (791 ft)

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