AUG 2024

AVIATION IMPACT ASSESSMENT

THEODORE WIND FARM

Prepared for ERM

DOCUMENT CONTROL

Document Title: Theodore Wind Farm – Aviation Impact Assessment

Reference: 100512-01

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Reviewed by: P White/B O'Connor

Released by: L Wang

REVISION HISTORY

Version	Description	Transmitted	Reviewed by	Date
0.1	First draft	12 July 2023		
0.2	Updated layout	06 February 2024		
0.3	Updated report	23 February 2024	Jack Petrakis	9 May 2024
0.4	Draft Final	03 July 2024	Sophie Allan	03 July 2024
0.5	Revised Draft Final	03 July 2024		
1.0	Final Report	07 August 2024		

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AVIATION PROJECTS

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ACRONYMS

AAAA	Aerial Application Association of Australia
AC	Advisory Circular
AFAC	Australasian Fire and Emergency Services Council
AGL	above ground level
AHD	Australian Height Datum
AIA	aviation impact assessment
AIP	Aeronautical Information Package
AIS	aviation impact statement
ALA	aircraft landing area
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
AS	Australian Standards
AsA	Airservices Australia
ATSB	Australian Transport Safety Bureau
BoM	Bureau of Meteorology
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

Theodore Energy Development (TED) (The Proponent) is proposing to develop the Theodore Wind Farm (the Project) in Central Queensland, located approximately 22 km east of the township of Theodore, within the Banana Shire Council local government area.

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.

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

- Queensland Government State Development Assessment Provisions, Queensland State Code 23: Wind farm development and the associated Planning Guideline
- 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 and the Civil Aviation Safety Authority.

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

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

Project description

The Theodore Wind Farm includes the following:

- A maximum of 170 wind turbine generators (WTGs) with a maximum tip height of 270 m above ground level (AGL). The elevation of the highest wind turbine, which is WTG 113, will not exceed 776.9 m (2548.9 ft AMSL).
- WTG foundations and hardstand areas;
- Temporary infrastructure such as concrete batching plants, laydown areas and site accommodation;
- Access tracks, underground cabling and overhead transmission lines;
- Electrical connections and substations;
- Potential Battery Energy Storage System (BESS);
- Permanent meteorological masts; and
- Central operational and maintenance facility

Conclusions

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

Planning considerations

1. The Project as proposed satisfies the planning provisions of Banana Shire Council and will not create incompatible intrusions or compromise the safety of existing airports and associated navigation and communication facilities.

Certified airports

2. The project site is located within 30 nm (55.56 km) of two certified airports –Theodore Airport (YTRD) and Thangool Airport (YTNG).
3. Theodore Airport (YTRD):
    a. The WTGs will not impact on the circling areas.
    b. The WTGs will impact both 10 nm and 25 nm MSA surfaces.
        i. The 10 nm MSA will need to be increased by 500 ft to 3400 ft.
        ii. The 25 nm MSA will need to be increased by 400 ft to 3600 ft or sectorized for the wind farm area.
    c. The WTGs will not impact PANS-OPS surfaces. However due to requirement of increasing the 25 nm MSA to 3600 ft the minimum altitudes in some segments of the instrument approaches will need to be increased.
4. Thangool Airport (YTNG):
    d. The WTGs will not impact on the circling areas.
    e. The WTGs will not impact the MSA surfaces.
    f. The WTGs will not impact PANS-OPS surfaces.

Obstacle Limitation Surfaces

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

Aircraft Landing Areas (ALAs)

6. There is no aircraft landing area (ALA) identified within 3 nm of the project site.

Air Routes and Lowest Safe Altitude (LSALT)

7. The WTGs will not impact the Grid LSALT related to the project area.
8. The WTGs will impact air route LSALT – W186, which will need to be increased by 200 ft to 3600 ft.
9. The WTGs will impact air route LSALT – UY409, which will need to be increased by 300 ft to 3600 ft.

Airspace

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

Aviation Facilities

11. The WTGs will not penetrate any protection areas associated with aviation facilities.

Radar

12. The project site is located outside of the Area of Interest for assessment of potential impact from the development on surveillance radar. The Project will not impact the Mt Alma route surveillance radar (RSR).

Aviation Impact Statement (AIS)

13. Based on the proposed WTG layout and maximum blade tip height of 270 m AGL, the blade tip elevation of the highest wind turbine, which is WTG 113, will not exceed 776.9 m (2548.9 ft AMSL. The Project WTGs:

    a) Will not penetrate OLS surfaces of any certified airport.

    b) Will not impact on circling areas of any certified airport.

    c) Theodore Airport (YTDR):

        a. Will impact both 10 nm and 25 nm MSA surfaces:

            i. The 10 nm MSA will need to be increased by 400 ft to 3300 ft.

            ii. The 25 nm MSA will need to be increased by 400 ft to 3600 ft or sectorised for the wind farm area.

        b. Will not impact PANS-OPS surfaces. However due to the requirement of increasing the 25 nm MSA to 3600 ft the minimum altitudes in some segments would need to be increased.

    d) Thangool Airport (YTNG):

        a. The WTGs will not impact the MSA surfaces.

        b. The WTGs will not impact PANS-OPS surfaces.

    e) There is no aircraft landing area (ALA) identified within 3 nm of the project site.

    f) The WTGs will impact airspace Grid LSALT – Grid 3300 ft LSALT will need to be increased by 100 ft to 3400ft.

    g) Will impact air route LSALT – W186, which will need to be increased by 200 ft to 3600 ft.

    h) Will impact air route LSALT – UY490, which will need to be increased by 200 ft to 3500 ft.

    i) Will be wholly contained within Class G airspace.

    j) Will be outside the clearance zones associated with civil aviation navigation aids and communication facilities.

    k) Will be outside the stated range of ATC radar systems.

Obstacle lighting risk assessment

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

15. Over the 12-year period between 2010-2022, no aircraft collided with a WTG or a WMT in Australia.

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

Consultation

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

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

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

Summary of key recommendations

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

Notification and reporting

1. Details of WTGs exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. 'As constructed' details of WTG coordinates and elevation should be provided to Airservices Australia, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
    a. The planned operational timeframe and maximum height of the crane; and
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
4. Details of the Project should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations.
5. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Marking of WTGs and WMTs

6. The rotor blades, nacelle and the supporting mast of the WTGs should be painted white, typical of most WTGs operational in Australia. No additional marking measures are required for WTGs.
7. It is not mandatory to mark the WMTs, however the following markings are recommended to be implemented in consideration of potential day VFR aerial work operations in accordance with NASF Guideline D:
    a. obstacle marking for at least the top 1/3 of the mast and be painted in alternating contrasting bands of colour

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

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

Lighting of WTGs and WMTs

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

9. Aviation Projects considers that the mast will require an obstacle light installed at the top to ensure aviation safety standards are met.

Micrositing

10. Providing the micrositing is within 100 m of the WTGs, it will not likely result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Triggers for review

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

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

    b. following any significant changes to the context in which the assessment was prepared

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

Aerial firefighting

12. The developer or operator should ensure that:

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

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

    c. wind turbines are shut down immediately during emergency operations – where possible, blades should be stopped in the 'Y' or 'rabbit ear' position, as this positioning allows for the maximum airspace for aircraft to manoeuvre underneath the blades and removes one of the blades as a potential obstacle.

1. INTRODUCTION

1.1. Situation

Theodore Energy Development (TED) (The Proponent) is proposing to develop the Theodore Wind Farm (the Project), in Central Queensland, located approximately 22 km east of the township of Theodore, within the Banana Shire Council local government area.

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.

1.2. Purpose and Scope

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

The 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*
- Queensland State Code 23: *Wind farm development (State Code 23)* of the State Development Assessment Provisions –effective February 2022, specifically Performance Outcomes PO1 and PO2
- Civil Aviation Safety Authority (CASA) MOS Part 139.

1.3. Methodology

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

- Confirm the scope and deliverables with the Proponent (or representative).
- Review client material.
- Review relevant regulatory requirements and information sources.
- Prepare a draft AIA and supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified.
- Prepare an AIS and a qualitative risk assessment to determine need for obstacle lighting and marking.
- Identify risk mitigation strategies that provide an acceptable alternative to night lighting. The risk assessment was completed following the guidelines in *ISO 31000:2018 Risk Management – Guidelines.*
- Consult with relevant Council/s, Part 173 procedure designers (Airservices Australia) and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable).
- Consult/engage with stakeholders to negotiate acceptable outcomes (if required).
- Finalise the AIA report for client acceptance once responses received from stakeholders for client review and acceptance.

1.4. Aviation Impact Statement (AIS)

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

Aerodromes:

- Specify all certified aerodromes that are located within 30 nm (55.6 km) of the project site.
- Nominate all instrument approach and landing procedures at these aerodromes.
- Review the potential effect of project operations on the operational airspace of the aerodrome(s).

Air Routes:

- Nominate air routes published in ERC-L & ERC-H which are located near/over the project site and review potential impacts of project operations on aircraft using those air routes.

Airspace:

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

Navigation/Radar:

- Nominate air traffic control radar with coverage overlapping the project site.
- Nominate aviation navigation systems in proximity to the project site.

1.5. Material reviewed

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

- THWF_LAY_20231117.zip
- THWF_LAY_20231117-b_Coordinates_GDA94-MGA56 (1).xlsx
- Theodore Preliminary Mast Locations 20221201.zip

2. BACKGROUND

2.1. Site overview

The project site boundary is approximately 22 km east of Theodore in Central QLD.

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

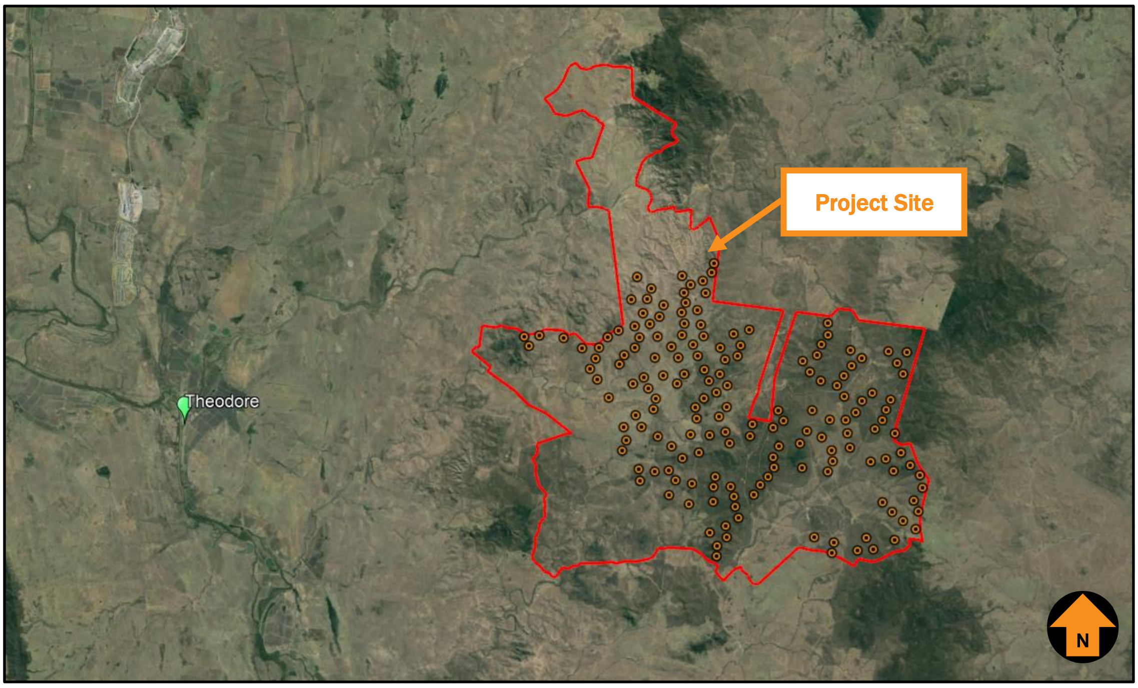


Figure 1 Project site overview

2.2. Project Description

The Project involves the construction, operation, maintenance and decommissioning of the Theodore Wind Farm, including a final layout of up to 170 wind turbine generators (WTGs) with associated electrical and ancillary infrastructure.

The WTGs will have a rotor diameter of approximately 175 m, with a maximum tip height of 270 m AGL. And three wind monitoring towers were installed.

Three WMTs will be installed within Theodore Wind Farm, which with a maximum height of 160 m above ground level (AGL).

3. EXTERNAL CONTEXT

3.1. National Airports Safeguarding Framework

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

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

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

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

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

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

3.2. Department of State Development, Infrastructure, Local Government and Planning

The Department of State Development, Infrastructure, Local Government and Planning released the State Development Assessment Provisions (SDAP), February 2022.

SDAP sets out the matters of interest to the state for development assessment, where the Director-General of the department is responsible for assessing or deciding development applications. State Code 23 addresses wind farm development.

The code applies to a material change of use for a new or expanding wind farm. The purpose of State Code 23 is:

- To protect individuals, communities, and the environment from adverse impacts as a result of the construction, operation and decommissioning of wind farm development.

- Wind farms should be appropriately located, sited, designed, and operated to ensure the safety, operational integrity and efficiency of air services and aircraft operations.

State Code 23 contains Performance Outcomes (PO) and Acceptable Outcomes (AO). PO1 and PO2 and associated Acceptable Outcomes address aviation safety, integrity and efficiency and are provided in Table 1.

Table 1 State Code 23 - Aviation safety, integrity, and efficiency for Material Change of Use

Performance outcomes	*Supporting Action (demonstrates compliance)*
PO1 – Development does not adversely affect the safety, operational integrity and efficiency of air services and aircraft operations as a result of its: • location • siting • design • operation	• No acceptable outcome is prescribed
PO2 – Development includes lighting and marking measures to ensure the safety, operational integrity and efficiency of air services and aircraft operations.	• No acceptable outcome is prescribed

Based on performance outcomes PO1 and PO2, the following actions will support an application in demonstrating compliance with State Code 23 addressing aviation safety, integrity and efficiency:

- Demonstrate all potential risks to air services have been identified.
- Provide evidence from a suitably qualified aerodrome consultant / specialist that the development will not adversely affect the safety, operational integrity, and efficiency of air services.

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

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

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

3.3. Banana Shire Council

The Banana Shire Planning Scheme 2021 does not specify specific performance outcomes for Air Services related development but states a requirement that new development does not compromise aircraft safety or airport operations for Taroom, Thangool and Theodore Airports.

3.4. Civil Aviation Safety Authority (CASA)

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

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

This Advisory Circular (AC) provides guidance for pilots of:

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

Purpose

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

2 Introduction

2.2 Use of Aerodromes

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

3.3 Performance Information

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

4 Information about aerodrome publications

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

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

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

4.2.4 The examples below are two of many possible considerations:

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

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

5 Permission to operate

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

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

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

2 Introduction

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

4 Related safety actions at non-controlled aerodromes

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

7.2 Traffic circuit direction

7.2.1 The standard aerodrome traffic circuit facilitates the orderly flow. Unless an alternative requirement for an aerodrome is stated in the ERSA or NOTAMs, all turns must be made to the left (regulation 91.385).

7.2.2 When arriving at an aerodrome to land, the pilot will normally join the circuit on upwind, crosswind (midfield), or at or before mid-downwind. Landings and take-offs should be made on the active runway or the runway most closely aligned into wind.

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

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

7.4 Circuit Heights

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

7.4.2 During initial climb-out, the turn onto crosswind should be appropriate to the performance of the aircraft but, in any case, not less than 500 ft above terrain so as to be at circuit height when turning downwind (regulation 91.390). Pilots may vary the size of the circuit depending on:

– the performance of the aircraft

– AFM/Pilot's Operating Handbook requirements

– company standard operating procedures

– other safety reasons.

7.7 Final approach

7.7.1 The turn onto final approach should be:

– completed by a distance and height that is common to all operations at the aerodrome

– commensurate with the speed flown in the circuit for all aircraft of the same type.

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

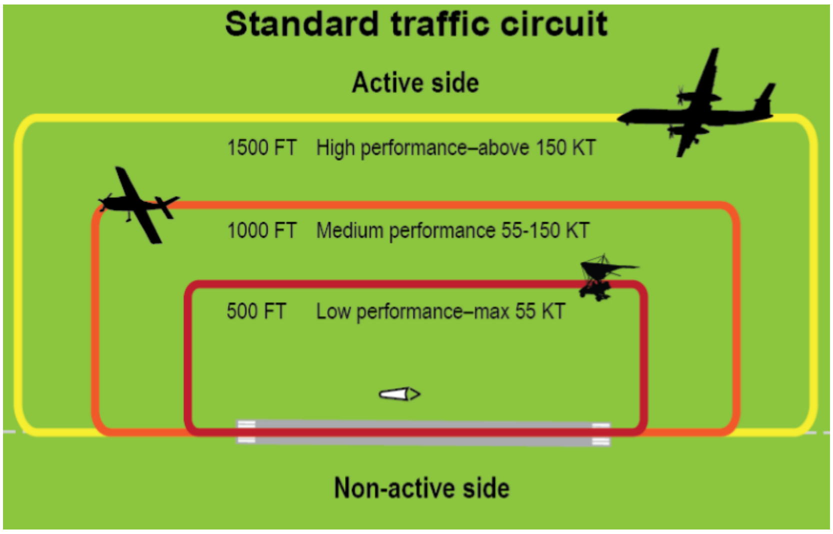


Figure 2 Lateral and vertical separation in the standard aerodrome traffic circuit

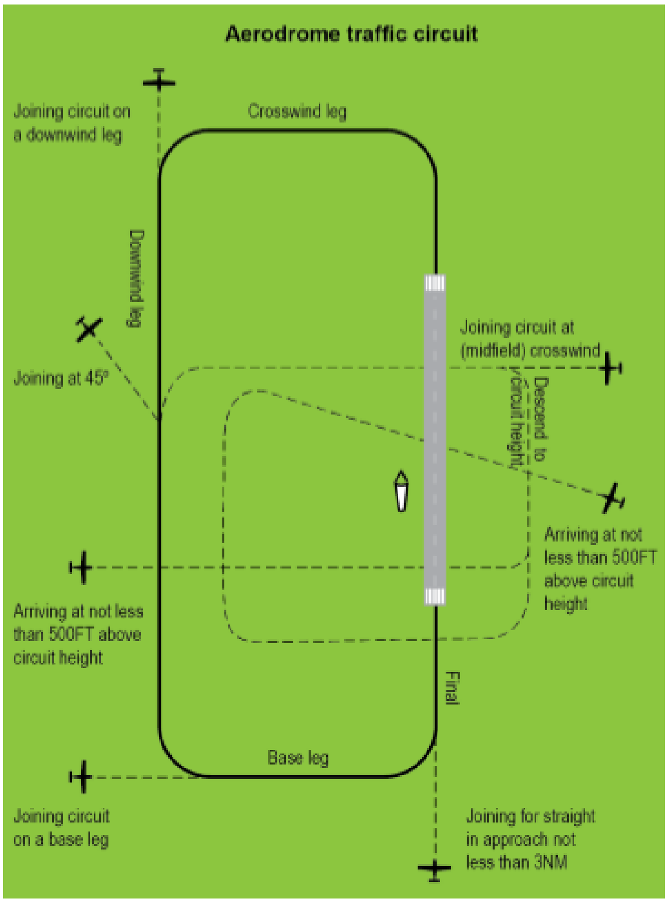


Figure 3 Aerodrome standard traffic circuit, showing arrival and joining procedures.

AC 91-10 v1.1. paragraph 7.10 refers to a distance that is “normally” well outside the circuit area and where no traffic conflict exists, which is at least 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. Aircraft operations at non-controlled aerodromes

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

3.6. Rules of flight

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

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

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

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

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

3.6.2. 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.*

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

According to CASR 91, flight under the instrument flight rules (IFR) requires an aircraft to be operated at a height clear of obstacles that is calculated according to an approved method.

Obstacle lights on structures not within the vicinity of an aerodrome are effectively redundant to an aircraft being operated under the IFR.

3.7. Aircraft operator characteristics

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

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

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

It is expected that the proposed WTGs will be sufficiently visually conspicuous to pilots conducting VFR operations within the vicinity of the project area to enable appropriate obstacle avoidance manoeuvring.

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

3.8. Passenger transport operations

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

3.9. Private operations

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

3.10. Military operations

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

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

3.11. Aerial application operations

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

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.

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

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

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

3.11.2. Local aerial application operators

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

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

Based on previous studies for other wind farm projects undertaken by Aviation Projects, and the results of consultation with AAAA and local aerial application operators, it is reasonable to conclude that safe aerial application operations would be possible on properties within the project 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, wind monitor towers (WMTs) and overhead powerlines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

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

3.12. Emergency services

3.12.1. Royal Flying Doctor Service

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

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

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

3.12.2. Aerial firefighting

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

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

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

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

> *Wind farm operators should be responsible for ensuring that the relevant emergency protocols and plans are properly executed in an emergency event. During an emergency, operators need to react quickly to ensure they can assist and intervene in accordance with their planned procedures.*

The developer or operator should ensure that:

- *liaison with the relevant fire and land management agencies is ongoing and effective*
- *access is available to the wind farm site by emergency services response for on-ground firefighting operations*
- *wind turbines are shut down immediately during emergency operations – where possible, blades should be stopped in the 'Y' or 'rabbit ear' position, as this positioning allows for the maximum airspace for aircraft to manoeuvre underneath the blades and removes one of the blades as a potential obstacle.*

Aerial personnel should assess risks posed by aerial obstacles, wake turbulence and moving blades in accordance with routine procedures.

4. INTERNAL CONTEXT

4.1. Wind farm site description

The Theodore Wind Farm site is located approximately 22 km east of the Theodore township in Central QLD. The site is predominantly undulating cattle grazing land.

Figure 4 show an aerial view of the Project site looking toward the east from the western boundary. (Source: Aviation Projects).

Figure 4 Project site aerial view

4.2. Wind turbine generator (WTG) description

The project site is to comprise of up to 170 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 113) is 506.9 m AHD, which with a 270 m AGL WTG height, results in a maximum overall height of 776.9 m AMSL (2548.9 ft AMSL).

Figure 5 illustrates the project layout identifying the highest WTG location, WTG 113 (source: Google Earth).

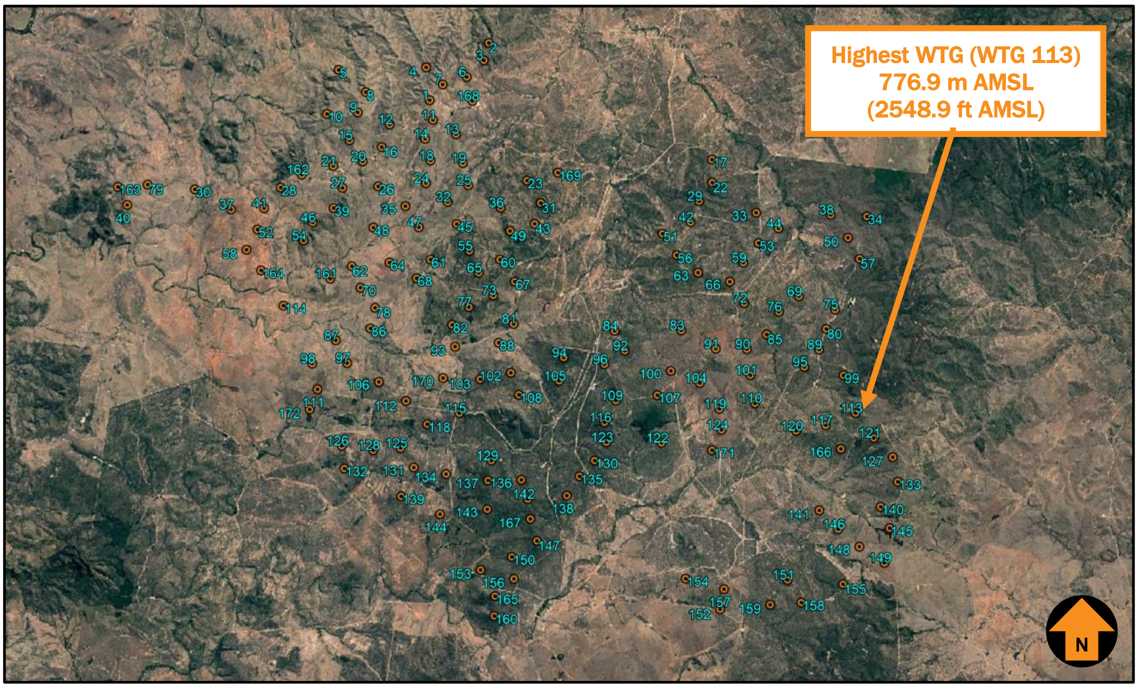


Figure 5 Project layout and highest WTG location

‘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. This AIA assumes that a maximum blade tip height of 270 m AGL is implemented at all WTG locations.

4.3. Wind monitoring tower description

The Proponent is proposing to install three WMTs to confirm the feasibility of the Theodore Wind Farm – The Project.

The WMTs are proposed to be installed with a maximum height of 160 m above ground level (AGL).

The location of the WMTs is indicated in Figure 6 (Source: ERM, Google Earth).

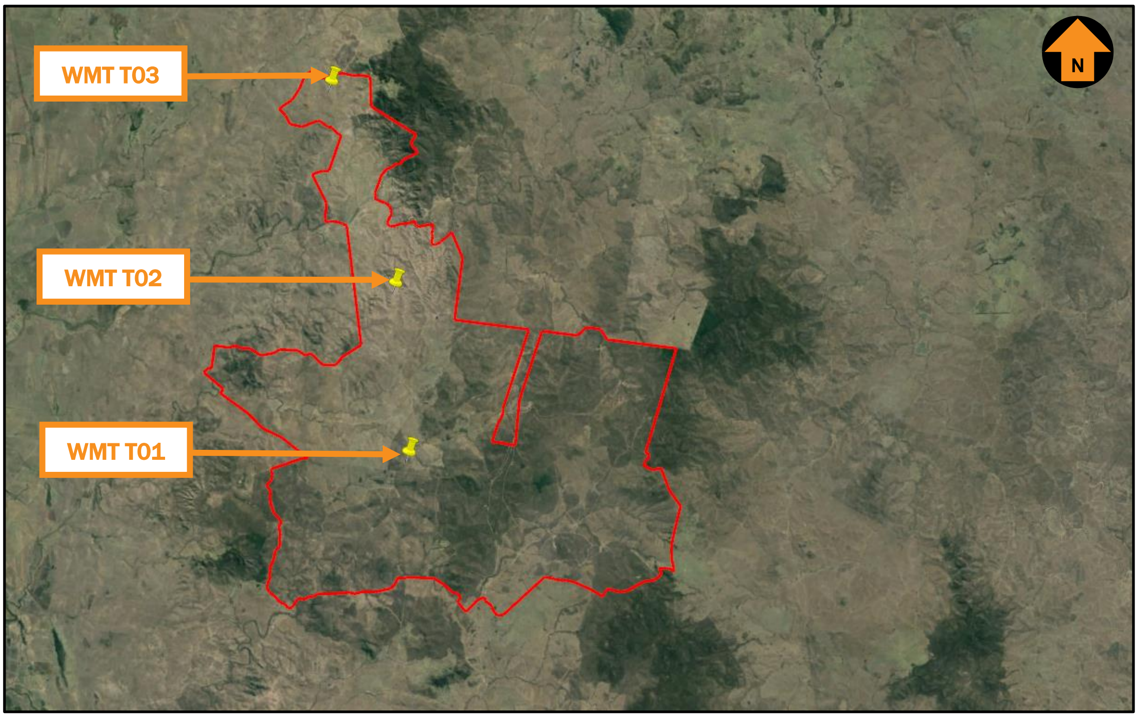


Figure 6 WMT Locations

Details of the proposed WMTs are provided in Table 2, (source: WMT report, dated 20 February 2023).

Table 2 WMT locations and heights

Mast	*Easting*	*Northing*	*Ground elevation m AHD*	*Mast Height m (ft) AMSL*
T01	235955.00	7236735.00	387 m	547 m (1794 ft)
T02	234925.00	7247125.00	377 m	537 m (1762 ft)
T03	230724.00	7259510.00	355 m	515 m (1690 ft)

5. CONSULTATION

The following list of stakeholders were identified as requiring consultation:

1. Airservices Australia
2. Department of Defence
3. Banana Shire Council
4. IDS Australia (Procedure designer for Theodore Airport instrument flight procedures)
5. Queensland Ambulance Service
6. Queensland Fire and Emergency Services
7. Queensland Police Services
8. Queensland Royal Flying Doctor Services

Details and results of the consultation activities are provided in Table 3.

Note: Consultation commenced on 04 July 2024, and a response was received from IDS Australia, Queensland Police Services, and Queensland Royal Flying Doctor Services. A few consultations are still ongoing (listed below), with a response anticipated to be received in the middle of September 2024.

- Airservices Australia
- Department of Defence
- Banana Shire Council
- Queensland Ambulance Service
- Queensland Fire and Emergency Services

Table 3 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices	04 July 2024 Email to Airport Development	On going		
Department of Defence	04 July 2024 Email to Department of Defence	On going		
Banana Shire Council	04 July 2024 Email to Banana Shire Council	On going		
IDS Australia	04 July 2024 Email to IDS Australia	04 July 2024 received from Dave Sheahan	No comments	Nil
Queensland Ambulance Service	04 July 2024 Email to Queensland Ambulance Service	On going		
Queensland Fire and Emergency Services	04 July 2024 Email to Queensland Fire	On going		

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
	and Emergency Services			
Queensland Police Services	04 July 2024 Email to Queensland Police Services	04 July 2024 received from Darryl Humphreys	*Nil issues – requested If MSA can be sectorised to minimise the raise required that is preferred option to QPS*	Nil
Queensland Royal Flying Doctor	04 July 2024 Email to Queensland Royal Flying Doctor	04 July 2024 received form Anthony Hooper (Operations Manager)	*Nil issues*	Nil

6. AVIATION IMPACT STATEMENT

6.1. Overview

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

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

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

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

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

6.2. Nearby certified aerodromes

There are two airports that are certified by the Civil Aviation Safety Authority (CASA) under Civil Aviation Safety Regulations (1998) (CASR) Part 139 and located within 30 nm of the proposed Project – Theodore Airport (YTDR) and Thangool Airport (YTNG).

The location of the project site relative to Theodore Airport (YTDR) and Thangool Airport (YTNG) is shown in Figure 7 (Source: ERM, Google Earth). The orange circle represents a distance of 30 nm from Theodore Airport's aerodrome reference point (ARP), while the green circle represents a distance of 30 nm from Thangool Airport's ARP.

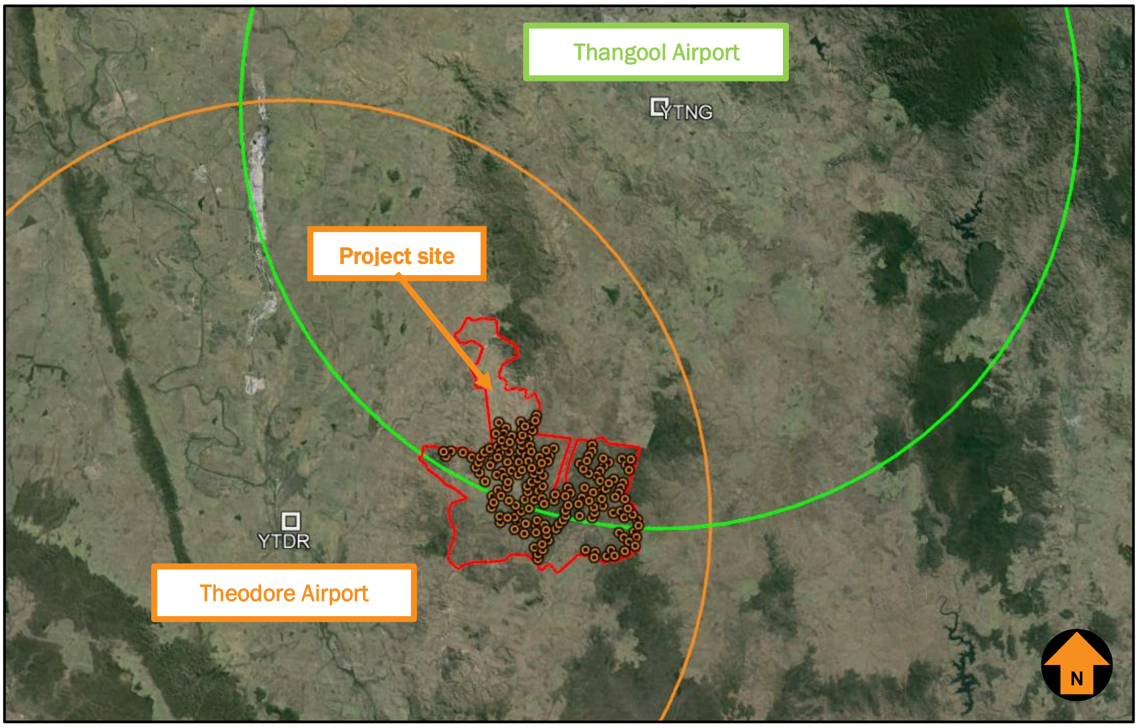


Figure 7 Location of Certified Airports in relation to Project site

6.3. Theodore Airport (YTDR)

Theodore Airport is a certified aerodrome. It is operated by Banana Shire Council with a published aerodrome elevation of 171 m AHD (560 ft AMSL) (source: Airservices Australia (AsA), FAC, RDS, dated 05 September 2024).

Theodore Airport's aerodrome reference point (ARP) coordinates published in Airservices Australia's Designated Airspace Handbook (DAH) are Latitude 24°59'11" S and Longitude 150°05'35" E, (source: Airservices Australia (AsA), DAH, dated 13 June 2024).

6.3.1. Instrument procedures

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

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

Table 4 Theodore Airport (YTDR) aerodrome and procedure charts

Chart name	Effective date
AERODROME CHART	30 November 2023 (Am 177)
RNP N	13 June 2024 (Am 179)
RNP S	13 June 2024 (Am 179)

6.3.2. MSA surfaces

The minimum sector altitude (MSA) is applicable for each instrument approach procedure at Theodore Airport. An image of the MSA published for Theodore Airport is shown in Figure 8 (source: AsA, 13 June 2024).

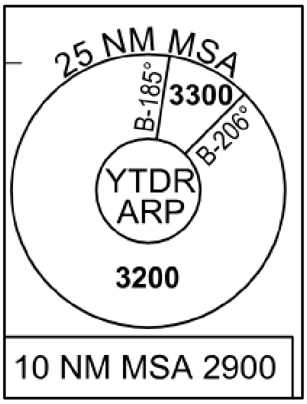


Figure 8 MSA at Theodore Airport

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

Obstacles within the 10 nm and 25 nm MSA of Theodore Airport's ARP define the height at which an aircraft can fly when within 10 nm and 25 nm.

The proposed project is partly within the 10 nm MSA of Theodore Airport. And it is completely within the south sector of the 25 nm MSA of the airport. The orange circle represents 10 nm and 25 nm MSA of Theodore Airport, Figure 9 (Source: ERM).

The 10 nm MSA minimum altitude is 884 m AHD (2900 ft AMSL), with a PANS-OPS surface elevation of 584 m AHD (1916 ft AMSL).

The north sector of the 25 nm MSA minimum altitude is 1006 m AHD (3300 ft AMSL), with a PANS-OPS surface elevation of 706 m AHD (2316 ft AMSL).

The south sector of the 25 nm MSA minimum altitude is 975 m AHD (3200 ft AMSL), with a PANS-OPS surface elevation of 675 m AHD (2216 ft AMSL).

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

Table 5 Theodore Airport MSA Impact analysis

MSA	Minimum altitude	PANS-OPS surface	Impact on airspace design	Potential solution	Impact on aircraft ops
10 nm	2900 ft AMSL	1916 ft AMSL	Higher than PANS-OPS surface by 370.1 ft	Increase minimum altitude by 400 ft	Yes
25 nm – North Sector	3300 ft AMSL	2316 ft AMSL	Outside the sector	Nil	Nil
25 nm - South Sector	3200 ft AMSL	2216 ft AMSL	Higher than the PANS-OPS surface by 332.9 ft	Increase minimum altitude by 400 ft or sectorise to exclude the wind farm.	Yes

There are 15 WTGs within the 10 nm MSA, which are all higher than the 10 nm MSA protection surface. The highest is WTG 54 (696.8 m AHD (2286.1 ft AMSL)), which is higher than 10 nm MSA by 112.8 m (370.1 ft).

There are 120 turbines higher than 25 nm MSA South Sector. The highest is WTG 113 (776.9 m AHD (2548.9 ft AMSL)), which is 101.5 m (332.9 ft) higher than the 25 nm MSA south sector's protection surface.

The Project will infringe on both the 10 nm and 25 nm South sector's PANS-OPS surface of Theodore Airport. The 10 nm MSA will need to be increased by 400 ft to 3300 ft. The 25 nm MSA south sector will need to be increased by 400 ft to 3600 ft or sectorised for the wind farm area.

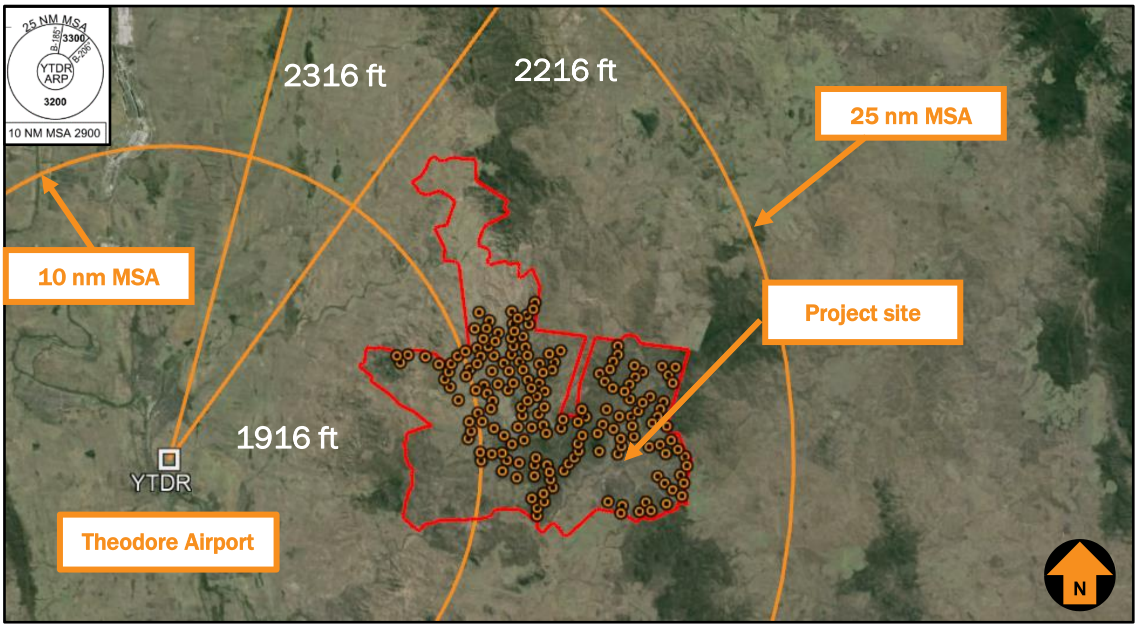


Figure 9 Theodore Airport MSA

The increase to the 25 nm MSA will require a commensurate increase in the commencement altitude and the minimum holding altitude for the 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.

6.3.3. IFR Circling areas

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

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

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

- Category A – 1.68 nm / 3.1 km
- Category B – 2.66 nm / 4.9 km
- Category C – 4.20 nm / 7.8 km

The closest WTG is 12 nm / 22.1 km from the threshold of Runway 17 and is beyond the circling area for all runway ends at Theodore Airport.

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

6.3.4. PANS-OPS Surfaces

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

The Project will be partly beneath the holding area of RNP N procedure surface of Theodore Airport and will outside RNP S procedure surface. It will not have any impact on approach procedures. Table 6 details the assessment for each instrument approach procedure.

Table 6 Theodore Airport PANS-OPS Assessment

Theodore Airport Instrument Approach Title	*Minimum Altitude over Project (ft AMSL)*	*PANS-OPS Surface (ft AMSL)*	*Impact on procedure by WTGs*	*Potential solution*	*Impact on aircraft ops*
RNP N	3200 (MSA)	2216	Nil – The project will be partly beneath the holding protection surface	N/A	N/A
RNP S	3200 (MSA)	2216	Nil – outside protection surface	N/A	N/A

The Project would not affect any PANS-OPS procedure; however, due to the requirement of increasing the 25 nm MSA south sector to 3600 ft, the minimum altitudes in some segments would need to be increased.

Figure 10 and Figure 11 detail the YTDR RNP N and RNP S instrument approach charts. The altitudes that would need to be amended to accommodate the project are circled in orange. The Project would be depicted on the plan view of this chart in the correct location for pilot reference. The MSA in the chart need to be increased to 3600 ft.

The procedure will need to be amended and a detailed assessment made by the procedure designer.

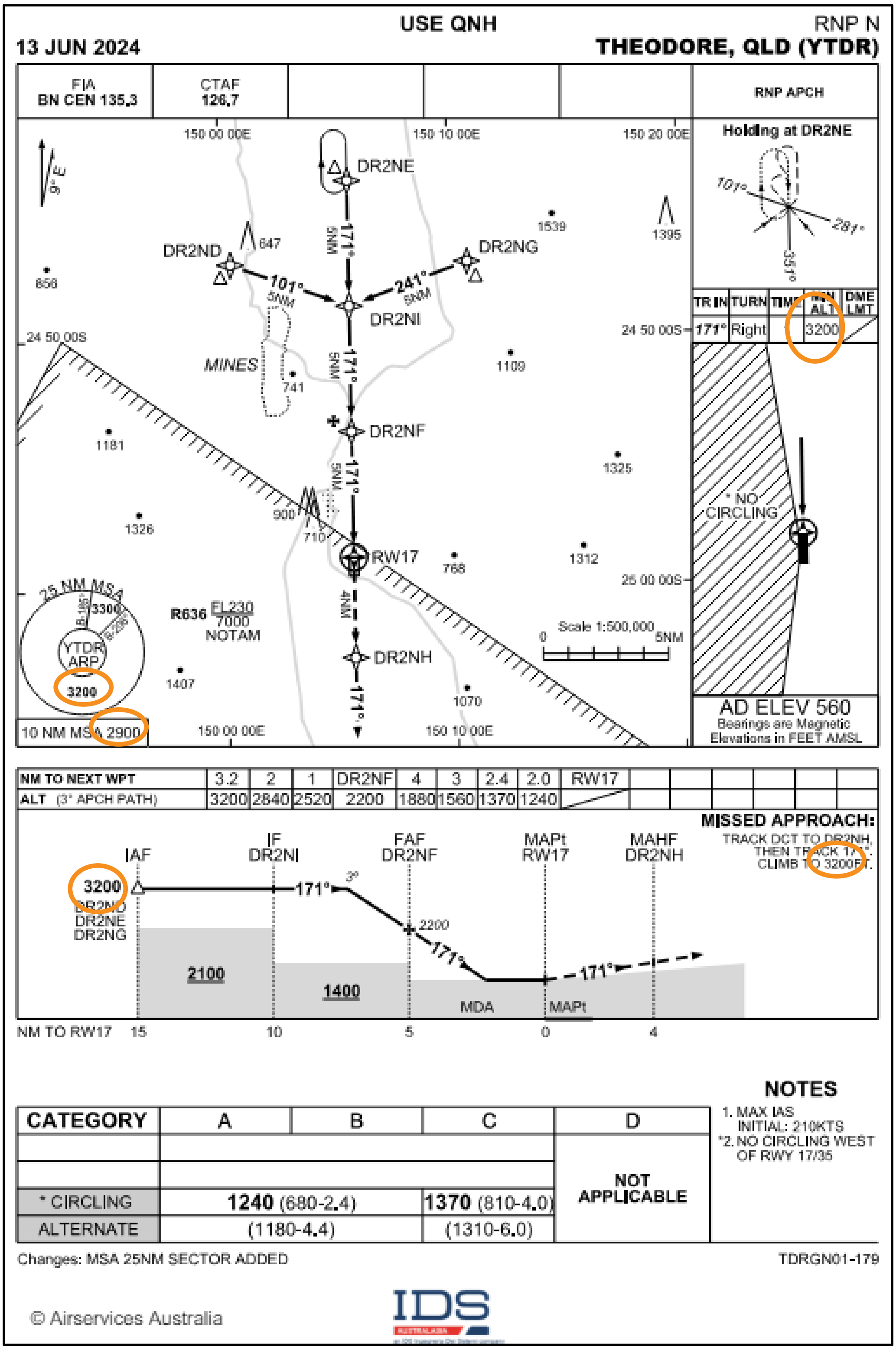
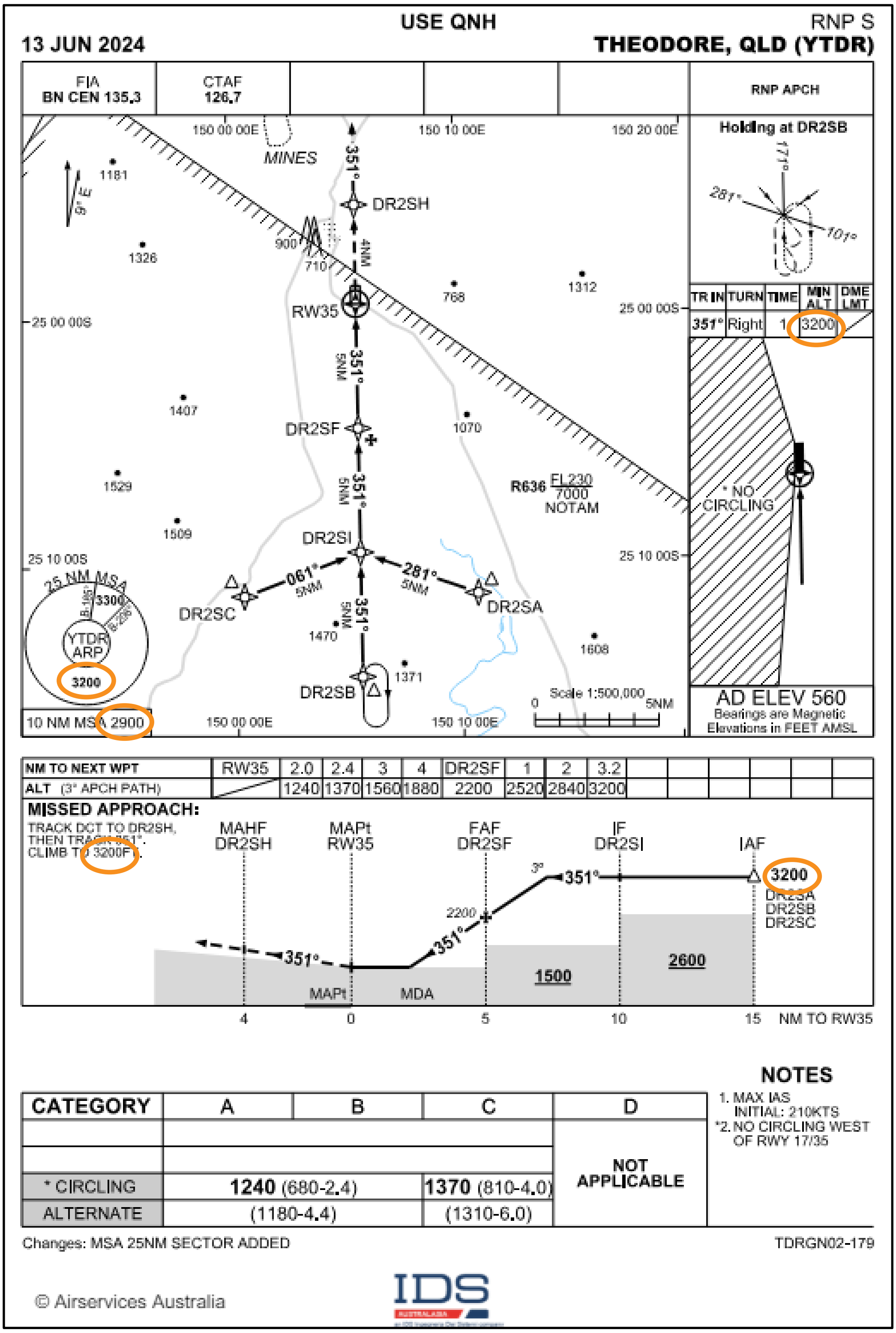


Figure 10 YTDR RNP N instrument approach chart



TR IN	TURN	TIME	MIN ALT	DME LMT
351°	Right	1	3200	

NM TO NEXT WPT	RW35	2.0	2.4	3	4	DR2SF	1	2	3.2
ALT (3° APCH PATH)		1240	1370	1560	1880	2200	2520	2840	3200

CATEGORY	A	B	C	D
				NOT APPLICABLE
* CIRCLING	1240 (680-2.4)		1370 (810-4.0)	
ALTERNATE	(1180-4.4)		(1310-6.0)	

Figure 11 YTDR RNP S instrument approach chart

6.4. Thangool Airport (YTNG)

Thangool Airport is a certified aerodrome. It is operated by the Banana Shire Council with a published aerodrome elevation of 196 m AHD (644 ft AMSL) (source: Airservices Australia (AsA), FAC, dated 05 September 2024).

Thangool Airport's aerodrome reference point (ARP) coordinates published in Airservices Australia's Designated Airspace Handbook (DAH) are Latitude 24°29'38" S and Longitude 150°34'34" E, (source: Airservices Australia (AsA), DAH, dated 13 June 2024).

6.4.1. Instrument Approach Procedures

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

Table 7 identifies the aerodrome and procedure charts for Thangool Airport, designed by Airservices Australia (AsA) as indicated.

Table 7 Thangool Airport (YTNG) aerodrome and procedure charts

Chart name	*Effective date*
AERODROME CHART	30 November 2023 (Am 177)
RNP RWY 10	13 June 2024 (Am 179)
RNP RWY 28	13 June 2024 (Am 179)

6.4.2. MSA surfaces

The minimum sector altitude (MSA) is applicable for each instrument approach procedure at Thangool Airport. An image of the MSA published for Thangool Airport is shown in Figure 12 (source: AsA, 13 June 2024).

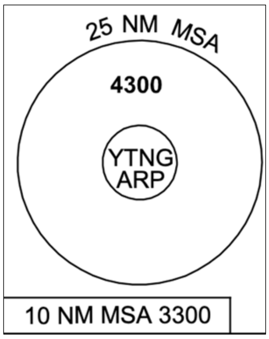


Figure 12 MSA at Thangool Airport

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

The proposed project is partly within the 25 nm MSA of Thangool Airport. The green circle represents 25 nm MSA of Thangool Airport, Figure 13 (Source: ERM, Google Earth).

The 25 nm MSA minimum altitude is 1311 m AHD (4300 ft AMSL), with a PANS-OPS elevation of 1011 m AHD (3316 ft AMSL).

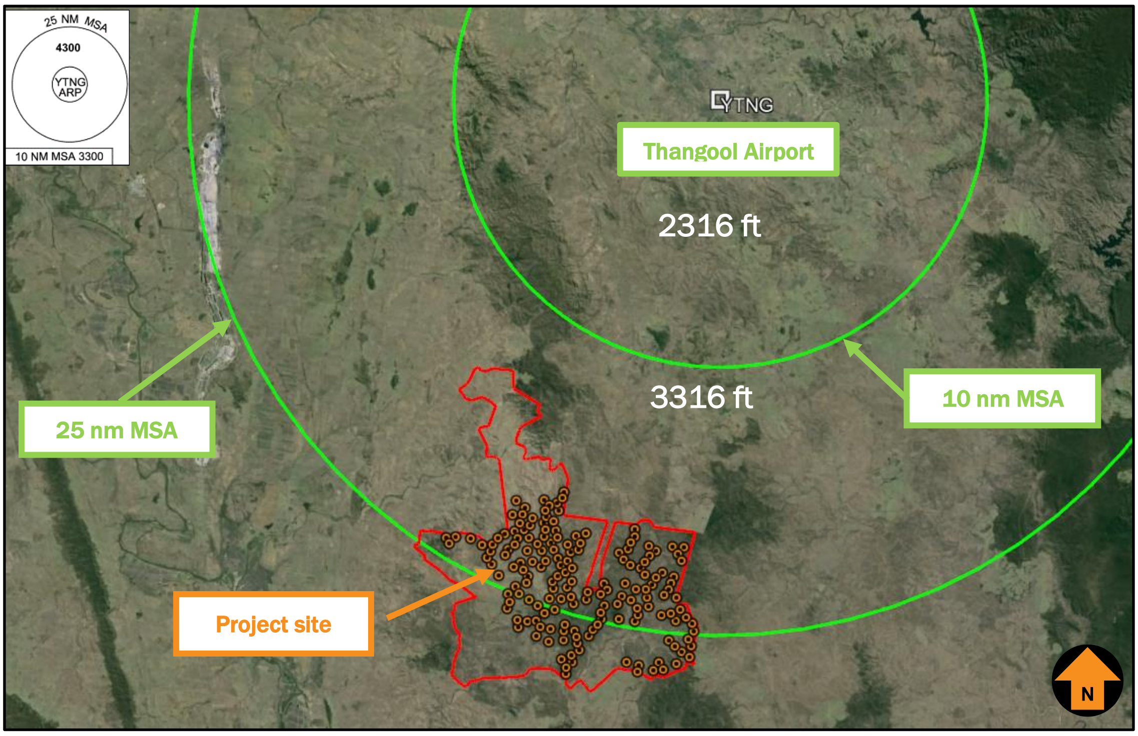


Figure 13 Thangool Airport MSA

Within 25 nm MSA, the highest WTG is WTG 113, which is 776.9 m AHD (2548.9 ft AMSL) and will be lower than the 25 nm MSA protection surface.

The Project will not affect Thangool Airport's MSA protection surface.

6.4.3. IFR Circling areas

The most demanding aircraft category provided for in Thangool Airport's instrument flight procedure's is Category C. The radii for Category C is 4.20 nm / 7.8 km

The Project is located approximately 23.5 nm / 43.5 km from the threshold of Runway 28 and is therefore beyond the circling area for all runway ends at Thangool Airport. It will not impact circling areas established for instrument flight procedures.

6.4.4. PANS-OPS Surfaces

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

The Project is outside both RNP procedures surfaces of Thangool Airport. It will not have any impact on approach procedures.

6.5. Obstacle Limitation Surfaces

Obstacle Limitation Surfaces (OLS) are established for each certified aerodrome runway.

For the Code 3 non-precision runway at Theodore Airport, the maximum lateral extent of the OLS is up to 5.5 km for the conical surface and 15 km for the take-off and approach surfaces.

For the Code 2 non-precision runway at Thangool Airport, the maximum lateral extent of the OLS is up to 4.7 km for the conical surface and 2.5 km for the take-off and approach surfaces.

The closest WTG in the project area is located approximately 22 km to the east of Theodore Airport's ARP and 44 km to the south of Thangool Airport's ARP, which is beyond the horizontal extent of the obstacle limitation surfaces of both Theodore and Thangool Aerodromes.

6.6. Nearby aircraft landing areas (uncertified aerodromes)

A search of various aviation datasets identified Aircraft Landing Areas (ALAs) in proximity to the project site. 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 14 shows the location of nearby ALAs relative to the project site and a nominal 3 nm buffer from the closer ALAs (source: ERM).

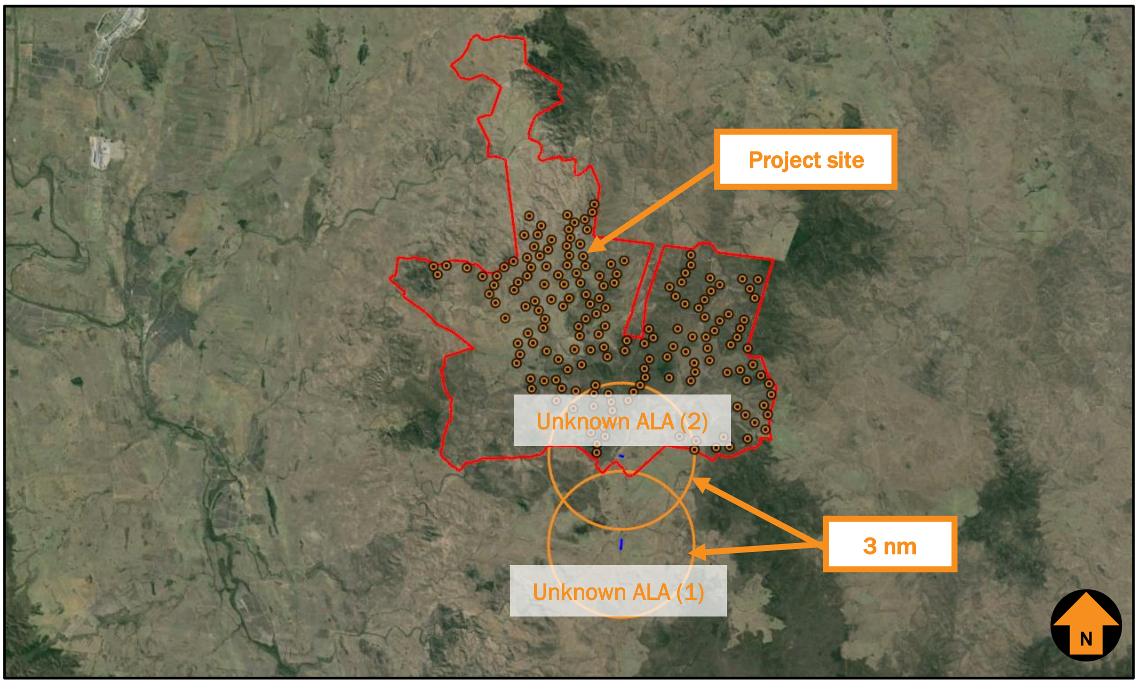


Figure 14 ALAs in the vicinity of the project site

Two Unknown ALAs are the closest in relation to the Project. Few WTGs are located within a radius of 3 nm of Unknown ALA (2) from the closest runway centre.

6.6.1. Unknown ALA (1)

Unknown ALA (1) is identified on the National Map, and the location was confirmed during an aerial survey. The location of the ALA to the Project site is shown in Figure 15 (Source: ERM, Google Earth). Figure 16 Shows an image taken during the aerial survey.

There are no WTGs within the 3 nm interest area of the Unknown ALA (1).

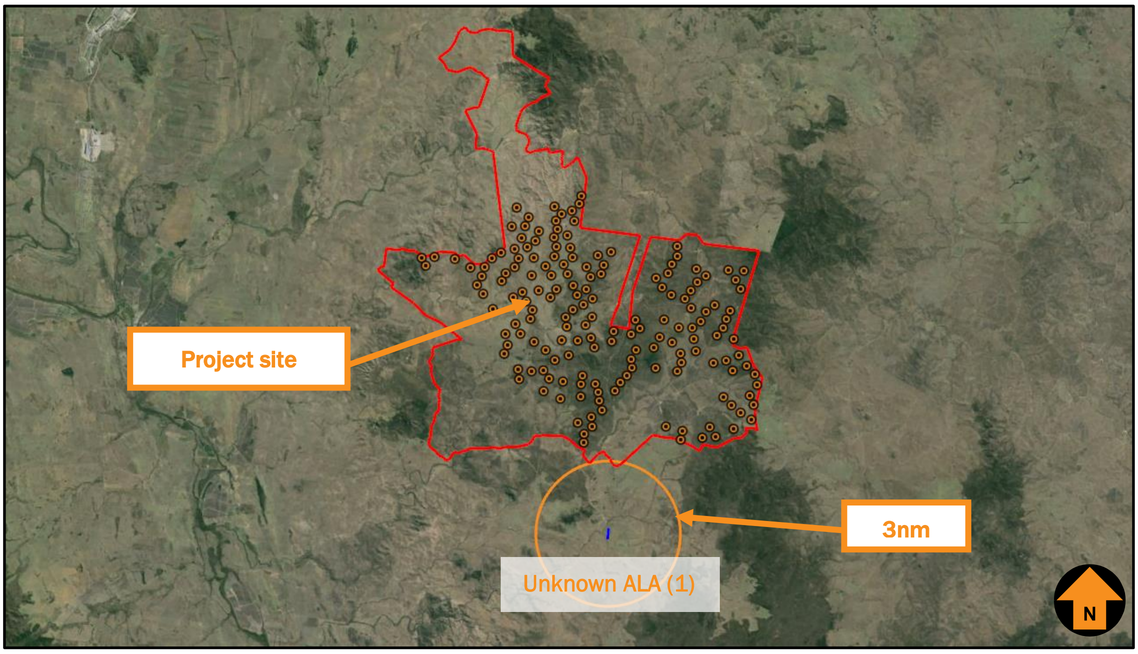


Figure 15 Unknown ALA (1) with 3 nm area of interest

Figure 16 Unknown ALA (1) in the vicinity of the Project

6.6.2. Unknown ALA (2)

The Unknown ALA (2) is next to the project boundary. It has been identified based on 250K topo from OzRunways. But it did not appear to be an active ALA, as satellite imaging from google earth shows tree growth in the middle. Aviation Projects would suggest the proponent contacts the landowner to confirm details about this ALA, which is shown in Figure 17 (Source: Google Earth).

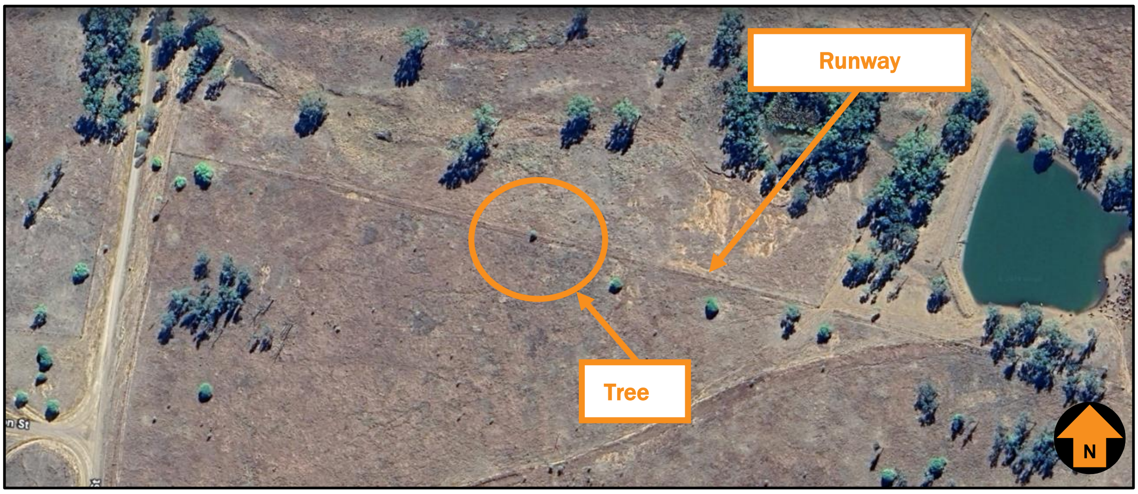


Figure 17 Close up satellite image of Unknown ALA (2) runway

6.7. Potential wake turbulence impacts

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

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

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

For the purpose of the wake turbulence analysis, a 175 m rotor diameter has been used. Based on this scenario, the effects of wake turbulence could be noticeable from the WTGs within 2800 m of the runway and 1 nm of the nominal circuit area.

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 175 m rotor diameter, this area would therefore extend to a distance of 1750 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 18 shows 10 times (1750 m) around the relevant boundary WTGs in relation to the Unknown ALA (1) (sources: ERM, Google Earth).

No wake turbulence from the closest WTGs will extend into the 3 nm area of the Unknown ALA (1).

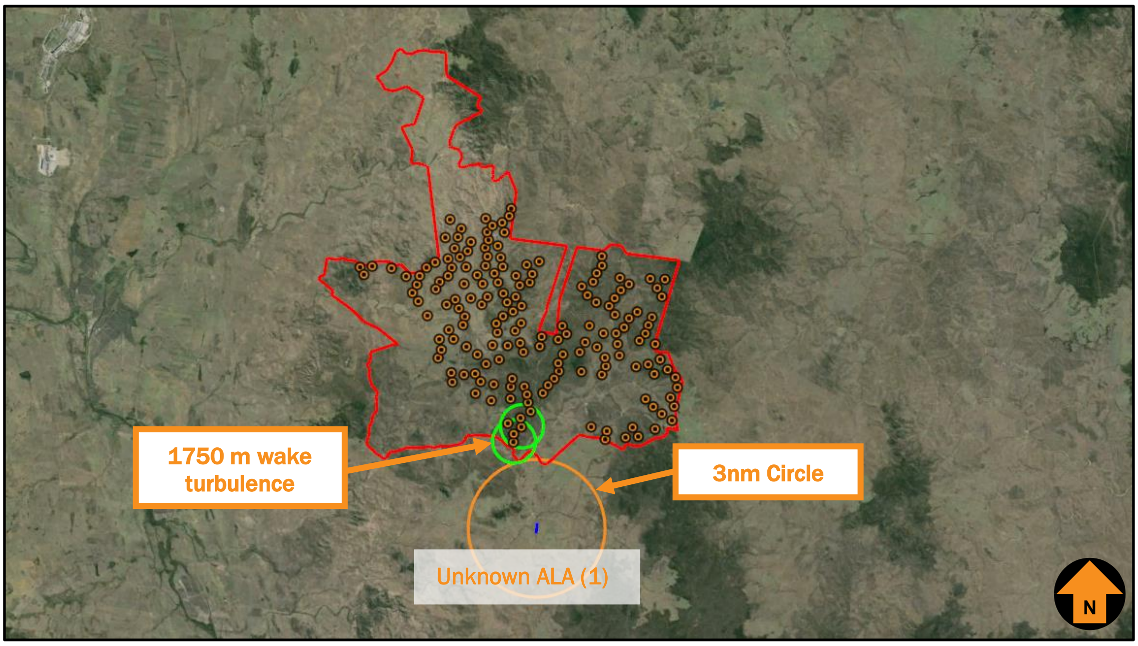


Figure 18 Possible extent of wake turbulence from WTGs

6.8. 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.

6.8.1. Grid LSALT

The project site is located within two airspace grids with LSALTs of 4600 ft AMSL and 3300 ft AMSL which provide clearance above obstacles with heights up to 3600 ft AMSL and 2300 ft AMSL, respectively.

Figure 19 shows the grid LSALTs in proximity to the project site (source: ERC Low National, OzRunways, August 2024, Google Earth).

An impact analysis of Grid LSALT is provided in Table 8.

The highest WTG (WTG 113) is located within the 4600 ft grid LSALT. With a maximum height of 776.9 m AHD (2548.9 ft AMSL), the WTG is below the 3600 ft obstacle height limit. Therefore, the WTGs will not impact the 4600 ft Grid LSALT.

There are 22 WTGs located within the 3300 ft grid LSALT. The highest WTG is WTG 147, with a maximum height of 730.2 m AHD (2395.7 ft AMSL), which will be higher than the height limit of 2300 ft AMSL by 95.7 ft. Therefore, the 3300 ft Grid LSALT will need to be raised by 100 ft to 3400 ft.

Table 8 Grid ISALT impact analysis

Grid ISALT	*Protection Surface*	*Covered WTGs*	*Infringe WTGs*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
4600 ft AMSL	3600 ft AMSL	149 WTGs	Nil	Nil	N/A	N/A
3300 ft AMSL	2300 ft AMSL	22 WTGs	11 WTGs: WTG140, 143 147 ~ 150, 155, 157, 158, 160, 165	The highest WTG will exceed 95.7 ft	LSALT raised by 100 ft	N/A

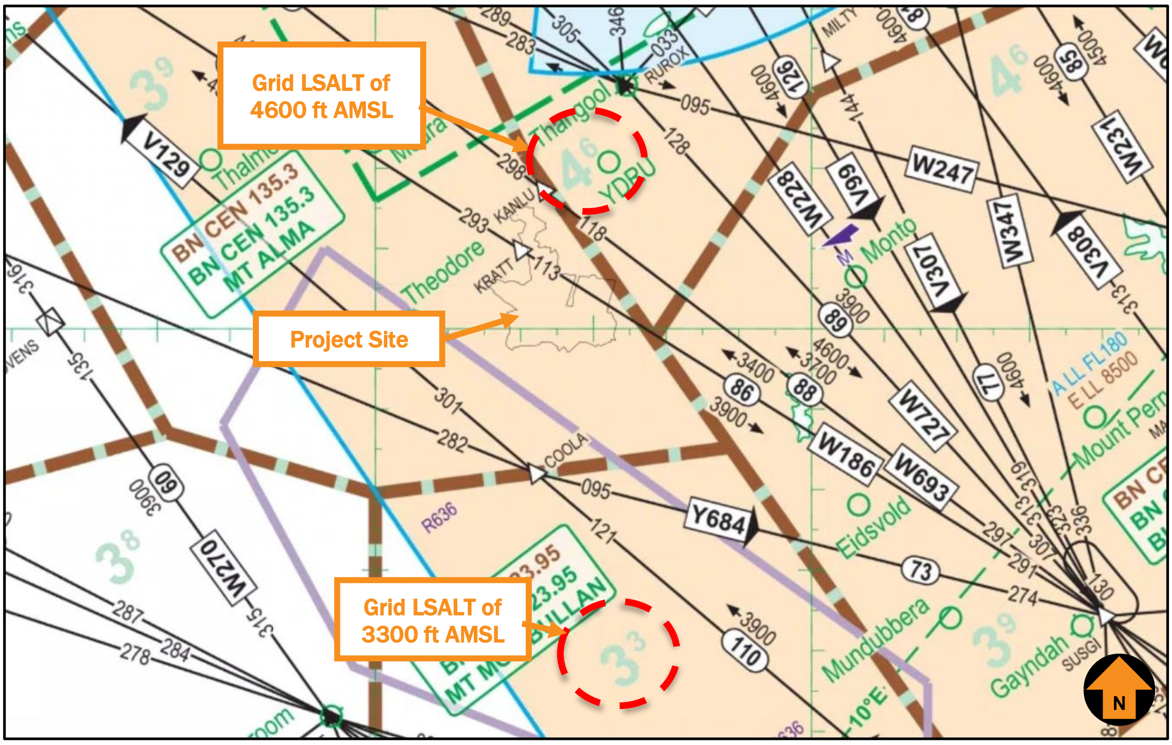


Figure 19 Grid LSALTs in proximity to the project site

6.8.2. Air Route LSALTs

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

There are few air routes within 7 nm of the project site. An impact analysis of the surrounding air routes is provided in the Table 9.

There are 19 WTGs that will impact air route W186, with WTG 113 the highest, at 776.9 m AHD (2548.9 ft AMSL). Air route W186 will need to be increased by 200 ft to 3600 ft.

There are 50 WTGs that will impact air route UY409, with WTG 49 the highest, at 757 m AHD (2483.6 ft AMSL). Air route UY409 will need to be increased by 200 ft to 3500 ft.

Table 9 Air route impact analysis

Air route	Waypoint pair	Route LSALT	Protection Surface	Covered WTGs	Infringe WTGs	Impact on airspace design	Potential solution	Impact on aircraft ops
W186	KRATT to SUSGI	3400 ft AMSL	2400 ft AMSL	167 WTGs	19 WTGs: WTG 3, 29, 31, 49, 55, 56, 65, 76, 91, 94, 95, 99, 102, 105, 108, 113, 116, 121, 130	The highest WTG will exceed 148.9 ft	LSALT raised by 200 ft	N/A
W693	SUSGI to KANLU	3700 ft AMSL	2700 ft AMSL	22 WTGs	Nil	Nil	Nil	N/A
UY409	EML NDB to BESBO	3300 ft AMSL (Grid)	2300 ft AMSL	129 WTGs	50 WTGs WTG 9, 12,20, 24, 27, 36, 43, 46, 49, 55, 60, 65, 67, 73, 83, 84, 91, 92, 94, 96, 101 ~ 105, 107 ~ 110, 116, 117, 120, 123, 130, 135, 136, 138, 140, 143, 147 ~ 150, 155, 157, 158, 160, 165, 166	Highest WTG will exceed by 183.6 ft	LSALT raised by 200 ft	N/A

6.9. Airspace Protection

The project site is located outside of controlled airspace (wholly within Class G airspace) and is not located in any Prohibited, Restricted and Danger areas. The Project will not have an impact on controlled or designated airspace.

6.10. Aviation facilities

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

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

6.11. 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 Mt Alma Route Surveillance Radar (RSR), which is located approximately 107 km to the north-east.

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

Primary Surveillance Radar (PSR)

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

Secondary Surveillance Radar (SSR)

- Zone 1: 0 - 500 m: Not permitted
- Zone 2: 500 m - 16 km but within maximum instrumented range and in radar line of sight: Detailed assessment
- Zone 4: Further than 16 km or not in radar line of sight: No assessment

(Zone 3 is not established for secondary surveillance radar)

The project site is outside the line of sight range of the Mt Alma RSR radar and will not impact this facility.

6.12. AIS Summary

Based on the WTG layout and maximum blade tip height of up to 270 m AGL, the blade tip elevation of the highest WTG, which is WTG 113, will not exceed 776.9 m AHD (2548.9 ft AMSL) and:

- There are two certified airports located within 30 nm (56 km) from the Project, Theodore Airport (YTDR) and Thangool Airport (YTNG).
- Theodore Airport (YTDR):
    - The WTGs will not impact on the OLS surfaces.
    - The WTGs will not impact on the circling areas.
    - The WTGs will impact both 10 nm and 25 nm MSA surfaces.
        - The 10 nm MSA will need to be increased by 400 ft to 3300 ft.
        - The 25 nm MSA will need to be increased by 400 ft to 3600 ft or sectorized for the wind farm area.
    - The WTGs will not impact PANS-OPS surfaces. However due to requirement of increasing the 25 nm MSA to 3600 ft the minimum altitudes in some segments would need to be increased.

- Thangool Airport (YTNG):
    - The WTGs will not impact on the OLS surfaces.
    - The WTGs will not impact on the circling areas.
    - The WTGs will not impact the MSA surfaces.
    - The WTGs will not impact PANS-OPS surfaces.
- There is no aircraft landing area (ALA) identified within 3 nm of the project site.
- The WTGs will impact airspace Grid LSALT – Grid 3300 ft LSALT will need to be increased by 100 ft to 3400ft..
- The WTGs will impact air route LSALT – W186, which will need to be increased by 200 ft to 3600 ft.
- The WTGs will impact air route LSALT – UY409, which will need to be increased by 200 ft to 3500 ft.
- The Project site is located within Class G airspace and outside all controlled airspace, Prohibited Restricted and Danger areas.
- The WTGs will not impact on the aviation facilities of nearby certified airports.
- The WTGs will not impact on the closest radar installations.
- The WTGs must be reported to CASA and construction details provided to Airservices.

6.13. Assessment recommendations

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

1. Details of WTGs exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. 'As constructed' details of WTG coordinates and elevation should be provided to Airservices Australia, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
    a. The planned operational timeframe and maximum height of the crane; and
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
4. Details of the Project site should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the Project on their operations.
5. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Marking of WTGs

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

Micrositing

8. Providing the micrositing is within 100 m of the planned WTGs it is not likely to result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Triggers for review

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

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

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

Aerial firefighting

10. The developer or operator should ensure that:

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

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

    c. wind turbines are shut down immediately during emergency operations – where possible, blades should be stopped in the ‘Y’ or ‘rabbit ear’ position, as this positioning allows for the maximum airspace for aircraft to manoeuvre underneath the blades and removes one of the blades as a potential obstacle.

7. HAZARD LIGHTING AND MARKING

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

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

Once the details of the Project, 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 Project 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. And obstacle lighting is fitted at the top of the mast to ensure visibility in low light and deteriorating atmospheric conditions.

7.1.1. National Airport Safeguarding Framework Guideline D

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

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

- *marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires;*
- *ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation; or*
- *a flashing strobe light during daylight hours.*

7.1.2. Civil Aviation Safety Authority - regulatory context

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

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

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

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

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

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

> *2.1.2 Regardless of CASA advice, planning authorities make the final determination whether a wind farm or a tall structure not in the vicinity of a CASA regulated aerodrome will require lighting or marking.*

2.2.1 All wind turbine developments and tall structures should be assessed to determine whether they could be a risk to aviation safety. This AC augments the information in the National Aerodromes Safeguarding Framework (NASF) Guideline D and provides additional guidance on the assessment of wind farm developments and guidance for establishing what reasonable measures may be put in place to mitigate any adverse effect the wind farm development could be to aviation safety.

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

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

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

2.5 Aviation hazard lighting - International best practice

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

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

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

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

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

2.6 Hazard Lighting

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

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

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

2.7 CASA's commitment to aviation safety

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

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

8. 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) published a summary of aviation occurrence statistics for the period 2010-2019 (AR-2020-047, Final - 4 November 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 10 (source: ATSB).

Table 10 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 20 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.

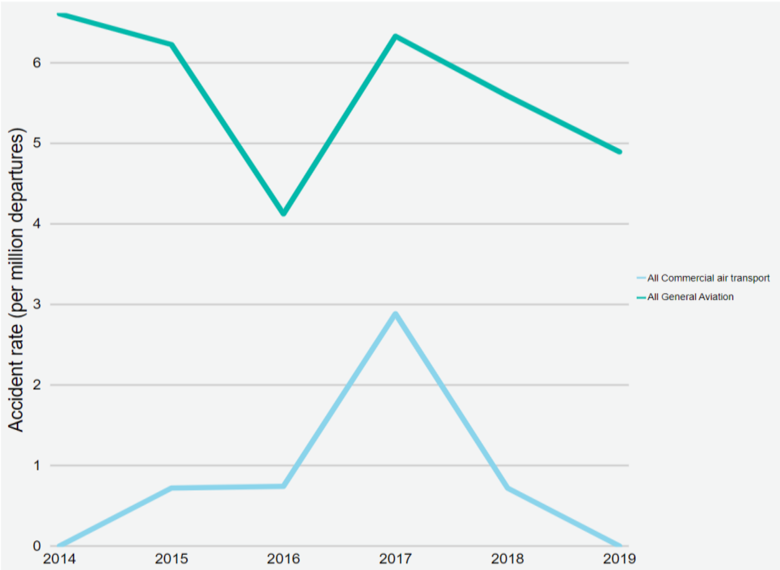


Figure 20 Fatal Accident Rate (per million departures) by Operation Type

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 11 (source: ATSB).

Table 11 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 2023, approximately 77.6 GW of wind power had been installed worldwide around the world at the end of 2022.

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

The 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 12.

Table 12 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

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	330 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. Notes: The subject WTG was 0.5 miles (800m) and 0.3 miles (480m) from the nearest WTGs either side in the string, both of which had functional obstacle lights. WTG hub height 213 ft (65 m) AGL Overall tip height 330 ft (100 m) AGL. The pilot was aware of the wind farm and **should not have been flying that low in those conditions.**

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 5), 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 13 through to Table 17.

Table 13 Aircraft collision with wind turbine generator (WTG)

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

Discussion

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

There have been 4 reported occurrences worldwide of aircraft collisions with a component of a WTG structure since the year 2000 as discussed in Section 1. These reports show a range of situations where pilots were conducting various flying operations at low level and in the vicinity of wind farms in both IMC and VMC. No reports of aircraft collisions with wind farms in Australia have been found.

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

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

Refer to the discussion of worldwide accidents in Section 1.

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

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

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

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

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

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

Consequence

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

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

Untreated Likelihood

There have been 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, but possible (has occurred rarely), which is classified as Possible.

</td></tr>
<tr><td colspan="2">*Untreated Likelihood*</td><td>Possible</td></tr>
</table>

• ***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 of any 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 height 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 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. • Aircraft are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles (including terrain) which are within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night). • Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities undertaken specifically for and prior to undertaking such authorised flights. Any obstacle including WTGs in the path of the authorised flight would be specifically risk assessed during that process. • The WTGs are typically coloured white so they should be visible to pilots during the day. • The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of all WTGs can be noted on aeronautical maps and charts. • Because the Project WTGs are proposed to be above 100 m AGL, there is a statutory requirement to report the WTGs to CASA and notified to Airservices Australia prior to construction.	
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8 (Unacceptable).	
Current Level of Risk	8 - Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Details of the Project should be communicated to local and regional aircraft operators prior to construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically:	

○ 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 14 Aircraft collision with wind monitoring tower (WMT)

Risk ID:	2. Aircraft collision with a wind monitoring tower (WMT) (CFIT)
Discussion An aircraft collision with a WMT would result in harm to people and damage to property. The 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 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. • 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: *1) Medium-intensity obstacle lights must:* *a) be visible in all directions in azimuth; and* *b) if flashing — have a flash frequency of between 20 and 60 flashes per minute.* *2) The peak effective intensity of medium-intensity obstacle lights must be 2 000 ☐ 25% cd with a vertical distribution as follows:* *a) for **vertical beam spread** — a minimum of 3 degrees;*		

b) *at -1 degree elevation — a minimum of 50% of the lower tolerance value of the peak intensity;* c) *at 0 degrees elevation — a minimum of 100% of the lower tolerance value of the peak intensity.* 3) *For subsection (2),* **vertical beam spread** *means the angle between 2 directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity.* 4) *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m² or greater.* • Ensure details of any additional WMTs at the Project 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 15 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, but possible (has occurred rarely), which is classified as Possible.	
Untreated Likelihood	Possible
Current Treatments (without lighting) • The Project is clear of the OLS of any aerodrome.	

- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. - WTGs will be a maximum of 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.	
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 16 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 17 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 (including recommended impact reduction measures) 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 the planning provisions of Banana Shire Council and 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 WTG layout and maximum blade tip height of 270 m AGL, the blade tip elevation of the highest WTG, which is WTG 113, will not exceed 776.9 m AHD (2548.9 ft AMSL) and:

- There are two certified airports located within 30 nm (56 km) from the Project, Theodore Airport (YTDR) and Thangool Airport (YTNG)
- Theodore Airport (YTDR):
    - The WTGs will not impact on the OLS surfaces.
    - The WTGs will not impact on the circling areas.
    - The WTGs will impact both 10 nm and 25 nm MSA surfaces.
        - The 10 nm MSA will need to be increased by 400 ft to 3400 ft.
        - The 25 nm MSA will need to be increased by 400 ft to 3600 ft or sectorized for the wind farm area.
    - The WTGs will not impact PANS-OPS surfaces. However due to requirement of increasing the 25 nm MSA to 3600 ft the minimum altitudes in some segments would need to be increased.
- Thangool Airport (YTNG):
    - The WTGs will not impact on the OLS surfaces.
    - The WTGs will not impact on the circling areas.
    - The WTGs will not impact the MSA surfaces.
    - The WTGs will not impact PANS-OPS surfaces.
- There is no aircraft landing area (ALA) identified within 3 nm of the project site
- The WTGs will impact airspace Grid LSALT – Grid 3300 ft LSALT will need to be increased by 100 ft to 3400ft
- The WTGs will impact air route LSALT – W186, which will need to be increased by 200 ft to 3600 ft.
- The WTGs will impact air route LSALT – UY409, which will need to be increased by 200 ft to 3500 ft.
- The project site is located within Class G airspace and outside all controlled airspace, Prohibited Restricted and Danger areas.

- The WTGs will not impact on the aviation facilities of nearby certified airports.
- The WTGs will not impact on the closest radar installations.
- The WTGs 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 must be reported to CASA. WTGs must be marked in accordance with Part 139 MOS 2019 Chapter 8 Division 10 section 8.110.
- CASA will review the proposed WTG and WMT development and make a recommendation for obstacle lighting if required.
- With respect to marking of WTGs, a white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- It is not mandatory to mark the WMT, however the following markings are recommended to be implemented in consideration of potential day VFR aerial work operations in accordance with NASF Guideline D:
    a. obstacle marking for at least the top 1/3 of the mast and be painted in alternating contrasting bands of colour
    b. marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires; and
    c. guy wire ground attachment points in contrasting colours to the surrounding ground/vegetation
- Temporary WMTs that are installed prior to WTG installation, and WMTs that are not in close proximity to a WTG, will require obstacle lighting to maintain an acceptable level of safety.

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 18.

Table 18 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. Details of WTGs exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. 'As constructed' details of WTG coordinates and elevation should be provided to Airservices Australia, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
    a. The planned operational timeframe and maximum height of the crane; and
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
4. Details of the Project should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the Project on their operations.
5. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Consultation

Refer to **Section 5** for detailed responses from relevant aviation stakeholders once received. The final report will be used with the application to the planning authority.

The following list of stakeholders were identified as requiring consultation:

- Airservices Australia
- Department of Defence
- Banana Shire Council
- IDS Australia (Procedure designer for Theodore Airport instrument flight procedures)
- Queensland Ambulance Service
- Queensland Fire and Emergency Services
- Queensland Police Services
- Queensland Royal Flying Doctor Services
- Aerial operators

Any changes to MSA and LSALT are subject to approval by Airservices Australia and the airport operator once final construction data has been provided.

Marking of WTGs and WMT

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

Lighting of WTGs and WMT

8. CASA will determine whether obstacle lighting is recommended for the WTGs and WMTs. It is not a formal requirement to light the WTGs and WMTs.
9. Aviation Project consider 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
10. 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

Micrositing

11. Providing the micrositing is within 100 m of the planned WTGs it is not likely to result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Aerial firefighting

12. The developer or operator should ensure that:
    a. liaison with the relevant fire and land management agencies is ongoing and effective
    b. access is available to the wind farm site by emergency services response for on-ground firefighting operations
    c. wind turbines are shut down immediately during emergency operations – where possible, blades should be stopped in the 'Y' or 'rabbit ear' position, as this positioning allows for the maximum airspace for aircraft to manoeuvre underneath the blades and removes one of the blades as a potential obstacle.

Triggers for review

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

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

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

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

ANNEXURES

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

ANNEXURE 1 – REFERENCES

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

- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures, En Route Supplement Australia and dated 05 September 2024
- Airservices Australia, Designated Airspace Handbook dated 13 June 2024
- Civil Aviation Safety Authority, Civil Aviation Regulations 1988 (CAR)
- Civil Aviation Safety Authority, Civil Aviation Safety Regulations 1998 (CASR)
- Civil Aviation Safety Authority, Advisory Circular (AC) 91-10 v1.1: *Operations in the vicinity of non-controlled aerodromes*, dated November 2021
- Civil Aviation Safety Authority, Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design, version 1.8, dated August 2022
- CASR Part 139 Manual of Standards– Aerodromes, F2024C00161 registered 16/02/2024
- Civil Aviation Safety Authority, Advisory Circular 139.E-01 v1.0—Reporting of Tall Structures , dated December 2021
- Civil Aviation Safety Authority, Advisory Circular (AC) 139.E-05 v1.1 Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome (October 2022)
- Department of 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 to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*, dated July 2012
- 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 August 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 aircraft or that extend above a defined surface intended to protect aircraft in flight.

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

ANNEXURE 3 – CASA REGULATORY REQUIREMENTS – LIGHTING AND MARKING

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

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

Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

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

Manual of Standards Part 139—Aerodromes

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

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

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

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

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

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

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

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

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

6. High-intensity obstacle lights:

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

b. must be flashing white lights.

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

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

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

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

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

c. all be synchronised to flash simultaneously; and

d. be seen from every angle in azimuth.

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

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

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

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

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

a. the surrounding ground (ground level); or

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

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

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

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

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

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

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

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

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

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

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

International Civil Aviation Organisation

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

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

6.2.4 Wind turbines

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

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

Note 2. — See 4.3.1 and 4.3.2

Markings

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

Lighting

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

a) to identify the perimeter of the wind farm;

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Section 4.3 Objects outside the OLS states the following:

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

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

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

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

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

Light characteristics

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

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

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

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

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

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

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

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

1. *Medium-intensity obstacle lights must:*

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

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

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

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

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

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

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

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

Visual impact of night lighting

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

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

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

Marking of WTGs

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

It is generally accepted that a 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

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: THWF_LAY_20231117-b_Coordinates_GDA94-MGA56 (1).xlsx

WTG ID	Coordinates (Easting)	Coordinates (Northing)	Base Elevation (m AHD)	Tip Height (m AHD)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
1	237000	7246091	433.4	270.0	718.4	2356.8
2	238910	7248019	446.9	270.0	731.9	2401.1
3	238766	7247426	477.7	270.0	762.7	2502.2
4	236860	7247174	413.5	270.0	698.5	2291.6
5	233957	7247054	395.2	270.0	680.2	2231.7
6	238207	7246878	437.3	270.0	722.3	2369.8
7	237418	7246613	434.1	270.0	719.1	2359.2
8	234884	7246325	423.0	270.0	708.0	2322.9
9	234632	7245646	434.2	270.0	719.2	2359.5
10	233604	7245590	405.2	270.0	690.2	2264.3
11	237120	7245448	442.2	270.0	727.2	2385.8
12	235697	7245268	449.1	270.0	734.1	2408.6
13	237888	7244991	431.3	270.0	716.3	2350.1
14	236872	7244824	427.7	270.0	712.7	2338.3
15	234378	7244726	430.3	270.0	715.3	2346.9
16	235444	7244523	422.2	270.0	707.2	2320.2
17	246345	7244317	430.0	270.0	715.0	2345.8
18	237065	7244113	428.3	270.0	713.3	2340.3
19	238129	7244052	423.8	270.0	708.8	2325.3
20	234830	7244043	438.3	270.0	723.3	2373.0
21	233857	7243876	420.2	270.0	705.2	2313.6
22	246368	7243560	458.9	270.0	743.9	2440.6
23	240261	7243510	457.3	270.0	742.3	2435.3
24	236926	7243370	441.4	270.0	726.4	2383.3
25	238324	7243323	417.7	270.0	702.7	2305.4
26	235345	7243239	386.5	270.0	671.5	2203.1
27	234176	7243161	457.9	270.0	742.9	2437.3

WTG ID	Coordinates (Easting)	Coordinates (Northing)	Base Elevation (m AHD)	Tip Height (m AHD)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
28	232125	7243141	399.1	270.0	684.1	2244.5
29	245953	7242944	462.5	270.0	747.5	2452.5
30	229273	7243037	350.6	270.0	635.6	2085.3
31	240728	7242777	481.6	270.0	766.6	2515.0
32	237649	7242770	403.1	270.0	688.1	2257.4
33	247844	7242604	406.4	270.0	691.4	2268.2
34	251496	7242544	428.7	270.0	713.7	2341.6
35	236255	7242605	394.7	270.0	679.7	2229.9
36	239410	7242604	455.8	270.0	740.8	2430.3
37	230479	7242398	354.8	270.0	639.8	2099.0
38	250305	7242578	410.8	270.0	695.8	2282.8
39	233889	7242498	407.7	270.0	692.7	2272.5
40	227041	7242484	365.8	270.0	650.8	2135.1
41	231579	7242459	363.4	270.0	648.4	2127.2
42	245681	7242247	453.3	270.0	738.3	2422.1
43	240539	7242093	448.6	270.0	733.6	2406.8
44	248589	7242105	398.9	270.0	683.9	2243.7
45	237963	7242047	400.2	270.0	685.2	2247.9
46	233213	7242008	431.3	270.0	716.3	2350.0
47	236713	7241918	383.0	270.0	668.0	2191.5
48	235205	7241884	367.4	270.0	652.4	2140.5
49	239734	7241844	487.0	270.0	772.0	2532.9
50	250883	7241836	432.7	270.0	717.7	2354.8
51	244761	7241849	458.4	270.0	743.4	2438.9
52	231369	7241752	349.2	270.0	634.2	2080.6
53	247939	7241608	422.6	270.0	707.6	2321.7
54	232915	7241413	426.8	270.0	711.8	2335.4
55	238411	7241167	472.5	270.0	757.5	2485.4
56	245239	7241153	481.6	270.0	766.6	2515.3
57	251276	7241148	452.0	270.0	737.0	2417.9

WTG ID	Coordinates (Easting)	Coordinates (Northing)	Base Elevation (m AHD)	Tip Height (m AHD)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
58	231016	7241081	336.9	270.0	621.9	2040.2
59	247447	7240951	436.9	270.0	721.9	2368.5
60	239419	7240903	453.7	270.0	738.7	2423.6
61	237122	7240864	408.6	270.0	693.6	2275.7
62	234514	7240601	371.4	270.0	656.4	2153.6
63	245957	7240595	459.3	270.0	744.3	2442.0
64	235762	7240745	371.5	270.0	656.5	2153.7
65	238729	7240452	472.9	270.0	757.9	2486.4
66	247013	7240318	454.4	270.0	739.4	2425.7
67	239916	7240189	434.6	270.0	719.6	2360.9
68	236673	7240242	394.4	270.0	679.4	2228.8
69	249299	7239881	441.4	270.0	726.4	2383.1
70	234816	7239898	371.5	270.0	656.5	2153.9
72	247497	7239626	458.5	270.0	743.5	2439.3
73	239220	7239723	441.8	270.0	726.8	2384.4
75	250502	7239469	426.8	270.0	711.8	2335.3
76	248641	7239358	463.9	270.0	748.9	2457.0
77	238421	7239326	428.6	270.0	713.6	2341.1
78	235312	7239249	377.0	270.0	662.0	2171.9
79	227701	7243168	336.2	270.0	621.2	2038.2
80	250220	7238825	455.8	270.0	740.8	2430.3
81	239904	7238799	400.7	270.0	685.7	2249.8
82	237877	7238735	422.0	270.0	707.0	2319.6
83	245442	7238693	447.5	270.0	732.5	2403.1
84	243242	7238636	452.9	270.0	737.9	2421.0
85	248254	7238609	459.9	270.0	744.9	2444.0
86	235172	7238566	370.0	270.0	655.0	2149.0
87	234031	7238155	365.3	270.0	650.3	2133.6
88	239423	7238175	410.2	270.0	695.2	2281.0
89	249991	7238146	452.1	270.0	737.1	2418.3

WTG ID	Coordinates (Easting)	Coordinates (Northing)	Base Elevation (m AHD)	Tip Height (m AHD)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
90	247614	7238116	459.5	270.0	744.5	2442.6
91	246583	7238107	474.4	270.0	759.4	2491.4
92	243593	7237989	439.1	270.0	724.1	2375.7
93	237982	7238021	381.3	270.0	666.3	2186.0
94	241582	7237727	472.8	270.0	757.8	2486.2
95	249518	7237567	481.7	270.0	766.7	2515.5
96	242928	7237531	450.1	270.0	735.1	2411.6
97	234422	7237412	380.3	270.0	665.3	2182.6
98	233272	7237374	395.9	270.0	680.9	2234.1
99	250809	7237317	487.4	270.0	772.4	2534.2
100	245123	7237356	426.5	270.0	711.5	2334.3
101	247747	7237263	454.5	270.0	739.5	2426.0
102	239848	7237196	485.1	270.0	770.1	2526.5
103	238837	7236966	436.2	270.0	721.2	2366.1
104	246083	7236975	446.9	270.0	731.9	2401.1
105	241445	7236958	482.6	270.0	767.6	2518.4
106	235486	7236815	382.4	270.0	667.4	2189.5
107	244688	7236550	436.9	270.0	721.9	2368.4
108	240125	7236479	472.9	270.0	757.9	2486.4
109	243328	7236349	448.9	270.0	733.9	2407.9
110	247920	7236343	443.6	270.0	728.6	2390.5
111	233456	7236533	351.1	270.0	636.1	2086.9
112	236389	7236203	380.1	270.0	665.1	2182.0
113	251225	7236084	506.9	270.0	791.9	2598.2
114	232270	7239264	329.9	270.0	614.9	2017.4
115	238167	7235838	430.0	270.0	715.0	2345.7
116	242965	7235626	474.7	270.0	759.7	2492.5
117	250259	7235665	451.5	270.0	736.5	2416.2
118	237106	7235453	391.1	270.0	676.1	2218.1
119	246745	7236141	416.5	270.0	701.5	2301.6

WTG ID	Coordinates (Easting)	Coordinates (Northing)	Base Elevation (m AHD)	Tip Height (m AHD)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
120	249287	7235465	457.3	270.0	742.3	2435.2
121	251846	7235283	477.4	270.0	762.4	2501.4
122	244858	7234985	422.0	270.0	707.0	2319.6
123	243039	7234976	453.2	270.0	738.2	2421.9
124	246830	7235451	417.1	270.0	702.1	2303.3
125	236240	7234652	378.2	270.0	663.2	2176.0
126	234295	7234690	374.8	270.0	659.8	2164.6
127	252490	7234660	450.0	270.0	735.0	2411.3
128	235333	7234561	369.7	270.0	654.7	2147.9
129	239255	7234299	402.0	270.0	687.0	2253.9
130	242661	7234370	461.6	270.0	746.6	2449.5
131	236693	7234024	393.6	270.0	678.6	2226.3
132	234393	7233944	350.6	270.0	635.6	2085.2
133	252670	7233856	446.8	270.0	731.8	2400.9
134	237762	7233828	398.0	270.0	683.0	2240.8
135	242171	7233841	448.3	270.0	733.3	2405.7
136	240256	7233687	433.6	270.0	718.6	2357.8
137	239155	7233650	427.3	270.0	712.3	2336.9
138	241765	7233198	434.6	270.0	719.6	2360.9
139	236292	7233066	387.0	270.0	672.0	2204.8
140	252124	7233025	433.4	270.0	718.4	2357.1
141	250106	7232867	421.8	270.0	706.8	2318.7
142	240481	7233060	459.4	270.0	744.4	2442.2
143	239147	7232697	440.1	270.0	725.1	2379.1
144	237590	7232506	395.7	270.0	680.7	2233.4
145	252433	7232330	428.1	270.0	713.1	2339.7
146	250734	7232262	425.3	270.0	710.3	2330.4
147	240804	7231695	460.2	270.0	745.2	2445.0
148	251449	7231702	433.5	270.0	718.5	2357.4
149	252279	7231190	445.5	270.0	730.5	2396.7

WTG ID	Coordinates (Easting)	Coordinates (Northing)	Base Elevation (m AHD)	Tip Height (m AHD)	Maximum Height (m AHD)	Maximum Height (ft AMSL)
150	239988	7231153	437.2	270.0	722.2	2369.3
151	249099	7230565	427.3	270.0	712.3	2336.9
152	246892	7229560	424.5	270.0	709.5	2327.7
153	238965	7230701	406.6	270.0	691.6	2269.0
154	245735	7230540	411.3	270.0	696.3	2284.6
155	250925	7230466	451.6	270.0	736.6	2416.6
156	240070	7230431	418.7	270.0	703.7	2308.7
157	247009	7230224	442.2	270.0	727.2	2385.8
158	249562	7229837	456.7	270.0	741.7	2433.5
159	248543	7229742	426.4	270.0	711.4	2333.9
160	239444	7229198	441.9	270.0	726.9	2384.7
161	233815	7240177	381.7	270.0	666.7	2187.2
162	232819	7243578	395.6	270.0	680.6	2233.1
163	226721	7243071	356.0	270.0	641.0	2103.1
164	231503	7240412	328.3	270.0	613.3	2012.3
165	239460	7229854	443.4	270.0	728.4	2389.7
166	250776	7234900	441.9	270.0	726.9	2384.9
167	240578	7232411	425.3	270.0	710.3	2330.3
168	238403	7246101	389.6	270.0	674.6	2213.4
169	241271	7243797	406.4	270.0	691.4	2268.2
170	237604	7236981	385.9	270.0	670.9	2201.0
171	246529	7234775	403.8	270.0	688.8	2259.7
172	233205	7235867	341.4	270.0	626.4	2055.1

ANNEXURE 6 – WIND MONITORING TOWERS - COORDINATES AND HEIGHTS

Reference file: Theodore Preliminary Mast Locations 20221201.shp

WMT ID	*Height*	*Coordinates (Easting)*	*Coordinates (Northing)*	*Base Elevation (AHD)*
T01	160	235955	7236735	387
T02	160	234925	7247125	377
T03	160	230724	7259510	355

AVIATION PROJECTS

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