Appendix I

Aviation Impact Assessment Report

TARONG WEST WIND FARM

AVIATION IMPACT ASSESSMENT

Prepared for RES Australia Pty Ltd

AVIATION PROJECTS

AVIATION PROJECTS

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ACRONYMS

AGL	above ground level
AHD	Australian Height Datum
AIP	Aeronautical Information Package
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
CAR	Civil Aviation Regulation (1988)
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation (1998)
CFIT	controlled flight into terrain
ERSA	En Route Supplement Australia
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions
MOS	Manual of Standards
MSA	minimum sector altitude
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
RPT	regular public transport
VFR	visual flight rules
VMC	visual meteorological conditions

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)

EXECUTIVE SUMMARY

Introduction

RES Australia Pty Ltd (RES Australia) is preparing a development application (DA) for a Material Change of Use (Wind Farm) for the proposed Tarong West Wind Farm (TWWF) (the Project).

The Project consists of up to 97 wind turbine generators (WTGs) and associated infrastructure to be developed over the project area. The Project area is located north of the Bunya Highway within the boundaries of South Burnett Regional Council local government area (LGA) and approximately 25.5 km (13.7 nm) from Kingaroy Airport.

The maximum tip height of the WTGs will be up to 280 m above ground level (AGL).

RES Australia has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) for the proposed Project and formally consult with aviation agencies before submitting the DA for consideration by the State Assessment and Referral Agency (SARA) of the Queensland Department of State Development, Infrastructure, Local Government and Planning (DSDILGP).

The AIA will review potential impacts identified in the TWWF Phase 1 Preliminary Aviation Assessment and provide aviation safety advice in respect of relevant requirements of air safety regulations and procedures and undertake consultation with relevant aviation agencies.

The Project now incorporates up to 97 WTGs with overall less aviation impacts than initially consulted on. Since the initial consultation in 2019, numerous background changes have occurred including:

- some regulatory changes
- changes in the airway structure overhead at the project site
- changes in the instrument flight procedures at Kingaroy Airport.

This assessment has considered the changes that have occurred since 2019 and determined that the overarching findings and recommendations are consistent or have a lesser impact to aviation safety in the area.

Further consultation should not be necessary as all new data and operations have been considered as part of this assessment and do not create any significant differences to operations in the area.

Project description

The proposed Project will comprise of the following:

- up to 97 WTGs with a maximum overall height (tip height) of the WTGs is up to 280 m AGL
- nominal hub height of the WTGs is 190 m and rotor diameter of up to 180 m
- 4 temporary WMTs will be constructed that are anticipated to be erected and dismantled during the construction period of the wind farm (approximately 2 years)
- 3 permanent WMTs

- The highest WTG is T4 with ground elevation of 580.7 m Australian Height Datum (AHD) and overall height of 860.7 m AHD (2823.7 ft above mean sea level (AMSL)).

Conclusions

Regulatory requirements

The following regulatory requirements apply:

- Wind farm development will be code assessable if all WTGs are 1,500m from a sensitive land use on a non-host lot, or there is a deed of agreement for WTGs to be less than 1,500m from a sensitive land use
- For WTGs State Code 23 : Wind Farm Development (v3.0) requires SARA determination, on balance, that the development complies with the purpose statement. The purpose statement of State Code 23 is:

  Wind farms should be appropriately located, sited, designed, constructed and operated to ensure:

  1. *the safety, operational integrity and efficiency of air services and aircraft operations;*
  2. *risks to people, property and quality of life are minimised by providing acceptable levels of:*
     a. *amenity and acoustic emissions at sensitive land uses; and*
     b. *resilience to natural hazards;*
  3. *development minimises adverse impacts on the natural environment, vegetation and associated ecological processes;*
  4. *development in an area identified by a local government as having high scenic amenity appropriately manages impacts on the character, scenic amenity and landscape values of the locality;*
  5. *the safe and efficient operation of transport networks and road infrastructure*
- All proposed objects with a height of 100 m or more AGL must be reported to CASA in accordance with Civil Aviation Safety Regulations Part 139 Division 139.E.1 139.165 (1)(2)
- WTGs must be marked in accordance with respect to CASR Part 139 Manual of Standards (MOS) Chapter 8 Division 10 8.110.
- WTGs must be lit in accordance with CASR Part 139 MOS Chapter 9 Division 4 9.3 and 9.31, unless an aeronautical study assesses they are of no operational significance.
- This AIA considers that lighting of the WTGs is not required to satisfy aviation safety standards.

Planning considerations

The Project as proposed satisfies the following Performance Outcomes of State Code 23: Wind Farm Development (Version 3) once amendments to the PANS-OPS surfaces are implemented:

Performance outcomes	*Acceptable outcomes - Compliance*
Aviation safety, integrity and efficiency	
PO1 Development does not adversely affect the safety, operational integrity and efficiency of air services and aircraft operations as a result of its: 1. location 2. siting 3. design 4. 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.

Consultation

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

Initial consultation for the Project was completed in 2019 using a previous layout which incorporated up to 151 WTGs. The Project now incorporates up to 97 WTGs with overall less aviation impacts than the initial consulted 151 WTG layout. Since the initial consultation in 2019, numerous background changes have occurred including –

- some regulatory changes
- changes in the airway structure overhead the project site
- changes in the instrument flight procedures at Kingaroy Airport.

Aviation Impact Statement

Based on the proposed Project layout and overall WTG blade tip height limit of 280 m AGL, the blade tip elevation of the highest WTG, which is T4, will not exceed 860.7 m AHD (2823.7 ft AMSL) and:

- will not infringe any OLS surfaces for Kingaroy Airport
- will infringe the PAN-OPS surface for the 10 nm MSA for Kingaroy Airport
- will not infringe the PANS-OPS surface of the 25 nm MSA Kingaroy Airport
- will have an impact on nearby designated air route V250
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

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.

Where required, the proponent will engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, carrying out of risk assessments to facilitate subject aircraft operations within the Project area when required.

WTGs are generally not a safety concern to aerial agricultural operators. Solitary WMTs remain the primary safety concern to aerial agricultural operators, who have expressed a general desire for these towers to be more visible.

Obstacle lighting risk assessment

- 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
- Up until 2023, no aircraft collided with a WTG or a WMT in Australia
- There is no regulatory requirement to mark or light power poles or overhead transmission lines, however the standards outlined in the Australian Standards (AS) 3891.2:2018 *Air navigation – Cables and their supporting structures – Marking and safety requirements Part 2: Low level aviation operations*, should be considered where power poles or overhead transmission lines exist in close proximity to runways.
- Following consultation with aerial operators by an individual landowner prior to a proposed aerial application operation, if a particular risk at a specific site is identified, the landowner should consult with the transmission line operator, to consider equipping the transmission line with the markers detailed in the standards outlined in the AS 3891.2:2018 Air navigation – Cables and their supporting structures – Marking and safety requirements Part 2: Low level aviation operations.

Summary of key recommendations

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

Notification and reporting

1. 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 or not the structure will be hazardous to aircraft operations. The notification should be provided to CASA via email to Airspace.Protection@casa.gov.au .
2. 'As constructed' details of WMT 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. Department of Defence should be consulted if there is any subsequent modification in the WTG height or scale of development, using the following email address: land.planning@defence.gov.au.
4. Any obstacles above 100 m AGL (including temporary construction equipment) must be reported to the Airservices Australia NOTAM office (via phone number: 02 6268 5063) to ensure pilots have access to the information via a NOTAM until they are incorporated in published operational documents at a later date. 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
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
5. Details of the final wind farm layout should be provided to local and regional aircraft operators prior to construction so they can plan their operations accordingly.

Marking of wind turbine generators (WTGs)

6. The WTG blades, nacelle, hubs and towers should be painted white, off-white or light grey, typical of most WTGs operational in Australia. No additional marking measures are required for WTGs.

Marking of wind monitoring towers (WMTs)

7. Although there is no regulatory requirement, to mitigate aviation safety risks to low level aircraft operations in the area, consideration should be given to marking any WMTs according to the requirements set out in MOS 139 Section 8.110 (as modified by the guidance in NASF Guideline D). Specifically:
    a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires
    b. paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast

c. ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation or

d. a flashing strobe light during daylight hours.

Markers and markings are recommended. Flashing strobe lights are not recommended, in consideration of local community amenity.

Micrositing

8. 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 have been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level is within 100 m of the nominal 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 280 m AGL is implemented at all WTG locations. No further assessment is likely to be required from micrositing WTGs and the conclusions of this AIA would remain the same.

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1. INTRODUCTION

1.1. Situation

RES Australia Pty Ltd (RES Australia) is preparing a development application (DA) for a Material Change of Use (Wind Farm) for the proposed Tarong West Wind Farm (TWWF) (the Project).

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RES Australia has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) for the proposed Project and formally consult with aviation agencies before submitting the DA for consideration by the State Assessment and Referral Agency (SARA) of the Queensland Department of State Development, Infrastructure, Local Government and Planning (DSDILGP).

The AIA will review potential impacts identified in the TWWF Phase 1 Preliminary Aviation Assessment and provide aviation safety advice in respect of relevant requirements of air safety regulations and procedures and undertake consultation with relevant aviation agencies.

Initial consultation for the Project was completed in 2019 using a previous layout which incorporated up to 151 WTGs. The Project now incorporates up to 97 WTGs with overall less aviation impacts than initially consulted on. Since the initial consultation in 2019, numerous background changes have occurred including:

- some regulatory changes
- changes in the airway structure overhead at the project site
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This assessment has considered the changes that have occurred since 2019 and determined that the overarching findings and recommendations are consistent or have a lesser impact to aviation safety in the area.

Further consultation should not be necessary as all new data and operations have been considered as part of this assessment and do not create any significant differences to operations in the area.

1.2. Purpose and Scope

The purpose and scope of work is to prepare an AIA for consideration by Airservices Australia, Civil Aviation Safety Authority (CASA) and Department of Defence and progress any ongoing dialogue through the planning process.

The assessment will specifically respond to the:

- Queensland State Code 23: *Wind farm development (State Code 23)* of the State Development Assessment Provisions – version 3.0 effective 04 Feb 2022, specifically Performance Outcomes PO1 and PO2;
- South Burnett Shire Council Planning Scheme 2017 V1.4 – 4 January 2021; and
- National Airport Safeguarding Framework (NASF), Guideline D: *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*.

1.3. Methodology

In undertaking this task, Aviation Projects:

1. confirmed the scope and deliverables with RES Australia
2. reviewed client material
3. conducted a site visit to properly investigate aviation safety aspects and identifying existing tall structures within or adjacent to the proposed Project area
4. reviewed relevant regulatory requirements and information sources
5. identified 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*
6. consulted with South Burnett Regional Council, Part 173 procedure designers (Airservices Australia and The Airport Group) and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures
7. consulted/engaged with relevant stakeholders to negotiate acceptable outcomes; and
8. finalised the AIA report following receipt of feedback from stakeholders.

1.4. Aviation Impact Statement

The Aviation Impact Statement (AIS) includes the following specific requirements as advised by Airservices Australia:

Aerodromes:

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

Air Routes:

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

Airspace:

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

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Stakeholders

An appropriate and justified level of consultation was undertaken with the following parties and considered in the preparation of this report:

- Airservices Australia
- aerial agricultural operators – South Burnett Air Services
- aerodrome operators - South Burnett Regional Council
- aircraft operators – Regional Express and Fly Corporate
- Civil Aviation Safety Authority
- Department of Defence
- The Airport Group
- Queensland Fire and Emergency Services (firefighting operators)
- Royal Flying Doctor Service
- South Burnett Regional Council
- other stakeholders where noted.

Since the initial consultation in 2019, numerous background changes have occurred including –

- some regulatory changes
- changes in the airway structure overhead the project site
- changes in the instrument flight procedures at Kingaroy Airport.

1.6. Material reviewed

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

- RES Australia Iron Leaf Wind Farm - 275kV tower.pdf file– email received 04 February 2022
- InfrastructureAreas_PAUSilf138_97T_20230721.kmz
- PAUSilf138_locked.kmz
- PAUSilf138 Coordinates and Elevation.xlsx

1.7. References

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

- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures and En Route Supplement Australia dated 30 November 2023
- Civil Aviation Safety Authority, Civil Aviation Regulations 1998 (CAR)
- Civil Aviation Safety Authority, Civil Aviation Safety Regulations 1998 (CASR)
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 92-1(1): Guidelines for aeroplane landing areas, dated July 1992
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 166-01 (v4.2): Operations in the vicinity of non-controlled aerodromes, dated February 2019
- Civil Aviation Safety Authority, Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design, version 1.5, dated March 2016
- Civil Aviation Safety Authority, *Part 139 (Aerodromes) Manual of Standards 2019 (as amended)*, dated 13 August 2020
- Civil Aviation Safety Authority, Advisory Circular (AC) 139-08 v2.0: *Reporting of Tall Structures*, dated March 2018
- QLD State Government, Department of State Development, Infrastructure, Local Government and Planning (DSDILGP), , Development Assessment mapping system and State Planning Policy Planning interactive mapping system
- QLD State Government, Department of State Development, Infrastructure, Local Government and Planning (DSDILGP), , State Development Assessment Provisions (SDAP), State Code 23: Wind Farm

Development and State Code 23: Wind farm development Planning Guideline (August 2023), SDAP version 3.0,

- Department of Infrastructure and Regional Development, Australian Government, National Airport Safeguarding Framework, Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*, dated June 2013
- International Civil Aviation Organization (ICAO) Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS)
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes
- OzRunways, aeronautical navigation charts extracts, dated 9 August 2022
- South Burnett Regional Council, South Burnett Regional Council Planning Scheme, 04 January 2021, version 1.4
- Standards Australia, ISO 31000:2018 *Risk management - Guidelines*
- Standards Australia, AS 3891.2:2018 *Air navigation – Cables and their supporting structures – Marking and safety requirements Part 2: Low level aviation operations*
- EUROCONTROL Guidelines on assessing the potential impact of wind turbines on surveillance sensors
- Other references as noted.

2. BACKGROUND

2.1. Site overview

An overview of the proposed Project layout and site area is provided in Figure 1 (Source: RES Australia, Google Earth).

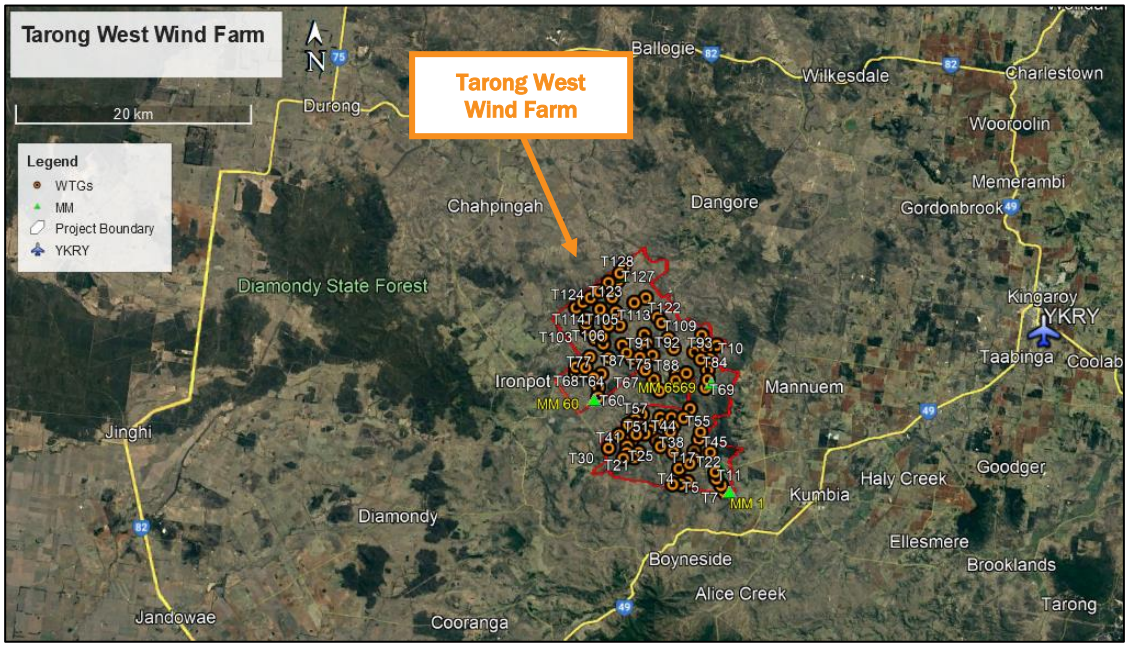

Figure 1 Proposed Project site overview

2.2. Project description

The proposed Project is to consist of up to 97 WTGs with an overall height of up to 280 m AGL.

Note that final turbine selection is subject to detailed design and actual turbine details may differ – but the maximum tip height of 280 m is fixed.

3. EXTERNAL CONTEXT

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

The Department of State Development, Infrastructure, Local Government and Planning (DSDILGP) released the State Development Assessment Provisions (SDAP), version 3.0, commencing on 04 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:*
>
> *(1) the safety, operational integrity and efficiency of air services and aircraft operations.*

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

Table 1 State Code 23, Wind Farm development V3.0) - Performance Outcomes for aviation safety, integrity and efficiency

Performance outcomes Aviation safety, integrity and efficiency	*Acceptable outcomes*
PO1 Development does not adversely affect the safety, operational integrity and efficiency of air services and aircraft operations as a result of its: 1. location; 2. siting; 3. design; 4. 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
- Consult with relevant entities detailed in Section 5.

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

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

3.2. South Burnett Regional Council

South Burnett Regional Council Planning Scheme (04 January 2021, version 1.4) contains information planning information regarding the Kingaroy Airport and incorporates an Airport Environs Overlay (Map 01).

Figure 2 illustrates the South Burnett Planning Scheme Airport Environs Overlay Map dated October 2017 (source: South Burnett Regional Council).

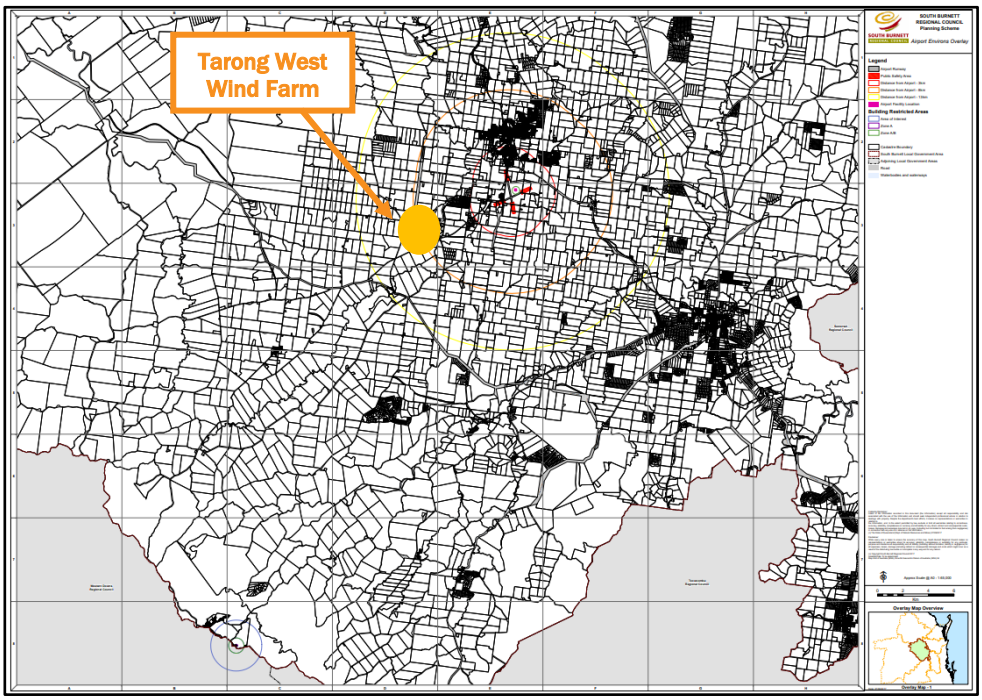

Figure 2 South Burnett Planning Scheme Airport Environs Overlay Map

The South Burnett Planning Scheme v1.4 identifies planning constraints with respect to Kingaroy Airport.

Part 6, Section 6.2.13 applies to assessing a material change of use or a reconfiguring a lot for development in the rural zone.

PO16 identifies the airport environs overlay and a public safety sub-area located at the ends of runways to a distance of approximately 900 m from the end of each runway.

The Project is located outside of the public safety areas shown on map OM-1 Airport Environs Overlay, shown below in Figure 3.

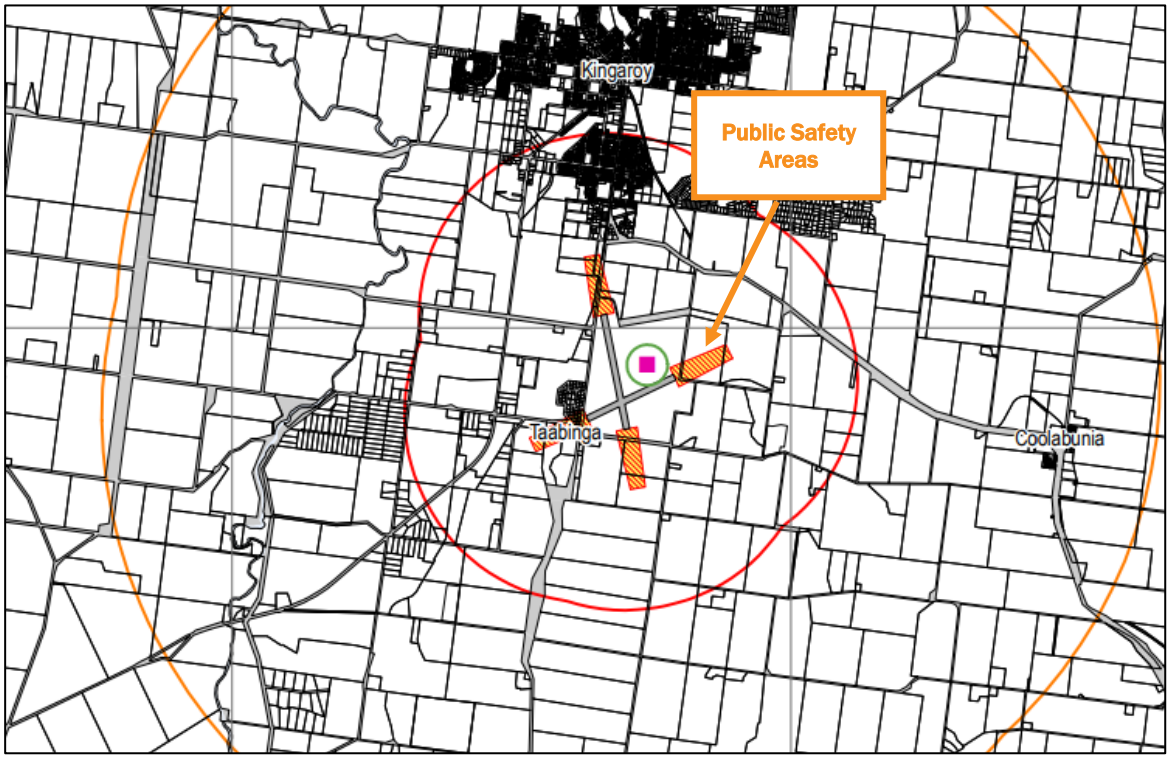

Figure 3 Kingaroy Airport Public Safety Areas

3.3. Aircraft operations at non-controlled aerodromes

CASA Advisory Circulars (AC) are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of compliance with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative, and explanatory material. AC 91-10 v1.1 – *Operations in the vicinity of non-controlled aerodromes* – 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.

AC-91-10, Section 7 describes the standard aerodrome traffic circuit procedures.

The standard circuit consists of a series of flight paths known as *legs* when departing, arrival or when conducting circuit practice. Illustrations of the standard aerodrome traffic circuit procedures are provided in Figure 4 and Figure 5.

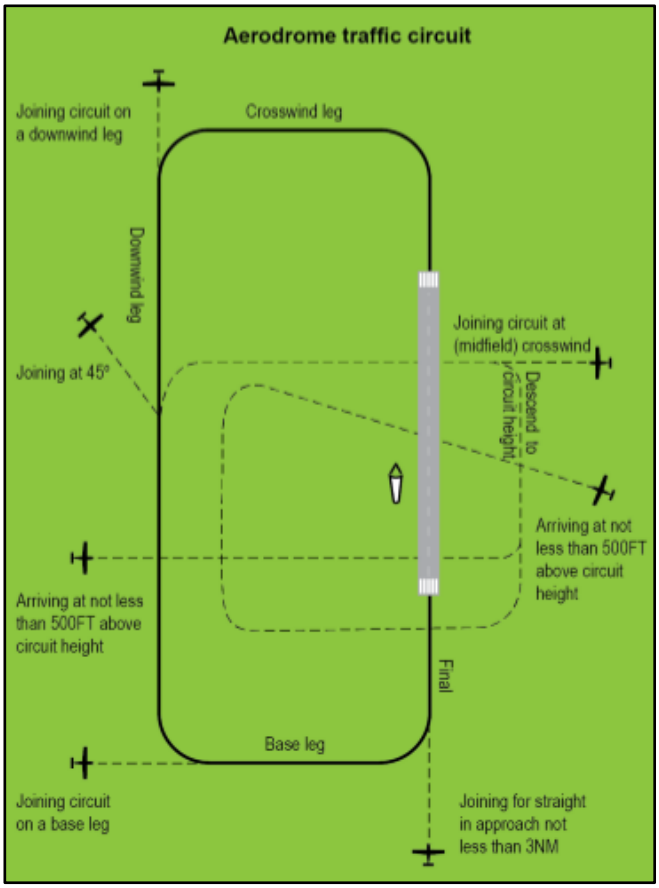

Figure 4 Aerodrome standard traffic circuit, showing arrival and joining procedures

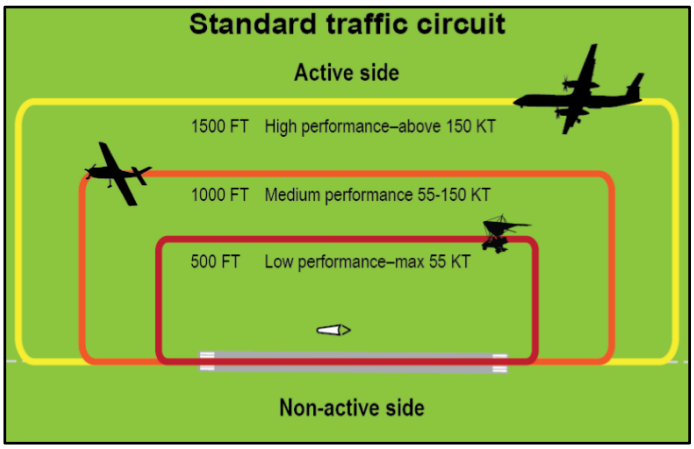

Figure 5 Lateral and vertical separation in the standard aerodrome traffic circuit

3.4. Rules of flight

3.4.1. 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 (Low flying) prescribes the minimum height for flight. Generally speaking, 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 (CASR 91.267) in visual flight during the day when not in the vicinity of built-up areas, and 1,000 ft AGL over built up areas.

These height restrictions do not apply during take-off and landing at a suitable aerodrome.

Flight below these height restrictions is also permitted in certain other circumstances prescribed in CASR 91.265 including low level flying training and emergency procedures training.

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

With respect to flight under the VFR at night, Civil Aviation Safety Regulations (1998) 91.277 prescribes the minimum height of 1000 ft *"above the highest obstacle.....within 10 nautical miles ahead of, either side of, the aircraft at the point..." unless " during taking off or landing, within 3 nm of the aerodrome from which the aircraft has taken off or which the aircraft will land".*

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

According to CASR Subdivision 91.D.4.3, 91.287 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.

3.5. Aircraft operator characteristics

Flying training may be conducted under either the instrument flight rules (IFR) or visual flight rules (VFR). Other general aviation operations under either IFR or VFR, during the day or at night, 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). During the day, the WTGs will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. Day VFR operators will most likely avoid the Project site once WTGs are erected.

Flight under day VFR is conducted above 500 ft (152.4 m) above the highest point of the terrain within a 300 m radius (CASR 91.267) unless the operation is approved to operate below 500 ft above the highest point of the terrain.

Given the irregular shape, height, and white, off-white or light grey colour of the WTGs, it is expected that the WTGs will be sufficiently visually conspicuous to pilots conducting day VFR operations within the vicinity of the Project site to enable appropriate obstacle avoidance manoeuvring.

3.6. Passenger transport operations

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

3.7. 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.

3.8. 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 Department of Defence.

3.9. Aerial application operations

Aerial application operations are likely to be conducted in the pastoral areas surrounding and within the Project boundary.

Activities such as delivery of fertiliser, pest and crop spraying are generally conducted under day VFR below 500 ft AGL: usually between 60 ft (18.3 m) and 100 ft (30.5 m) AGL.

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

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

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

3.9.1. Aerial Application Association of Australia (AAAA)

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

As a result of the overwhelming safety and economic impact of wind farms and supporting infrastructure on the sector, AAAA opposes all wind farm developments in areas of agricultural production or elevated bushfire risk.

In other areas, AAAA is also opposed to wind farm developments unless the developer is able to clearly demonstrate they have:

1. consulted honestly and in detail with local aerial application operators;

2. sought and received an independent aerial application expert opinion on the safety and economic impacts of the proposed development;

3. clearly and fairly identified that there will be no short or long term impact on the aerial application industry from either safety or economic perspectives;

4. if there is an identified impact on local aerial application operators, provided a legally binding agreement for compensation over a fair period of years for loss of income to the aerial operators affected; and

5. adequately marked any wind farm infrastructure and advised pilots of its presence.

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

At the development stage, AAAA remains strongly opposed to all windfarms that are proposed to be built on agricultural land or land that is likely to be affected by bushfire. These areas are of critical safety importance to legitimate and legal low-level operations, such as those encountered during crop protection, pasture fertilisation or firebombing operations.

However, AAAA realises that some wind farm proposals may be approved in areas where aerial application takes place. In those circumstances, AAAA has developed the following national operational protocols to support a consistent approach to aerial application where windfarms are in the operational vicinity.

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

3.9.2. 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 5.

To facilitate the flight planning of aerial application operators, details of the Project, including location and height information of WTGs, wind 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.

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

3.10. Emergency services

3.10.1. 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.

Refer to Refer to Section 5 for detailed responses from emergency service stakeholders.

3.10.2. 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 description

The wind farm is situated in an area comprised mainly of farming properties on a gently rolling landscape with medium terrain hills. The site is located north of the Bunya Highway on freehold farmland.

Figure 6 shows a view looking west from Mannuem Road towards the proposed Project. The recently constructed WTGs for the Coopers Gap Wind Farm are located nearby the Project site and can be seen from this location.

Figure 6 Mannuem Road looking west at the proposed Project site

Figure 7 shows a view from Ironpot Road looking to the north-west towards the proposed Project site.

Figure 7 Ironpot Road looking north-west towards the proposed Project site

Figure 8 shows a view looking north-west to the Project site from the intersection of Ironpot and Jarail Roads.

Figure 8 Intersection of Ironpot and Jarail Roads looking north-west at the Project site

4.2. Wind Turbine Generator description

The maximum blade tip height of the proposed WTGs will be up to 280 m AGL.

The maximum ground elevation for the proposed T4 WTG is 580.7 m AHD, which results in a maximum overall height of 860.7 m AHD (2823.7 ft AMSL) located north of the Bunya Highway.

Figure 9 provides the proposed Project layout (source: RES Australia, Google Earth).

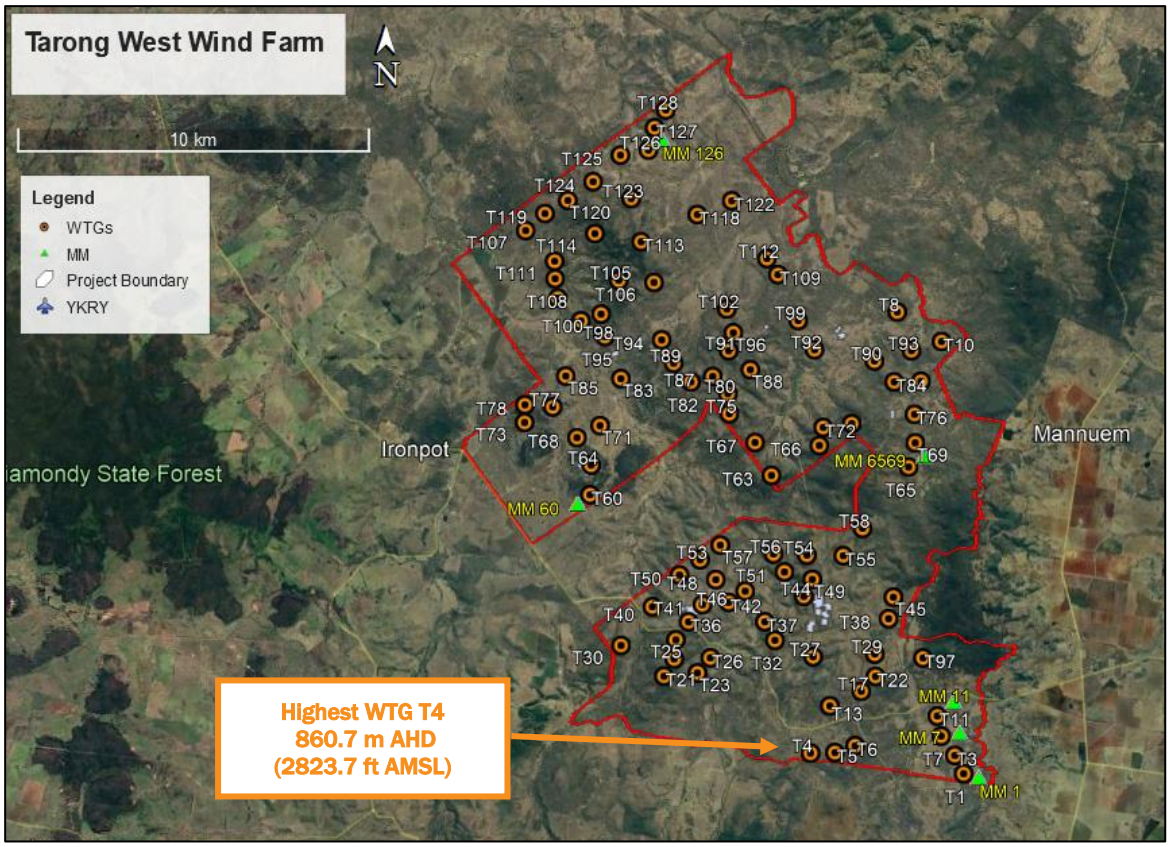

Figure 9 Proposed Project layout and highest WTG

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

The coordinates and ground elevation of the Project WTGs are listed in Annexure 1.

4.3. Grid transmission alignment

RES Australia advised a 275 kV Overhead line will run through the site to reticulate electricity back to the switching station and into the National Electricity Market. This would involve limited overhead wiring throughout the project site, typically of a height no more than 43 m AGL. Figure 10 refers to typical details.

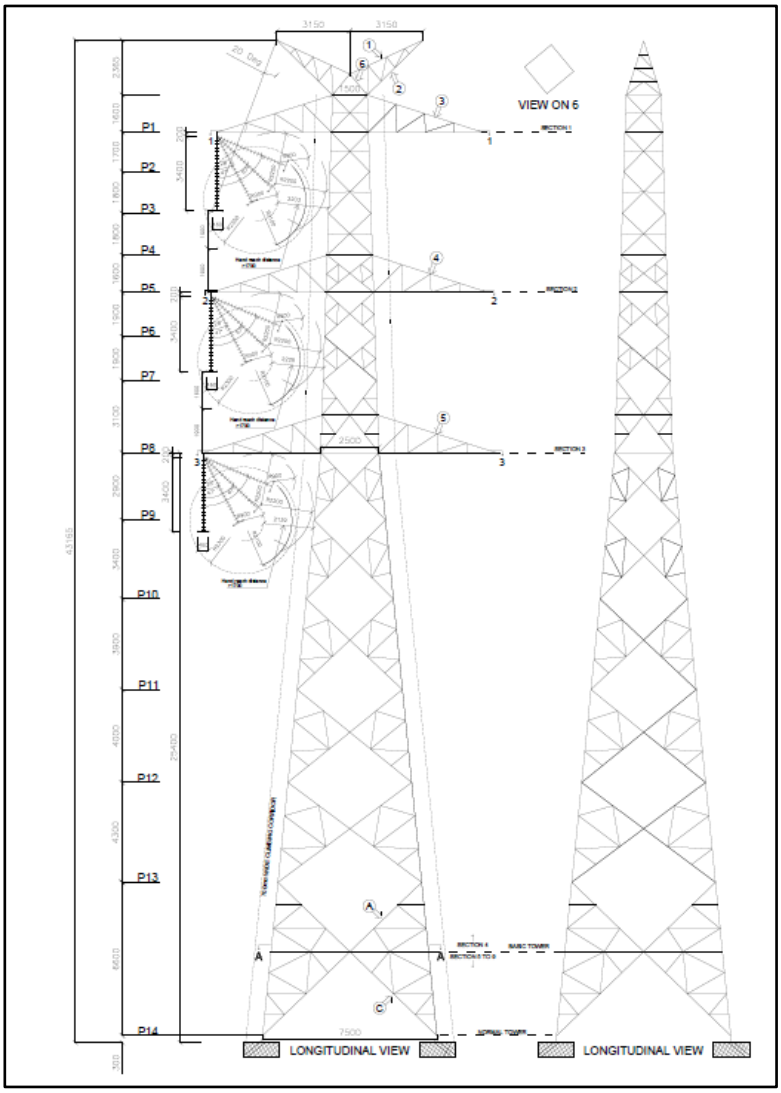

Figure 10 typical details of dimensions of towers

Designs are subject to change during detailed design, and the indicative designs provided are to indicate potential height to enable assessment under the AIA.

5. CONSULTATION

Consultation was initially conducted in 2019 when the project consisted of up to 151 WTGs.

The project has since been modified to include a reduced WTG layout consisting of 97 WTGs.

The following stakeholders were consulted:

- Airservices Australia
- aerial agricultural operators – South Burnett Air Services
- aerodrome operators - South Burnett Regional Council
- aircraft operators – Fly Corporate and Regional Express
- Civil Aviation Safety Authority
- Department of Defence
- The Airport Group
- Queensland Fire and Emergency Services (firefighting operators)
- Royal Flying Doctor Service
- South Burnett Regional Council
- other stakeholders where noted.

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

The consultation is still valid as the WTGs that have been removed have reduced the impact to some areas.

This updated AIA should be provided to Airservices Australia to enable them to update their information and assessment.

Table 2 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices Australia	12 November 2019 Email to Airport Developments	12 December 2019 Email from Mr John Graham (Airport Development Applications Coordinator)	*Note: The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* During initial email consultation Airservices Australia was informed of the Project. In an email response, Mr Graham advised that Airservices requires that the operator of Kingaroy Airport (South Burnett Regional Council), to be consulted and to confirm that the proposed permanent changes to the MSA and RNAV (GNSS) RWY 16 will not adversely impact on operations before any change (temporary or permanent) can be supported by Airservices. The wind farm, to a maximum height of 861m/2824ft AHD, will not adversely impact the performance of Precision/Non-Precision Navigational Aids, HF/VHF Communications, A-SMGCS, Radar, PRM, ADS-B, WAM, or Satellite/Links. Further Airservices Australia advised that any Airservices work associated with amending the flight procedures would be	Consult the operator of Kingaroy Airport (South Burnett Regional Council) – **completed.** Airservices work associated with amending the flight procedures will be undertaken on a commercial basis, which requires further consultation with Airservices **– to be completed once construction is complete.**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			undertaken on a commercial basis which would require further consultation with Airservices. Additionally if the wind farm receives approval, as soon as construction commences, the proponent must complete the Vertical Obstacle Notification Form for tall structures and submit the completed form to VOD@airservicesaustralia.com.	
Airservices Australia	10 February 2022 Email to Airport Developments	4 May 2022 Email from William Zhao (Advisor Customer Engagement)	***Response:*** ***Airspace Procedures*** *With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 870m/2855ft AHD, the wind farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Kingaroy aerodrome.* *The wind farm will affect route V250. The route LSALT will need to be increased to by 300ft from 3600ft to 3900ft for the wind farm to have no impact.* *Note: procedures not designed by Airservices at Kingaroy aerodrome were not considered in this assessment.* ***Communications/Navigation/Surveillance (CNS) Facilities*** *We have assessed the proposal to a maximum height of 870m/2855ft AHD for any impacts to Airservices Precision/Non-Precision Navigation Aids, Anemometers, HF/VHF/UHF*	No further assessment required. RES After approval is granted: - Reporting of Tall Structures to be undertaken. - Contact Airservices Australia to organise amendment to air route V250.

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			Communications, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links and have no objections to it proceeding. ***Summary*** *Based on the above assessment, our view is that the proposed Tarong West Wind Farm would not have an impact on Airservices designed instrument procedures, CNS facilities or ATC operations at Kingaroy Airport. However, the wind farm will impact the V250 route LSALT.* *Note: All work we conduct to amend the V250 route LSALT will be undertaken on a commercial basis and require further consultation.* ***Vertical Obstacle Notification*** *If this wind farm receives approval, we request that the proponent completes the Vertical Obstacle Notification Form for tall structures and submits it to VOD@airservicesaustralia.com as soon as the development reaches the maximum height.* *For further information regarding the reporting of tall structures, please contact (02) 6268 5622, email VOD@airservicesaustralia.com or refer to the web links below:* *Civil Aviation Safety Regulation Part 175 — Airservices and You - Airservices (airservicesaustralia.com)*	

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			Vertical Obstacle Notification Form: *https://www.airservicesaustralia.com/wp-content/uploads/Tall-Structure-Vertical-Obstacle-Form.pdf*	
Aerial agricultural operators **(South Burnett Air Services)**	12 November 2019 Email to South Burnett Air Services	9 January 2020 Email from Mr Frank Drinan (Operator and Chief Pilot SBAIR)	*Note: The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* During initial email consultation SBAIR was informed of the Project. In an email response, Mr Drinan advised that SBAIR conducts aerial application flights from Kingaroy and Wondai, with flights being conducted at low level in the same environment as wind farms. Mr Drinan advised that the Project is located outside of any major cropping areas that they look after in the South Burnett, although it is adjacent to the Mannuem region there is sufficient distance from the cropping areas. The main aerial application activity likely to be conducted in the Project area is the application of pellet herbicides, the ad hoc placement of the WTGs could preclude the conduct of any pellet applications in the area. There is the potential for a hazard to aircraft ferrying across the Bunya Mountains in poor weather, Aircraft will normally fly to the north of the mountains in times of low cloud cover to avoid the	No further actions required

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			higher ground. The windfarm may add to these hazards however there is also another windfarm to the west which has already made this an area of concern. Finally, Mr Bruce advised that SBAIR aircraft are being used to assist QFES ground crews in waterbombing for firefighting efforts. He advised that given the complex and low visibility nature of the operations he assessed that aerial firefighting would not be able to be done within the proposed Project area, which could bring additional concerns.	
Airline operators (Fly Corporate)	9 January 2020 Email to Fly Corporate	26 February 2020 Email from Ms Jenna Corporate Air – Charter Department	*Note: The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* At the request of South Burnett Regional Council, Fly Corporate were consulted about the Project. In an email response, Ms Jenna advised that Fly Corporate does not currently operate RPT services at Kingaroy or in the vicinity and this is extremely unlikely to change in the foreseeable future. As such, there will be no impact to our current flying operations.	No further actions required.

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airline operators (Regional Express)	9 January 2020 Email to Regional Express (REX)	25 February 2020 Email from Mr Steve Jones State Manager QLD	*Note: The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* At the request of South Burnett Regional Council, REX were consulted about the Project. In an email response Mr Jones advised that Rex do not foresee any issues with this. Their assessment usually goes to 13nm around an airport and all the WTGs are outside that area. The increase in altitudes for the instrument approach don't cause an increase in approach gradient and the missed approach gradient is also unaffected. Further, Rex do not currently operate RPT services to Kingaroy and do not anticipate doing so in the foreseeable future.	No further actions required
Civil Aviation Safety Authority	CASA has advised that it will only review assessments referred to it by a planning authority or agency. RES engaged with QLD State Assessment and Referral Agency via a pre-lodgement meeting on Thursday 5th July 2023 who confirmed this was the case.			
Department of Defence	12 November 2019 Email to Department of Defence	6 April 2020 letter from Charles Mangion (Director Land Planning and	*Note: The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.*	Submit Final AIA to CASA – **no further actions required.** Notify Airservices Australia of 'as-constructed' details – **not completed.**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
		Regulation) Department of Defence	During initial email consultation the Department of Defence was informed of the Project. In the formal letter response, Mr Mangion advised Defence has conducted an assessment of the amended proposal for potential impacts on the safety of Defence flying operations as well as possible interference to Defence communications and radar. Defence has no objection to the proposed wind farm provided that the project complies with the conditions outlined in the letter response (refer to Annexure 2). Defence recommends that the risk assessment be submitted to the Civil Aviation Safety Authority (CASA) to determine whether the proposal is a hazard to aircraft safety and requires approved lighting or marking. Defence requests that the applicant provide ASA with "as constructed" details. The details can be emailed to ASA at vod@airservicesaustralia.com A letter response from the Department of Defence with reference ID-EP-DLP&R/OUT/2020/BS9566076, dated 6 April 2020 is provided in Annexure 2.	
The Airport Group	12 November 2019 Email to The Airport Group	10 December 2019 Email from Ray Romano (Airspace	*Note: TAG no longer produces the instrument flight procedures for YKRY. This consultation is no longer valid.* *The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and*	Consult the operator of Kingaroy Airport (South Burnett Regional Council), consult with Airservices Australia– **completed.** The Airport Group work associated with amending the flight procedures for RNAV-

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
		Specialist, Chief Designer TAG)	*location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* During initial email consultation The Airport Group (TAG) was informed of the Project. In an email response and an additional report, TAG confirmed that the proposed changes to the 10 nm and 25 nm MSA would be required in order to accommodate the Project. Additionally, the missed approach climb for RNAV-z RWY 34 would need to be amended. TAG advised that they would only endorse the project with the support of Airservices Australia, and the South Burnett Regional Council. Additionally, upon approval of the Project, Instrument Flight Procedures for YKRY RNAV-z (GNSS) RWY 34 would need to be re-designed and a new procedure plate published, which would need to occur on a commercial basis.	z (GNSS) for RWY 34 will need to be undertaken on a commercial basis, which requires further consultation with TAG – **not required as TAG no longer produces the instrument flight procedures at YKRY. Airservices Australia produces the instrument flight procedures. Airservices to be consulted on updated project layout – complete.**
Queensland Fire and Emergency Services	12 November 2019 Email to Queensland Fire and Emergency Services	7 January 2020 Email from Mr Wesley Bruce (Acting Inspector, Manager Air Operations)	*The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* During initial email consultation QFES was informed of the Project. In the email response, Mr Bruce advised that the Project will not impact in anyway the response from their aviation assets to	Keep informed of the project. No further actions required.

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
			Bushfires. Further, Mr Bruce advised that they would work with Airservices Australia should they need to resolve any issues arising from the project in the future.	
Royal Flying Doctor Service	12 November 2019 Email to Royal Flying Doctor Service	13 November 2019 Email from Mr Anthony Hooper (Manager Line Operations)	*The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* During initial email consultation RFDS was informed of the Project. In the email response, Mr Hooper advised that the Project will not impact on the RFDS' operations in the area, in particular RFDS' operations at Kingaroy aerodrome to which they operate. Further Mr Hooper advised RFDS will not be impacted by the proposed raising of the 10 nm MSA by 200ft to 3600ft	No further actions required.
South Burnett Regional Council	12 November 2019 Email to South Burnett Regional Council	5 December 2019 Email from Mr Michael Hunter (Senior Recreation and Services Officer)	*The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* During initial email consultation South Burnett Regional Council were informed of the Project. In the email response, Mr Hunter advised that the council does not see any perceived issues with the Project impact Kingaroy Airport. However, the council was	Await further communication from council regarding recommended changes – **completed.**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			seeking further advice regarding the recommended changes to the MSA.	
South Burnett Regional Council		20 December 2019 Letter from Mr Greg Griffiths (Manager NRM and Parks)	*The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* After initial consultation regarding the Project, South Burnett Regional Council sought additional advice regarding the recommended changes to the MSA at Kingaroy Airport. In the letter council had additional questions pertaining to the Project and impacts that it would have on Kingaroy Airport. Council noted the limited feedback from users of the Kingaroy Airport, and how the Project would affect operations at the Airport particularly for Emergency Services and any potential future RPT opportunities. The council proposed additional questions in order for them to understand the project further: *What would the impact (if any) be if KRY was to secure RPT operations at some point in the future?* *What is the nature of the feedback received from other stakeholders?*	Respond to the questions raised by council, additional consultation (Fly Corporate and Regional Express), and await formal feedback – **completed.**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			What is the process for lowering the MSA, who would apply and what costs if any are there? *Is the purpose of raising the MSA to avoid having to light the obstacles, would all of the obstacles require lighting, and it there a degree of shadowing available by lighting the tallest?* *Has consultation occurred with neighbours within the vicinity of the wind farm?* Council advised that once they have received clarification of the matters raised, then they would provide additional formal feedback.	
South Burnett Regional Council		11 March 2020 Letter from Mr Greg Griffiths (Manager NRM and Parks)	*Note: TAG no longer produces the instrument flight procedures for YKRY (Airservices Australia no produce these).* *The project has since been modified to include a reduced WTG layout consisting of 97 WTGs. These previous aviation impacts which were identified are no longer valid due to the reduction and location of the remaining WTGs. The only impact is now on an over flying air route which has since been introduced since 2019.* Following additional clarification of matters raised, Council provided formal feedback. In the letter response Council advised that feedback had been reviewed and particular comments from Airservices Australia and The Airport Group report dated 12 December 2019 were noted. Additionally, Council followed up with The Airport Group on 21	Commence redesign Instrument Flight Procedure for YKRY RNAV-z (GNSS) RWY 34 and to publish a new procedure plate, further consultation with Airservices Australia, once completed. – **Redesign not required as this was based on previous layout. No further action required.**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			February 2020 to fully understand the required changes and associated costs which appear to be minimal. Council approves of the necessary changes to the flight charts to ensure the safety of aircraft and allow for the development of the Tarong West Wind Farm Project on the following conditions: • All associated costs are met by the Tarong West Wind Farm project in undertaking the amendments to the existing flight charts • All recommendations contained within The Airport Group report dated 12 December 2019 are met • All changes are approved and accepted by Airservices Australia and The Airport Group prior to the commencement of the Tarong West Wind Farm project.	

6. AVIATION IMPACT STATEMENT

6.1. Nearby certified aerodromes

Kingaroy Airport (YKRY) is the only certified or military aerodrome that is located within 30 nm of the Project site. The airport is located approximately 27.8 km (15 nm) east of the TWWF boundary.

Buffer areas for Kingaroy Airport extending to 10 nm MSA (+ 5 nm buffer) and 25 nm MSA (+5 nm buffer) are shown in Figure 11 (source: RES Australia, Google Earth).

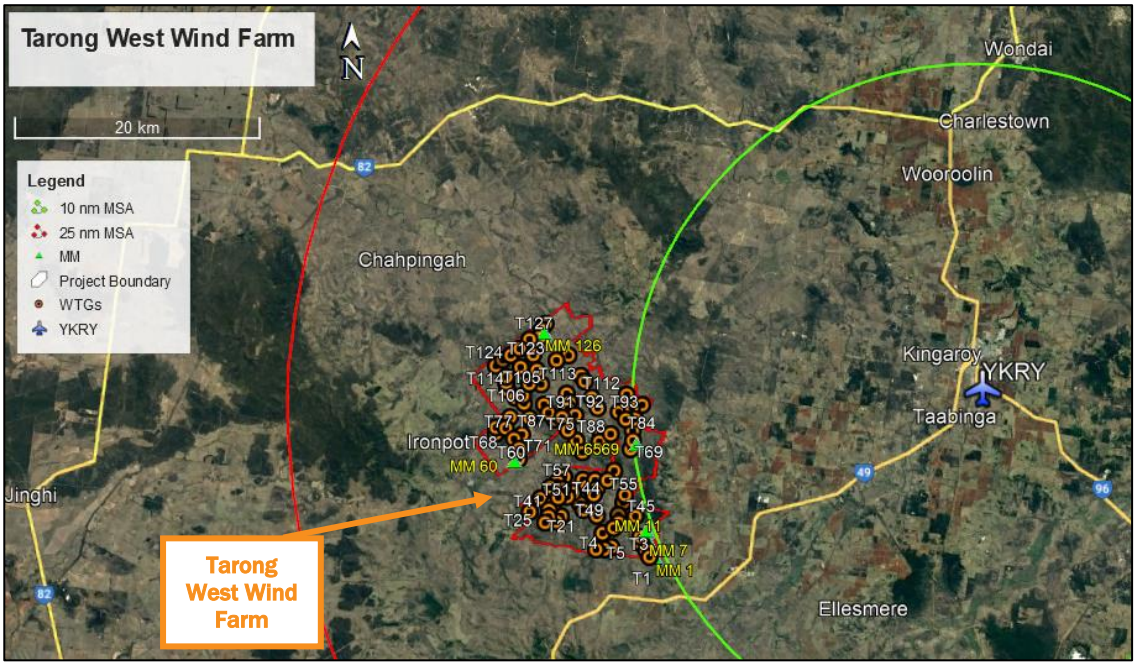

Figure 11 Kingaroy Airport's 25 nm and 10 nm MSA areas

6.2. Kingaroy Airport

Kingaroy Airport (YKRY) is a certified, code 3, instrument non-precision approach runway, operated by South Burnett Regional Council, with a published aerodrome elevation of 455 m AHD (1492 ft AMSL) (source: Airservices Australia, AIP Australia, 30 November 2023).

Kingaroy Airport has three runways:

- runway 16/34 sealed surface with a length of 1600 m, width 30 m and runway strip 150 m
- runway 05/23 grass surface with a length of 1303 m, width 30 m and runway strip 90 m and has shared glider operations; and
- parallel airstrip to runway 16/34 for glider operations (Kingaroy Soaring Gliding Club).

Figure 12 shows the Kingaroy Airport (YKRY) runway layout and location of the airstrip used for glider operations (source: Airservices Australia).

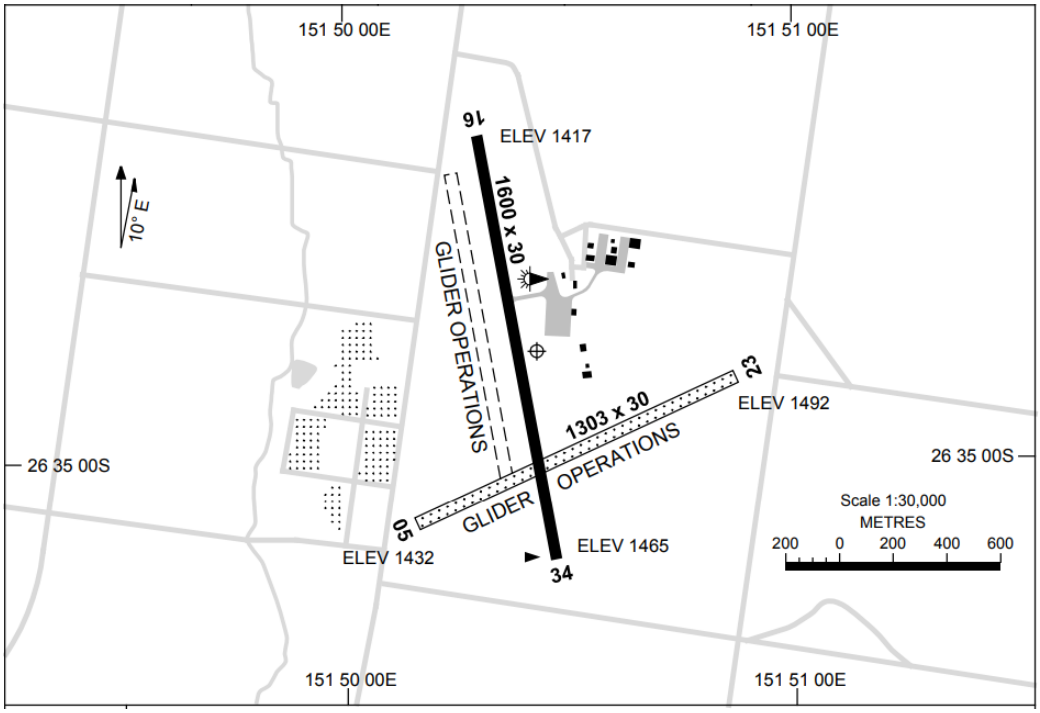

Figure 12 Kingaroy Airport (YKRY) runway layout

Kingaroy Airport Aerodrome Reference Point (ARP) coordinates published in Airservices Australia's Designated Airspace Handbook are Latitude 26°34'51"S and Longitude 151°50'28"E.

Kingaroy Airport has aerodrome and approach lighting, including runway edge lighting and Pilot-Activated Lighting (PAL). Night operations consist of some training flights and medivac operations of patients to coastal hospitals.

6.3. Instrument procedures

A check of the AIP via the Airservices Australia website showed that Kingaroy Airport is served by non-precision terminal instrument flight procedures, as per Table 3 (source: Airservices Australia, effective 30 November 2023).

Procedure charts for Kingaroy Airport are designed by Airservices Australia (AsA).

Table 3 Kingaroy Airport (YKRY) aerodrome and procedure charts

Chart name	*Effective date*
AERODROME CHART	15 June 2023 (Am-175)
RNP RWY 16	15 June 2023 (Am-175)
RNP RWY 34	15 June 2023 (Am-175)

6.4. PANS-OPS surfaces

The minimum safe altitude (MSA) is applicable for each instrument approach procedure at Kingaroy Airport. An image of the MSA published for the aerodrome is shown in Figure 13.

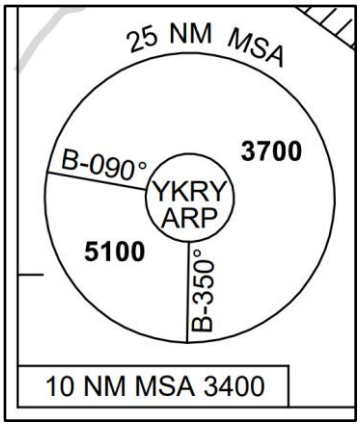

Figure 13 MSA at Kingaroy Airport

The Manual of Standards 173 *Standards Applicable to Instrument Flight Procedure Design* (MOS 173), requires that a minimum obstacle clearance (MOC) of 984 ft above the highest terrain or obstacle within the lateral limits of the MSA area is maintained.

Within 30 nm (25 nm MSA + 5 nm buffer) of Kingaroy Aerodrome Reference Point (ARP), aircraft are subject to the following minimum sector altitudes:

- 3700 ft AMSL between bearings 090°M and 350°M, north anticlockwise from the 090 bearing (270 from YKRY ARP); and

5100 ft AMSL between bearings 350°M and 090°M, west anticlockwise from 350 bearing (170 from YKRY ARP.

Figure 14 shows Kingaroy Airport MSA sectors (source: Airservices Australia, RES Australia and Google Earth).

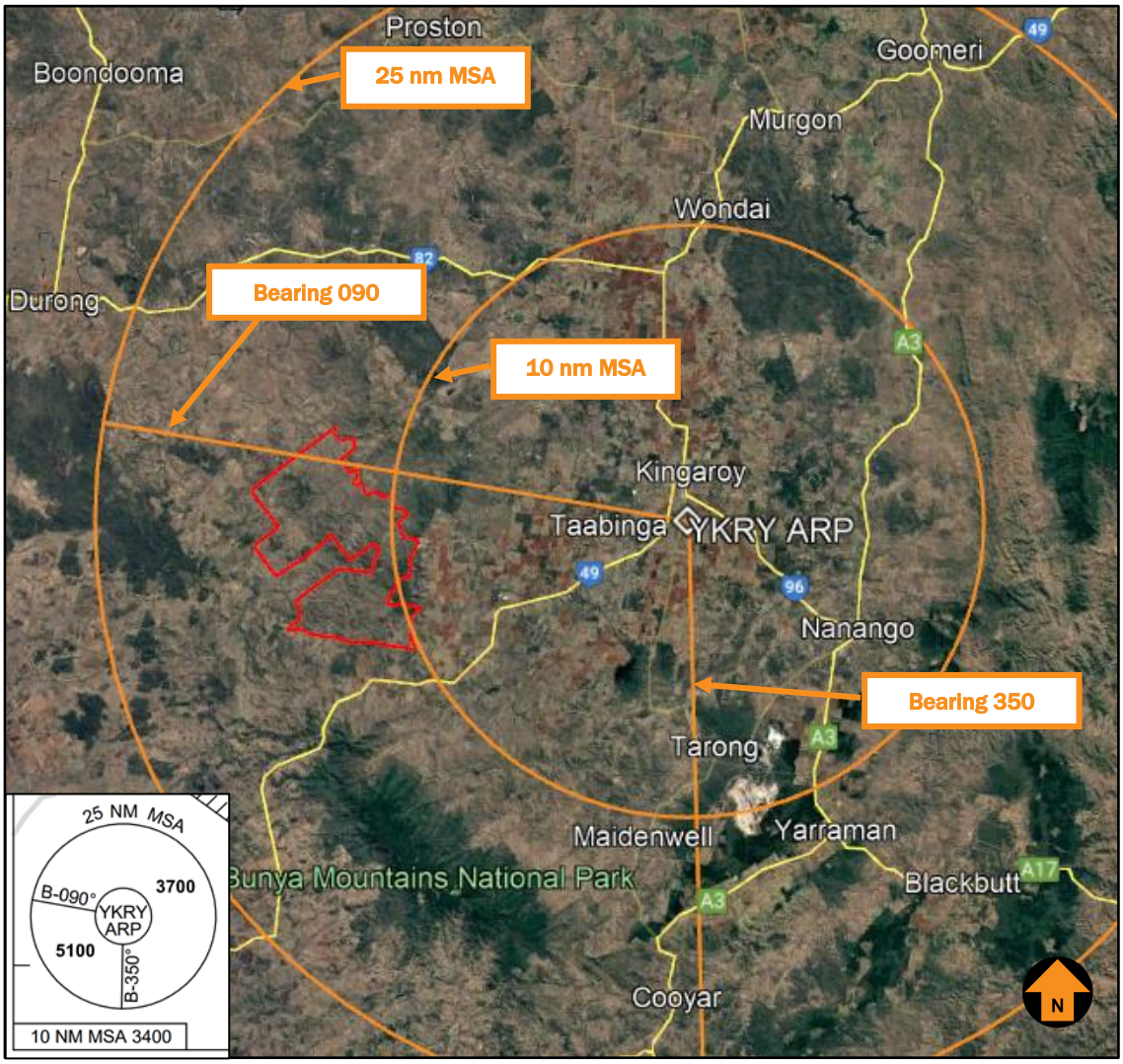

Figure 14 Kingaroy Airport MSA sectors

10 nm MSA

Five (5) WTGs are located within the 10 nm MSA area of Kingaroy Airport' ARP, all of which infringe the PANS-OPS surface of 2400 ft AMSL.

Figure 15 shows WTGs are located within the 10 nm MSA boundary of Kingaroy Airport (source: RES Australia, Google Earth).

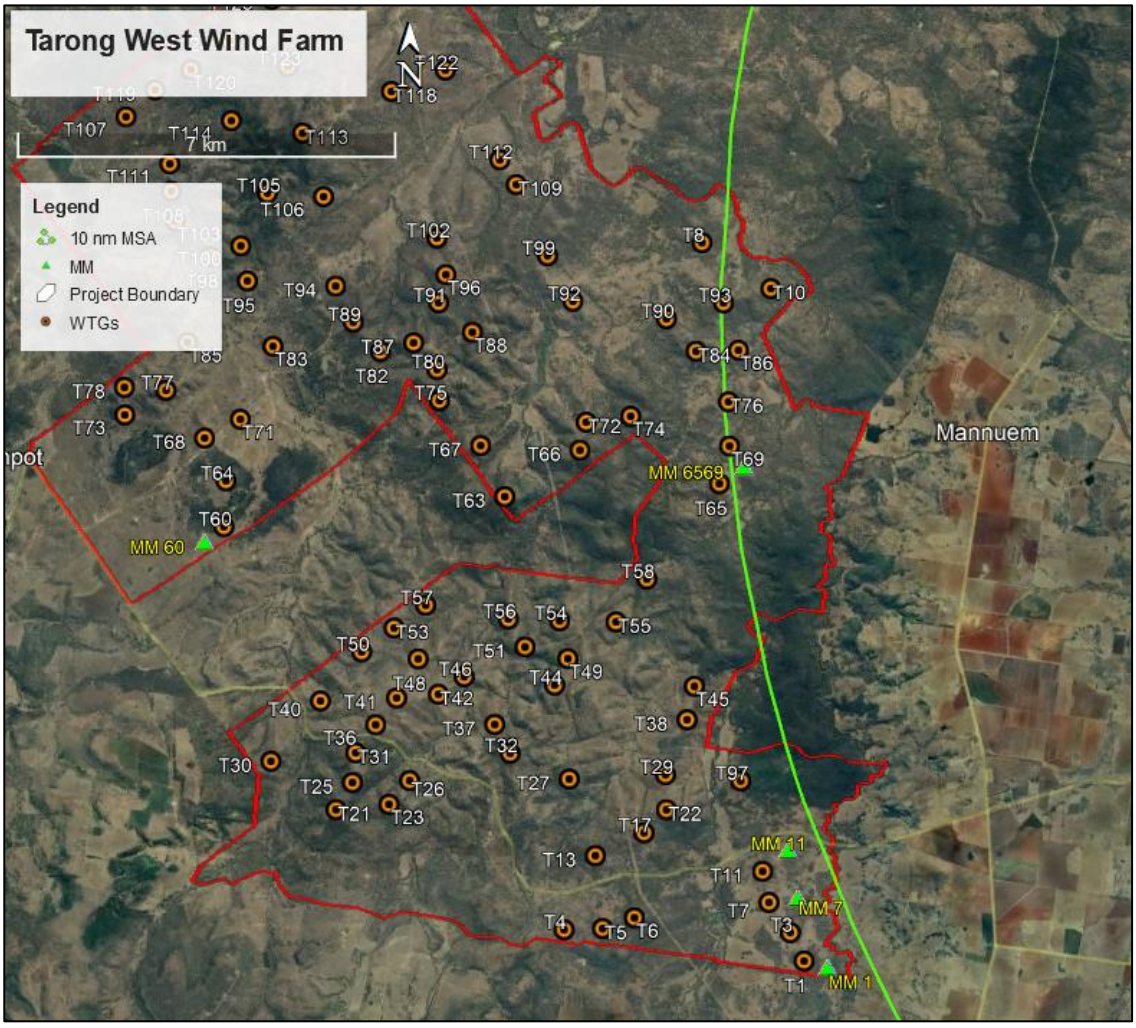

Figure 15 Kingaroy Airport 10 nm MSA

The largest infringement is created by T69 and T93 (97 ft) and will require the 10 nm MSA minimum altitude to be increased by 100 ft to 3500 ft AMSL. This increase is unlikely to cause an adverse impact to aviation safety and are likely to be approved by airport management, Airservices Australia and CASA.

25 nm MSA

The maximum allowable obstacle heights for the 25 nm MSA are respectively 2716 ft AMSL and 4116 ft AMSL.

The highest WTG located inside the horizontal extent of the 25 nm MSA of Kingaroy Airport in the sector between bearings 350° and 090° from the YKRY ARP is WTG T4. This includes a 5nm buffer south of the 090 bearing.

All WTGs located within the 5 nm of the bearing 090° have a maximum height below 2700 ft AMSL and therefore do not infringe the 25 nm minimum height in the northern sector. Refer to Figure 16 (source: RES Australia, Google Earth).

The maximum overall height for WTG T4 is 860.7 m AHD (2823.7 ft AMSL) which is below the maximum allowable obstacle height of 4116 ft AMSL. Therefore, the 25 nm MSA will not be impacted.

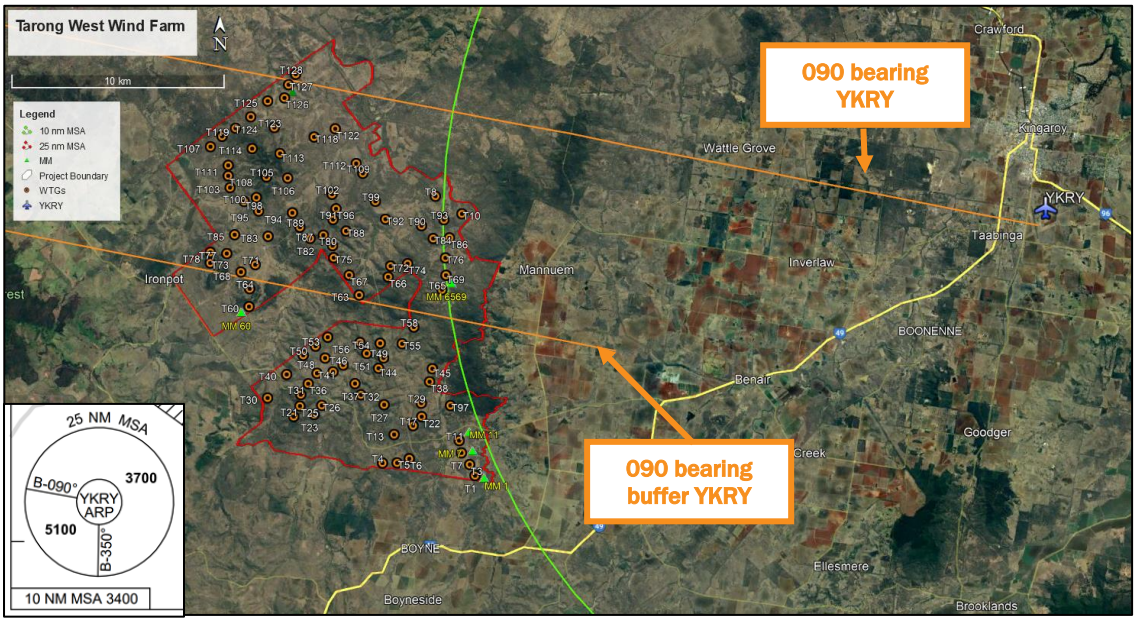

Figure 16 Analysis of the 25 nm MSA sector areas

6.5. IFR Circling areas

All WTGs are located beyond the horizontal extent of all circling areas at Kingaroy Airport.

6.6. Obstacle limitation surfaces

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

The closest proposed WTG is located approximately 24 km (13 nm) west from Kingaroy Airport.

Therefore, the Project site is located outside the horizontal extent of obstacle limitation surfaces and will not impact the OLS of any certified airport.

6.7. Nearby aircraft landing areas

A search on OzRunways, which sources its data from Airservices Australia (AIP) and Aircraft Owners and Pilots Association (AOPA) Australia Airfield Directory, returned no further nearby non-regulated aerodromes within a nominal 3 nm buffer from the Project site. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

The closest aircraft landing area (ALA) is the Rosevale ALA located approximately 19.5 km (10.5 nm) west of the Project boundary.

6.8. Air route and Grid LSALT

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

The Project is wholly located in the area with a Grid LSALT of 1585 m AHD (5200 ft AMSL) with a maximum allowable obstacle height of 1280 m AHD (4200 ft AMSL).

The highest WTG T4, with a maximum overall height of 860.7 m AHD (2823.7 ft AMSL) is below the LSALT maximum allowable obstacle height of 4200 ft AMSL. Therefore, the proposed Project will not affect the grid LSALT of 5200 ft AMSL.

Figure 17 provides the grid LSALT and air routes in proximity to the proposed Project (source: ERC Low National, OzRunways, 16 June 2022).

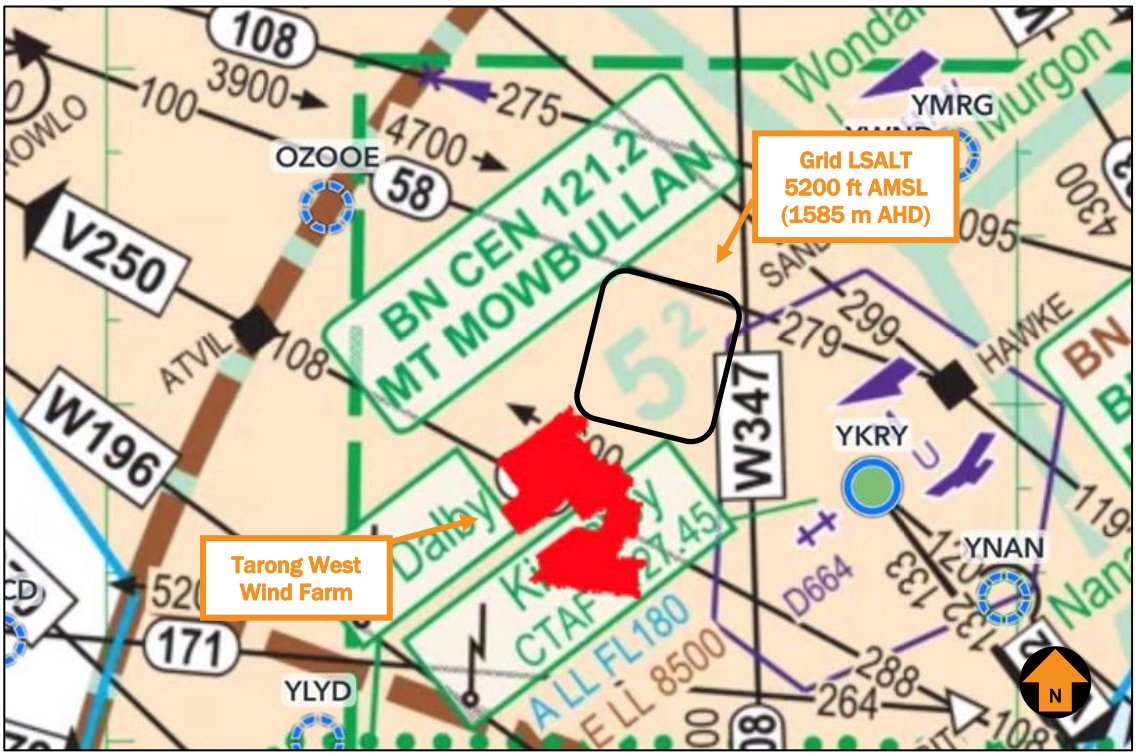

Figure 17 Air routes in proximity to the proposed Project

An impact analysis of the surrounding air routes is provided in Table 4.

Table 4 Air route impact analysis

Air route	*Waypoint pair*	*Route LSALT*	*Maximum Allowable Obstacle Height*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
V250	LEBIT and ATVIL	3600 ft AMSL	792 m AHD 2600 ft AMSL	WTG T4 (2823.7 ft) infringes by 68.7m / 223.7 ft	Raise LSALT by 300 ft to 3900 ft	Minor
W196	JEDDA and Taroom Airport	5300 ft AMSL	1311 m AHD 4300 ft AMSL	Nil	N/A	N/A
W347	Oakey and Gayndah Airport	5200 ft AMSL	1280 m AHD 4200 ft AMSL	Nil	N/A	N/A

The Project will impact route V250. The LSALT on route V250 will have to be raised from 3600 ft AMSL to 3900 ft AMSL.

6.9. Airspace

The proposed 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 site area of the project is outside Kingaroy Airport Danger Area D664 and Oakey Army Aviation Centre Restricted Area R654C as shown in Figure 18 (source: Bundaberg VNC, OzRunways, 9 August 2023).

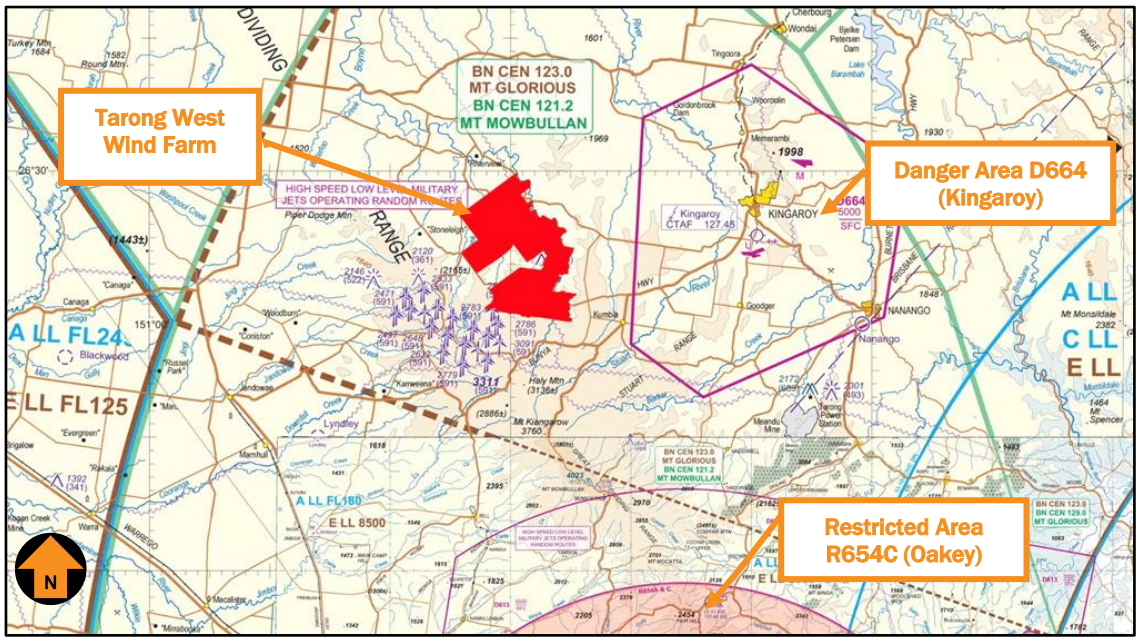

Figure 18 The Project site location and surrounding airspace

6.10. Aviation facilities

A search was conducted on State Planning Policy (SPP) interactive mapping, South Burnett Regional Council (Airport Environs overlay code) and SPP – state interest guideline Strategic airports and aviation facilities Appendix 5, to identify any aviation facilities that may be affected by proposed Project. According to these online resources, the WTGs of the Project will not infringe any protection areas associated with identified aviation facilities.

The Project site is well clear of and will not impact the closest aviation facility - Mt Mowbullan VHF station, which is located approximately 23.9 km (12.9 nm) south from the Project.

6.11. ATC Surveillance Radar Systems

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

With respect to aviation radar facilities, the closest radar is Brisbane Airport Secondary Surveillance Radar (SSR) which is located approximately 170 km (91.7 nm) south-east of the Project site.

The proposed Project site is located in Zone 4 and outside the radar line of sight of the SSR. The EUROCONTROL guidelines state:

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

Therefore, it is unlikely that the Project will impact Brisbane Airports SSR.

6.12. Summary

Based on the proposed Project layout and overall WTG blade tip height limit of 280 m AGL, the blade tip elevation of the highest WTG (T4) will not exceed 860.7 m AHD (2823.7 ft AMSL) and:

- will not infringe any OLS surfaces for Kingaroy Airport
- will infringe the PAN-OPS surface for the 10 nm MSA for Kingaroy Airport
- will not infringe the PANS-OPS surface of the 25 nm MSA Kingaroy Airport
- will have an impact on one nearby designated air route (V250 will have to be raised from 3600 ft AMSL to 3900 ft AMSL
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

The list of WTGs (obstacles), showing coordinates and elevation data that are applicable to this Aviation Impact Statement (AIS), are provided in **Annexure 1**.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 9 it is concluded that aviation lighting is not required for WTGs. For completeness, relevant lighting standards and guidelines are summarised in **Annexure 3.**

This section therefore assesses the need for aviation marking for the proposed WMTs and the overhead transmission lines.

Four (4) temporary WMTs will be constructed that are anticipated to be erected and dismantled during the construction period of the wind farm (approximately 2 years).

Three (3) permanent WMTs will be constructed within the wind farm.

7.1. Wind monitoring towers (WMTs)

WMTs are generally free-standing and not surrounded by any other obstacles. They should be marked with red/white/red bands as per the NASF Guideline D.

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

WMTs should be marked according to the requirements set out in MOS 139 Chapter 8 Division 10 Obstacle Markings; specifically:

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

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

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

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

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

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

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

7.2. Overhead transmission line

The proposed development involves an existing 275kV overhead line within the site to reticulate electricity back to the switching station and into the National Electricity Market. This transmission line is not equipped with obstacle lighting.

There is no regulatory requirement to mark or light power poles or overhead transmission lines that are located outside of aerodrome OLS.

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

Most agricultural land in Australia is crisscrossed with powerlines and aerial application companies and pilots put enormous effort into managing these hazards safely, generally using a risk identification, assessment and management process in line with Australian Standard AS4360/ISO 3[1]000.

The agricultural pilot curriculum mandated by CASA includes training for the safe management of powerlines and AAAA has been active in providing ongoing professional development for application pilots that includes a focus on planning, risk management and a knowledge of human factors relevant to managing powerlines in a low-level aviation environment.

AAAA runs a specific training course for aerial application pilots entitled 'Wire Risk Management' to address these issues.

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

8.110 Marking of hazardous obstacles

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

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

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

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

The transmission line operator, or developer, should consult with local landowners whose properties surround the proposed transmission line, to determine whether the proposed transmission line could create a hazard to aerial application operations.

Should a landowner be concerned that the proposed transmission line could create a risk to aerial application operations to a particular paddock or landing site, the developer should consider equipping the transmission line with the markers detailed in the standards outlined in the AS 3891.2:2018 *Air navigation – Cables and their supporting structures – Marking and safety requirements Part 2: Low level aviation operations.*

The existing Powerlink 275kV transmission line running through the site is presently unmarked.

Landowners and aerial application companies have a joint responsibility for the safe operation of aircraft. The identification of hazards such as trees, single-wire earth return power lines to sheds and residences, areas that cannot be exposed to the particular spray on the day, residences, feedlots, etc is a major discussion between them prior to aerial application flight operations being conducted.

8. ACCIDENT STATISTICS

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

8.1. General aviation operations

The general aviation (GA) activity group is considered by the Australian Transport Safety Bureau (ATSB) to be all flying activities that do not involve commercial air transport (activity group), which includes scheduled (RPT) and non-scheduled (charter) passenger and freight type. It may involve Australian civil (VH–) registered aircraft, or aircraft registered outside of Australia. General aviation/recreational encompasses:

- Aerial work (activity type). Includes activity subtypes: agricultural mustering, agricultural spreading/spraying, other agricultural flying, photography, policing, firefighting, construction – sling loads, other construction, search and rescue, observation and patrol, power/pipeline surveying, other surveying, advertising, and other aerial work
- Own business travel (activity type)
- Instructional flying (activity type). Includes activity subtypes: solo and dual flying training, and other instructional flying
- Sport and pleasure flying (activity type). Includes activity subtypes: pleasure and personal transport, glider towing, aerobatics, community service flights, parachute dropping, and other sport and pleasure flying
- Other general aviation flying (activity type). Includes activity subtypes: test flights, ferry flights and other flying.

8.2. ATSB occurrence taxonomy

The ATSB uses a taxonomy of occurrence sub-type. Of specific relevance to the subject assessment are terms associated with **terrain collision**. Definitions sourced from the ATSB website are provided below:

- **Collision with terrain**: Occurrences involving a collision between an airborne aircraft and the ground or water, where the flight crew were aware of the terrain prior to the collision
- **Controlled flight into terrain (CFIT):** Occurrences where a serviceable aircraft, under flight crew control, is inadvertently flown into terrain, obstacles, or water without either sufficient or timely awareness by the flight crew to prevent the event
- **Ground strike:** Occurrences where a part of the aircraft drags on, or strikes, the ground or water while the aircraft is in flight, or during take-off or landing
- **Wirestrike:** Occurrences where an aircraft strikes a wire, such as a powerline, telephone wire, or guy wire, during normal operations.

8.3. National aviation occurrence statistics 2010-2019

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

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

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

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

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

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

Figure 19 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.

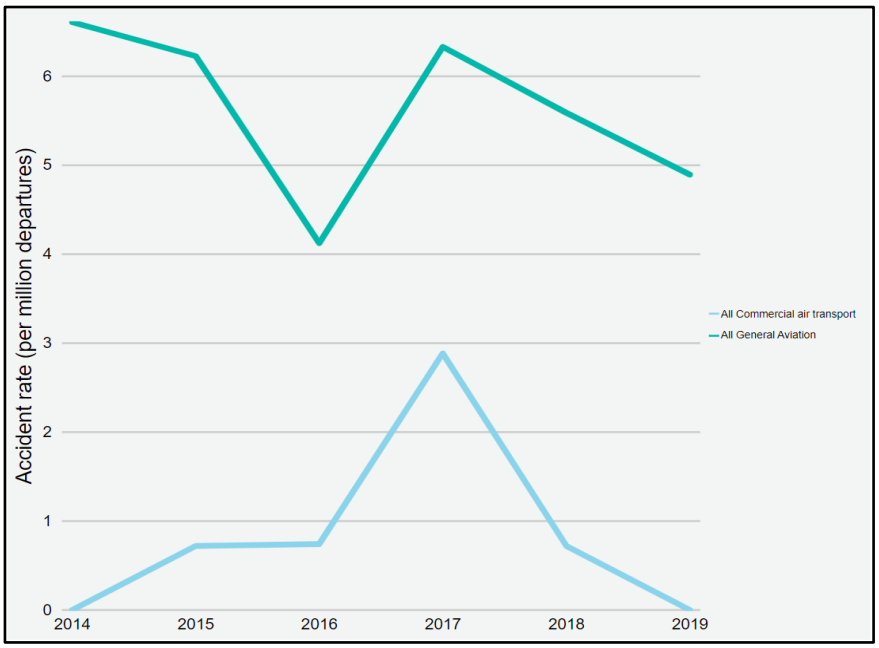

Figure 19 Fatal Accident Rate (per million departures) by Operation Type

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

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

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

Sub-category	*Fatal accidents*	*Fatalities*
Agricultural spreading/spraying	13	13
Agricultural mustering	11	12
Other agricultural	1	1
Survey and photographic	5	10
Search and rescue	2	2
Firefighting	2	2
Other aerial work	3	4
Instructional flying	11	19

Sub-category	Fatal accidents	Fatalities
Own business travel	3	5
Sport and pleasure flying	53	94
Other general aviation flying	11	12
Total	115	174

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

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

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

8.4. Worldwide accidents involving wind farms

Worldwide since aviation accident statistics have been recorded, there have been a total of 4 aviation accidents involving a wind farm (i.e. where WTGs were erected). To provide some perspective on the likelihood of a VFR aircraft colliding with a WTG, a summary of the 4 accidents and the relevant factors applicable to this assessment is incorporated in this section.

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

Based on the Australia's Clean Energy Council statistics there were 102 wind farms in Australia at the end of 2019. Aviation Projects has researched public sources of information, accessible via the world wide web, regarding aviation safety occurrences associated with wind farms. Occurrence information published by Australia, Canada, Europe (Belgium, Denmark, France, Germany, Norway, Sweden and The Netherlands), New Zealand, the United Kingdom and the United States of America was reviewed.

The 4 recorded aviation accidents involving a wind farm are summarised as follows:

- One accident, which resulted in 2 fatalities, occurred in Palm Springs, USA 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 7.

Table 7 Summary of accidents involving collision with a WTG

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

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

ID	Description	Date	Location	Fatalities	Flight rules	WTG height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
3	Beechcraft B55 The pilot was attempting to remain in VMC by descending the aircraft through a break in the clouds. The pilot, distracted by trying to visually locate the aerodrome, flew into an area of known 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 second WTG. The pilot was able to maintain control of the aircraft and landed safely.	04 Apr 2008	Plougin, France	0	Day VFR The weather in the area of the 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	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 by the Project.

Four (4) temporary WMTs will be constructed that are anticipated to be erected and dismantled during the construction period of the wind farm (approximately 2 years).

Three (3) permanent WMTs will be constructed within the wind farm.

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 and Regional Development, 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 Tables 8 to 12.

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

Discussion

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

There have been four reported occurrences worldwide of aircraft collisions with a component of a WTG structure since the year 2000 as discussed in Section 8. 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; and
- 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 at Section 8.4.

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

Any object that extends to a height of 100 m or more above local ground may be determined as a hazard to aircraft operations by CASA.

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

There have been four 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. Similarly, aircraft damage sustained ranged from minor to catastrophic. One of these accidents resulted from structural failure of the aircraft before the collision. Only two relevant accidents occurred during the day, and only one resulted in a single fatality. It is assessed that collision with a WTG resulting in multiple fatalities and damage beyond repair is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments (without lighting)

- The Project is clear of the obstacle limitation surfaces of any aerodrome
- Aircraft are restricted to a minimum height of 500 ft (152.4 m) AGL above the highest point of the terrain and any object on it within a radius of 300 m (CASR 91.267) in visual flight during the day when not in the vicinity of built-up areas. The proposed WTGs will be a maximum of 280 m (918.6 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 127.6 m (418.6 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
- 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) AGL (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, off-white or light grey 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
- Because the WTGs are above 100 m AGL, there is a statutory requirement to report the towers to CASA.

Level of Risk

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

Current Level of Risk	8 - Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Proposed Treatments

The following treatments will provide an acceptable level of safety:

- Details of the Project should be communicated to local and regional aircraft operators prior to, during and following construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically:
- Provide the details to the Queensland Regional Airspace and Procedures Advisory Committee for consideration by its members in relation to VFR transit routes in the vicinity of the wind farm.

• Engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the WTG rotor blades prior to the commencement of the subject aircraft operations within the Project area • Arrangements should be made to publish details of the wind farm in ERSA for surrounding aerodromes
Residual Risk With the additional recommended treatments, the likelihood of an aircraft collision with a 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 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 WTG, without obstacle lighting on the WTGs of the Project. However, the Proponent will provide obstacle lighting to the Project if required by assessment authority.

Residual Risk	7 - Tolerable

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

Discussion

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

The construction of WMTs is not anticipated with this project.

There are a few instances of aircraft colliding with a WMT, but they were all during the day with good visibility, and none were in Australia.

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

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

For objects at a height of 100 m AGL or more and outside the OLS of an aerodrome, CASA must be notified. Obstacle lighting may be required unless CASA, in an aeronautical study, assesses it as being shielded by another lit object or that it is of no obstacle significance.

Any object that extends to a height of 100 m or more above local ground may be determined as a hazard to aircraft operations by CASA.

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 was in Australia. It is assessed that collision with a WMT without obstacle lighting that would be effective in alerting the pilot to its presence may only occur in exceptional circumstances, which is classified as Rare.

Untreated Likelihood	Rare

Current Treatments (without lighting)

- WMT locations are advised to CASA and Airservices Australia
- The top 1/3 of new mast structures are be painted in red and white alternating bands
- 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 AGL (500 ft), the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of the tower
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night)

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

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 will provide an acceptable level of safety:

- Details of any WMTs, if they are constructed, would be advised to Airservices Australia
- Consideration would be given to marking any WMTs 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.

- Ensure details of any 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 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 would be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with any temporary WMTs and the Project permanent WMTs, without obstacle lighting on the WMTs.

Residual Risk	7 - Tolerable

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 obstacle limitation surfaces 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 280 m (918.6 ft) AGL at the top of the blade tip, so the rotor blade at its maximum height will be approximately 127.6 m (418.6 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.

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.

Assumed risk treatments

- The WTGs are typically coloured white, off-white or light grey 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.

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

There are a few ground collision accidents resulting from manoeuvring to avoid wind farms, but none in Australia, and all were during the day. It is assessed that a ground collision accident following manoeuvring to avoid a 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 obstacle limitation surfaces 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 area.
- WTGs will be a maximum of 280 m (918.6 ft) AGL at the top of the blade tip, so the rotor blade at its maximum height will be approximately 127.6 m (418.6 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 WTG.
- If cloud descends below the WTG hub, obstacle lighting would be obscured and therefore ineffective
- At night, aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight and potentially even higher during instrument flight (day or night)
- Aircraft authorised to intentionally fly below 152.4 m 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, , off-white or light grey 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

Proposed Treatments

The following treatments will provide an acceptable level of safety:

- Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction.

• Although there is no requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the Project area.
Residual Risk With the additional Recommended Treatments listed above, the likelihood of ground collision resulting from manoeuvring to avoid 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 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 assessed that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a Project WTG without obstacle lighting on the WTGs.

Residual Risk	7 - Tolerable

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

Discussion

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

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

Consequence

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

Consequence	Minor

Untreated Likelihood

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

Untreated Likelihood	Possible

Current Treatments (without lighting)

- The Project is clear of the obstacle limitation surfaces 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 280 m (918.6 ft) AGL at the top of the blade tip, so the rotor blade at its maximum height will be approximately 127.6 m (418.6 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, off-white or light grey 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 Minor consequence is 5.	
Current Level of Risk	5 - Tolerable
Risk Decision A risk level of 5 is classified as Tolerable: Treatment action possibly required to achieve ALARP. Relevant manager to consider for appropriate action.	
Risk Decision	Accept, conduct appropriate action
Proposed Treatments Given the current treatments and the limited scale and scope of flying operations conducted within the vicinity of the Project, there is likely to be little additional safety benefit to be gained by installing obstacle lighting, other than if a WMT exceeds 150 m AGL in height and is not in relatively close proximity to a WTG. However, the following treatments, will provide an additional margin of safety: • Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction • Where required, the Proponent will engage with local aerial agricultural and aerial firefighting operators to develop procedures for such aircraft operations in the vicinity of the Project.	
Residual Risk Notwithstanding the current level of risk is considered **Tolerable,** the additional Recommended Treatments listed above will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **ALARP.** It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew, without obstacle lighting on the Project WTGs.	
Residual Risk	5 - Tolerable

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 the WTGs or WMTs will be higher than 150 m AGL (492 ft), the WTGs 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.

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 WMT will be higher than 100 m AGL (328 ft), they may 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

Proposed Treatments

Not installing obstacle lighting would completely remove the source of the impact.

If lighting is required, there are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours, including:

- reducing the number of 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; and
- mitigating light glare from obstacle lighting through measures such as baffling.

There are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours. These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to those on the ground.

Consideration may be given to activating the obstacle lighting via a pilot activated lighting system.

An option is to consider using Aircraft Detection Lighting Systems (referred in the United States Federal Aviation Administration Advisory Circular AC70/7460-1L CHG1 – *Obstruction Marking and Lighting*). Such a system would only activate the lights when an aircraft is detected in the near vicinity and deactivate the lighting once the aircraft has passed. This technology reduces the impact of night lighting on nearby communities and migratory birds and extends the life expectancy of obstruction lights.

Residual Risk

Not installing obstacle lights would clearly be an acceptable outcome to those potentially affected by visual impact.

If lighting is required, consideration of visual impact in the lighting design should enable installation of lighting that reduces the impact to neighbours.

The likelihood of a **Moderate** consequence remains **Likely**, with a resulting risk level of **7 – Tolerable**.

It is our assessment that visual impact from obstacle lights can be negated if they are not installed. If obstacle lights are to be installed, they can be designed so that there is an acceptable risk of visual impact to neighbours

Residual Risk	7 - Tolerable

9.3. Summary of risks

A summary of the level of risk associated with the proposed Project, under the proposed treatment regime, is provided in Table 8.

Table 8 Summary of Risks

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with WTG	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with monitoring tower	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). It is recommended that WMTs should be marked according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings, specifically 8.10.2.6 and 8.10.2.8 (as modified by the guidance in NASF Guideline D). 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 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 to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights	Moderate	Likely	7	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact.

10. CONCLUSIONS

The results of this study are summarised as follows:

10.1. Project description

The proposed Project will comprise of the following:

- up to 97 WTGs with a maximum overall height (tip height) of the WTGs is up to 280 m AGL
- nominal hub height of the WTGs is 190 m and rotor diameter of up to 180 m
- 4 temporary WMTs will be constructed that are anticipated to be erected and dismantled during the construction period of the wind farm (approximately 2 years)
- 3 permanent WMTs
- The highest WTG is T4 with ground elevation of 580.7 m Australian Height Datum (AHD) and overall height of 860.7 m AHD (2823.7 ft above mean sea level (AMSL)).

10.2. Planning considerations

The Project as proposed satisfies the following Performance Outcomes of State Code 23:

Performance outcomes	*Acceptable outcomes - Compliance*
Aviation safety, integrity and efficiency	
PO1 Development does not adversely affect the safety, operational integrity and efficiency of air services and aircraft operations as a result of its: 1. location; 2. siting; 3. design; 4. 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.

Regulatory requirements

The following regulatory requirements apply:

- Wind farm development will be code assessable if all WTGs are 1,500m from a sensitive land use on a non-host lot, or there is a deed of agreement for WTGs to be less than 1,500m from a sensitive land use
- For WTGs State Code 23 : Wind Farm Development (v3.0) requires SARA determination, on balance, that the development complies with the purpose statement. The purpose statement of State Code 23 is:

  Wind farms should be appropriately located, sited, designed, constructed and operated to ensure:

  1. *the safety, operational integrity and efficiency of air services and aircraft operations;*
  2. *risks to people, property and quality of life are minimised by providing acceptable levels of:*
     - c. *amenity and acoustic emissions at sensitive land uses; and*
     - d. *resilience to natural hazards;*
  3. *development minimises adverse impacts on the natural environment, vegetation and associated ecological processes;*
  4. *development in an area identified by a local government as having high scenic amenity appropriately manages impacts on the character, scenic amenity and landscape values of the locality;*
  5. *the safe and efficient operation of transport networks and road infrastructure*
- All proposed objects with a height of 100 m or more AGL must be reported to CASA in accordance with Civil Aviation Safety Regulations Part 139 Division 139.E.1 139.165 (1)(2)
- WTGs must be marked in accordance with respect to CASR Part 139 Manual of Standards (MOS) Chapter 8 Division 10 8.110.
- WTGs must be lit in accordance with CASR Part 139 MOS Chapter 9 Division 4 9.3 and 9.31, unless an aeronautical study assesses they are of no operational significance.
- This AIA considers that lighting of the WTGs is not required to satisfy aviation safety standards.

10.3. Consultation

An appropriate and justified level of consultation was undertaken with relevant parties. Refer to Section 5 for details of the stakeholders and a summary of the consultation. Airservices Australia will need to review this updated report.

Initial consultation for the Project was completed in 2019 using a previous layout which incorporated up to 151 WTGs. The Project now incorporates 97 WTGs with overall less aviation impacts than the initial consulted 151 WTG layout. Since the initial consultation in 2019, numerous background changes have occurred including:

- some regulatory changes

- changes in the airway structure overhead the project site
- changes in the instrument flight procedures at Kingaroy Airport.

10.4. Aviation Impact Statement

Based on the proposed Project layout and overall WTG blade tip height limit of 280 m AGL, the blade tip elevation of the highest WTG, which is T4, will not exceed 860.7 m AHD (2823.7 ft AMSL) and:

- will not infringe any OLS surfaces at Kingaroy Airport
- will infringe the PAN-OPS surface for the 10 nm MSA at Kingaroy Airport which will require the 10 nm MSA to be raised from 2400 ft to 2600 ft AMSL
- will not infringe the 25 nm MSA of Kingaroy Airport
- will have an impact on the LSALT of nearby designated air route (V250 LSALT will have to be raised from 3600 ft AMSL to 3900 ft AMSL
- is wholly contained within Class G airspace; and
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

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.

Where required, the proponent will engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, carrying out of risk assessments to facilitate subject aircraft operations within the Project area when required.

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.

Obstacle lighting risk assessment

- 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
- Over the 10-year period between 2010-2019, no aircraft collided with a WTG or a WMT in Australia
- There is no regulatory requirement to mark or light power poles or overhead transmission lines

Following consultation with aerial operators by an individual landowner prior to a proposed aerial application operation, if a particular risk at a specific site is identified, the landowner should consult with the transmission line operator, to consider equipping the transmission line with the markers detailed in the standards outlined in the AS 3891.2:2018 *Air navigation – Cables and their supporting structures – Marking and safety requirements Part 2: Low level aviation operations*.

Risk Assessment

A summary of the level of risk associated with the proposed Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table E1.

Table E1 Risk assessment summary

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with WTG	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with monitoring tower	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). It is recommended that new WMTs should be marked according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings, specifically 8.10.2.6 and 8.10.2.8 (as modified by the guidance in NASF Guideline D). 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 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 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 required by the assessment manager, design to minimise impact.

11. RECOMMENDATIONS

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

Notification and reporting

1. 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 or not the structure will be hazardous to aircraft operations. The notification should be provided to CASA via email to Airspace.Protection@casa.gov.au .

2. 'As constructed' details of WMT 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. Department of Defence should be consulted if there is any subsequent modification in the WTG height or scale of development, using the following email address: land.planning@defence.gov.au.

4. Any obstacles above 100 m AGL (including temporary construction equipment) must be reported to the Airservices Australia NOTAM office (via phone number: 02 6268 5063) to ensure pilots have access to the information via a NOTAM until they are incorporated in published operational documents at a later date. 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

    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

5. Details of the final wind farm layout should be provided to local and regional aircraft operators prior to construction so they can plan their operations accordingly.

Marking of wind turbine generators (WTGs)

6. The WTG blades, nacelle, hubs and towers should be painted white, off-white or light grey, typical of most WTGs operational in Australia. No additional marking measures are required for WTGs.

Marking of wind monitoring towers (WMTs)

7. Although there is no regulatory requirement, to mitigate aviation safety risks to low level aircraft operations in the area, consideration should be given to marking any WMTs according to the requirements set out in MOS 139 Section 8.110 (as modified by the guidance in NASF Guideline D). Specifically:

    a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires

    b. paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast

c. ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation or

d. a flashing strobe light during daylight hours.

Markers and markings are recommended. Flashing strobe lights are not recommended, in consideration of local community amenity.

Micrositing

8. 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 have been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level is within 100 m of the nominal 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 280 m AGL is implemented at all WTG locations. No further assessment is likely to be required from micrositing WTGs and the conclusions of this AIA would remain the same.

ANNEXURES

1. WTG coordinates and heights
2. CASA Regulatory Requirements Lighting and Marking
3. Risk Framework

ANNEXURE 1 – WTG COORDINATES AND HEIGHTS

Source: RES Australia, file - *PAUSilf138 Coordinates and Elevation.xlsx*

WTG ID	Easting	Northing	Base Elevation (m AHD)	WTG Tip Height (m AGL)	Maximum Tip Height (m AGL)	WTG tip height (ft AMSL)
T1	358373	7047561	514.65	280	795	2607.1
T3	358115	7048069	515.36	280	795	2609.4
T4	354061	7048104	580.66	280	860.7	2823.7
T5	354742	7048122	553.29	280	833	2733.9
T6	355302	7048317	542.71	280	823	2699.2
T7	357725	7048612	518.45	280	798	2619.6
T8	356329	7060549	455.02	280	735	2411.5
T10	357592	7059734	458.03	280	738	2421.4
T11	357613	7049179	543.83	280	824	2702.9
T13	354575	7049425	540.46	280	820	2691.8
T17	355459	7049850	544.56	280	825	2705.2
T21	349902	7050210	574.15	280	854	2802.3
T22	355855	7050269	540.739	280	821	2692.7
T23	350828	7050310	552.78	280	833	2732.2

WTG ID	Easting	Northing	Base Elevation (m AHD)	WTG Tip Height (m AGL)	Maximum Tip Height (m AGL)	WTG tip height (ft AMSL)
T25	350170	7050696	564.26	280	844	2769.9
T26	351175	7050736	531.97	280	812	2663.9
T27	354086	7050802	542.61	280	823	2698.9
T29	355824	7050897	529.31	280	809	2655.2
T30	348641	7051055	524.79	280	805	2640.4
T31	350201	7051230	531.43	280	811	2662.2
T32	352997	7051251	530.26	280	810	2658.3
T36	350550	7051738	537.2	280	817	2681.1
T37	352695	7051765	511.51	280	792	2596.8
T38	356200	7051895	525.55	280	806	2642.9
T40	349497	7052152	497.1	280	777	2549.5
T41	350946	7052228	550.97	280	831	2726.3
T42	351670	7052301	519.17	280	799	2621.9
T44	353803	7052493	549.35	280	829	2721.0
T45	356332	7052501	535.15	280	815	2674.4
T46	352131	7052622	521.58	280	802	2629.9

WTG ID	Easting	Northing	Base Elevation (m AHD)	WTG Tip Height (m AGL)	Maximum Tip Height (m AGL)	WTG tip height (ft AMSL)
T48	351301	7052937	529.809	280	810	2656.9
T49	354039	7052973	540.569	280	821	2692.2
T50	350275	7053052	532.21	280	812	2664.7
T51	353241	7053173	529.51	280	810	2655.9
T53	350848	7053489	515.12	280	795	2608.7
T54	353876	7053653	535.12	280	815	2674.3
T55	354909	7053646	546.93	280	827	2713.0
T56	352926	7053676	522	280	802	2631.2
T57	351405	7053908	508.77	280	789	2587.8
T58	355433	7054425	519.74	280	800	2623.8
T60	347686	7055290	477.1	280	757	2483.9
T63	352841	7055886	533.1	280	813	2667.7
T64	347701	7056123	468.99	280	749	2457.3
T65	356704	7056175	478.26	280	758	2487.7
T66	354177	7056747	508.54	280	789	2587.1
T67	352337	7056817	485.51	280	766	2511.5

WTG ID	Easting	Northing	Base Elevation (m AHD)	WTG Tip Height (m AGL)	Maximum Tip Height (m AGL)	WTG tip height (ft AMSL)
T68	347272	7056901	452.62	280	733	2403.6
T69	356885	7056858	486.13	280	766	2513.5
T71	347924	7057250	453	280	733	2404.9
T72	354277	7057258	491.74	280	772	2532.0
T73	345794	7057309	475.25	280	755	2477.9
T74	355083	7057375	491.59	280	772	2531.5
T75	351627	7057609	526.5	280	807	2646.0
T76	356853	7057663	477.84	280	758	2486.4
T77	346592	7057753	494.97	280	775	2542.6
T78	345795	7057807	468.16	280	748	2454.6
T80	351580	7058168	521.43	280	801	2629.4
T82	350517	7058495	503.67	280	784	2571.1
T83	348500	7058583	459.88	280	740	2427.4
T84	356277	7058557	504.8	280	785	2574.8
T85	346929	7058639	450.88	280	731	2397.9
T86	357025	7058599	480.13	280	760	2493.9

WTG ID	Easting	Northing	Base Elevation (m AHD)	WTG Tip Height (m AGL)	Maximum Tip Height (m AGL)	WTG tip height (ft AMSL)
T87	351147	7058647	520.12	280	800	2625.1
T88	352204	7058852	511.2	280	791	2595.8
T89	350030	7059013	521.51	280	802	2629.6
T90	355701	7059156	475.88	280	756	2479.9
T91	351582	7059381	506.27	280	786	2579.6
T92	354001	7059449	488.96	280	769	2522.8
T93	356749	7059450	485.99	280	766	2513.1
T94	349658	7059680	472.71	280	753	2469.5
T95	348047	7059757	477.37	280	757	2484.8
T96	351707	7059891	504.61	280	785	2574.2
T97	357184	7050800	517.93	280	798	2617.9
T98	347350	7060199	466.66	280	747	2449.7
T99	353525	7060270	483.86	280	764	2506.1
T100	347944	7060380	498.569	280	779	2554.4
T102	351493	7060575	474.55	280	755	2475.6
T103	346679	7060840	446.48	280	726	2383.5

WTG ID	Easting	Northing	Base Elevation (m AHD)	WTG Tip Height (m AGL)	Maximum Tip Height (m AGL)	WTG tip height (ft AMSL)
T105	348454	7061325	515.26	280	795	2609.1
T106	349420	7061300	484.68	280	765	2508.8
T107	345727	7062745	433.98	280	714	2342.5
T108	346587	7061391	453.4	280	733	2406.2
T109	352928	7061566	463.56	280	744	2439.5
T111	346585	7061874	464.85	280	745	2443.7
T112	352605	7062022	447.05	280	727	2385.3
T113	349070	7062423	501.46	280	781	2563.8
T114	347742	7062649	475.56	280	756	2478.9
T118	350619	7063236	459.79	280	740	2427.1
T119	346286	7063224	449.28	280	729	2392.7
T120	346927	7063604	440.7	280	721	2364.5
T122	351589	7063641	451.46	280	731	2399.8
T123	348752	7063653	482.17	280	762	2500.6
T124	347640	7064140	450.95	280	731	2398.1
T125	348418	7064889	457.94	280	738	2421.1

WTG ID	Easting	Northing	Base Elevation (m AHD)	WTG Tip Height (m AGL)	Maximum Tip Height (m AGL)	WTG tip height (ft AMSL)
T126	349204	7065046	458.47	280	738	2422.8
T127	349375	7065675	459.41	280	739	2425.9
T128	349697	7066171	471.62	280	752	2465.9

ANNEXURE 2 – 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

In areas remote from an aerodrome, 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 is to allow CASA to assess the effect of the structure on aircraft operations and determine whether or not the structure will be hazardous to aircraft operations.

Manual of Standards Part 139—Aerodromes

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

Section 9.30 provides guidance on Types of and Their Use:

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

    Note CASA recommends the use of flashing red medium-intensity obstacle lights.
4. *Medium-intensity obstacle lights must be used if:*

a. *the object or structure is an extensive one; or*

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

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

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

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

6. *High-intensity obstacle lights:*

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

b. *must be flashing white lights.*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Advisory Circular 139-08 v2—Reporting of Tall Structures

In Advisory Circular (AC) 139-08 v2—*Reporting of Tall Structures*, CASA provides guidance to those authorities and persons involved in the planning, approval, erection, extension or dismantling of tall structures so that they may understand the vital nature of the information they provide.

Airservices Australia has been assigned the task of maintaining a database of tall structures, the top measurement of which is:

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

b) 45 metres or more above ground level elsewhere.

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

The proposed 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.*
>
> *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 obstacle limitation surfaces 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 MOS 139.

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

MOS 139 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.*

MOS 139 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.*

   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 MOS 139 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
  - such that no light is emitted at or below 10 degrees below horizontal
- Where two lights are mounted on a nacelle, dynamic shielding or light extinction of one light at a time, for the period that a blade is passing in front of the light, is permissible, providing that at all times at least one light can be seen, without interruption, from every angle of azimuth

- If flashing obstacle lighting is required, all obstacle lights on a wind farm should be synchronised so that they flash simultaneously
- 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, off-white or light grey, unless otherwise indicated by an aeronautical study.

It is generally accepted that a shade of white, off-white or light grey 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

Whilst it is not expected that WMTs will be included in the project, consideration should be given to marking any WMTs according to the requirements set out in MOS 139 Chapter 8 Division 10 Obstacle Markings; 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*

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

- the top 1/3 of WMTs 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
- a flashing strobe light during daylight hours.

ANNEXURE 3 – RISK FRAMEWORK

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

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

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

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

Likelihood

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

Table 1 Likelihood Descriptors

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

Consequence

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

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

Table 2 Consequence Descriptors

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

Risk matrix

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

Table 3 Risk Matrix

		CONSEQUENCE				
		INSIGNIFICANT 1	MINOR 2	MODERATE 3	MAJOR 4	CATASTROPHIC
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). Relevant manager to consider for appropriate action.
0-4/5	**Broadly Acceptable Risk**	Managed by routine procedures and can be accepted with no action.

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