WINTERBOURNE WIND FARM

AVIATION IMPACT ASSESSMENT

Prepared for Environmental Resources Australia Pty Ltd

AVIATION PROJECTS

AVIATION PROJECTS

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ACRONYMS

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

ERC-L	en-route chart low
ERSA	En Route Supplement Australia
GA	general aviation
GNSS	global navigation satellite system
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions
LGA	local government area
LSALT	lowest safe altitude
MOC	minimum obstacle clearance
MOS	Manual of Standards
MSA	minimum sector altitude
NASAG	National Airports Safeguarding Advisory Group
NASF	National Airports Safeguarding Framework
NDB	non-directional radio beacon
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
RAAF	Royal Australian Air Force
RFDS	Royal Flying Doctor Service
RNAV	area navigation
RPT	regular public transport
RSR	route surveillance radar
SEARs	Secretary's Environmental Assessment Requirements
SARPs	standards and recommended practices
VFR	visual flight rules
VFRG	visual flight rules guide
VHF	very high frequency
VOR	VHF omni-directional radio range
VMC	visual meteorological conditions

WMTs	wind monitoring towers
WTGs	wind turbine generators
WWF	Winterbourne Wind Farm

UNITS OF MEASUREMENT

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

DEFINITIONS

Definitions of key aviation terms are included in **Annexure 2**.

NOTES

5 m error budget has been applied for an assessment of the wind turbines maximum height.

EXECUTIVE SUMMARY

Introduction

Winterbournewind Pty Ltd proposes to construct and operate the Winterbourne Wind Farm (WWF, or the Proposal), a renewable energy development located to the north and east of Walcha in the Northern Tablelands of New South Wales (NSW).

Winterbournewind Pty Ltd (WWPL) is the proponent for the Winterbourne Wind Farm proposal.

WWPL is seeking State Significant Development (SSD) Consent under Division 4.7 of Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act) for the proposal.

WWF is located 75 km north-east of Tamworth and approximately 35 km south of Armidale within both Walcha Council and Uralla Shire Council local government areas (LGAs). The proposed WWF is roughly bounded by Thunderbolts Way to the west, the Oxley Highway to the south, the Oxley Wild Rivers National Park to the east, and the Salisbury Plains to the north.

Environmental Resources Management Pty Ltd (ERM) has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) to assess the potential aviation safety impacts associated with the proposal to support the proposed SSD application and formally consult with aviation agencies. The SSD application will be submitted to the Department of Planning and Environment (DPE) for approval.

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

Proposal description

The Winterbourne Wind Farm Project involves the construction and operation of a wind farm with up to 119 wind turbine generators (WTG), together with associated and ancillary infrastructure.

The Project design has been revised and refined in response to the identification and assessment of environmental constraints, constructability requirements, and consideration of the outcomes of Agency, landowner, and community consultations.

The Project consists of the following key components:

- up to 119 WTGs, each with:
    - a generating capacity of approximately 6.2 MW;
    - three blades mounted to a rotor hub (hub height of 149 m) on a nacelle above a tubular steel tower, with a blade tip height (blade length plus hub height) of up to 230 m AGL;
    - a gearbox and generator assembly housed in the nacelle; and
    - adjacent hardstands for use as crane pads, assembly and laydown areas;
- decommissioning of 4 temporary meteorological monitoring masts and installation of up to 2 permanent meteorological monitoring masts for power testing. The permanent monitoring masts

will be located close to a WTG location with a maximum height of approximately 149 m AGL, equivalent to the hub height of the installed WTGs;

- two 33/330 kV electrical substations, including control room, transformers, circuit breakers, switches and other ancillary equipment;
- an operations and maintenance facility;
- a battery energy storage system (BESS) of up to 100 MW/200 MWh capacity (two hours of storage);
- aboveground and underground 33 kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substations (generally following site access tracks);
- a 330 kV single or double circuit twin conductor overhead transmission line (transmission line) route of approximately 50 km connecting the two substations to a new electrical switchyard (including circuit breakers, switches and other ancillary equipment), located approximately 7 km south of Uralla and adjacent to TransGrid's 330 kV Tamworth to Armidale transmission line (Line 85);
- internal access tracks (combined total length of approximately 113 km) connecting the WTGs and associated Project infrastructure with the public road network; and
- upgrades to roads and intersections required for the delivery of oversize and overmass WTG components, transformers and associated construction-phase materials and vehicular movements.

The following temporary elements will be required during the construction phase of the Project:

- site buildings and facilities for construction contractors / equipment, including site offices, car parking and amenities for the construction workforce;
- mobile concrete batching plant/s to supply concrete for WTG footings and substation construction works;
- earthworks for access tracks, WTG platforms and foundations, potentially including controlled blasting in certain areas;
- potential rock crushing facilities for the generation of suitable aggregates for concrete batching and/or for access track and hardstand construction;
- hardstand laydown areas for the storage of construction materials, plant, and equipment;
- external water supply and storage for concrete batching and construction activities;
- the transport, storage and handling of fuels, oils and other hazardous materials for construction and operation of wind farm infrastructure; and
- beneficial reuse of materials won from within the development footprint during cut and fill and WTG foundation excavation works for use in access track, hardstands and foundation material.

The Project may also require the subdivision of land for the substations and switchyard.

Conclusions

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

Planning considerations

The Proposal as proposed satisfies the following planning documents:

- *Walcha Local Environment Plan 2012* (Walcha LEP, current version dated 14 July 2021)
- *Uralla Local Environment Plan 2012* (Uralla LEP, current version dated 14 July 2021).

Certified airports

1. The Proposal is located beyond 30 nautical miles (nm) (55.56 km) (area used to identify possible constraints) from Tamworth Regional Airport (YSTW), however is located within 30 nm of Armidale Airport (YARM).
2. Armidale Airport is a certified, code 3, non-precision approach runway, operated by Armidale Regional Council.
3. The Proposal is located outside the 10 nm minimum safe altitude (MSA) of Armidale Airport but within the 25 nm MSA of Armidale Airport with an MSA of 6100 ft AMSL which has a minimum obstacle clearance (MOC) of 5100 ft AMSL.
4. The highest WTG which is located inside of the horizontal extent of the 25 nm MSA of Armidale Airport (including 5 nm buffer area) is B007. The maximum overall height for wind turbine B007 is approximately 1538 m AHD (5046 ft AMSL) (including 5 m error budget). As a result, WTG B007 will be approximately 16 m (54 ft) below the 5100 ft MOC. Therefore, the 25 MSA of 6100 ft AMSL will not be impacted.
5. The Proposal will not impact instrument procedures of Armidale Airport.
6. The Proposal is located outside the horizontal extent of circling areas at Armidale Airport and will have no impact.

Aircraft Landing Areas (ALAs)

7. As a guide, an area of interest within a 3 nm radius of an aircraft landing area (ALA) is used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA.
8. The majority of identified ALAs are Involved Landowner ALAs. There are 2 Non-Involved Landowner ALAs to the east of the Project, Rowleys Creek and Argyll ALAs.
9. Rowleys Creek and Argyll ALAs may be affected by wake turbulence in stronger westerly winds.

Obstacle Limitation Surfaces

10. The approach and take-off surfaces of Armidale Airport and Tamworth Airport will not be impacted.

Air Routes and Lowest Safe Altitude

11. The Proposal is located in the area with 2 grid lowest safe altitudes (LSALT) of 1951 m AHD (6400 ft AMSL) with a minimum obstacle clearance (MOC) surface of 1646 m AHD (5400 ft AMSL)

and 2011 m AHD (6600 ft AMSL) with a MOC surface of 1707 m AHD (5600 ft AMSL). The highest WTG is B130, with a maximum overall height of 1564 m AHD (5132 ft AMSL) and is below the LSALT MOC of 5400 ft AMSL and 5600 ft AMSL.

The Proposal will impact the air route W128 LSALT MOC. Note: Airservices has assessed as no impacts to air routes (refer Section 5).

Airspace

12. The Proposal is located outside of controlled airspace (wholly within Class G airspace).

Aviation Facilities

13. The Proposal will not penetrate any protection areas associated with aviation facilities.

Radar

14. With respect to aviation radar facilities, the closest radar is the Round Mountain Route Surveillance Radar (RSR) which is located approximately 60 km (32 nm) north-east of the Proposal.

15. The Proposal is located in Zone 4 (accepted zone) and outside the radar line of sight of Round Mountain Route RSR and will not interfere with the serviceability of this aviation facility.

16. It is unlikely that the Proposal will impact Namoi Black Jack Mountain DWSR 8502S 2° S-band Doppler radar located at Black Jack Mountain near Gunnedah, as the Proposal is located more than 183 km from this meteorological radar.

Aviation Impact Statement

17. Based on the Proposal layout and overall turbine overall blade tip height limit of 230 m AGL, the blade tip elevation of the highest wind turbine, which is B130, will not exceed 1564 m AHD (5132 ft AMSL).

18. This AIS concludes that the Proposal:

- will not penetrate any OLS surfaces
- will not penetrate PANS-OPS surfaces
- will have an impact on nearby designated air route (W128). Note: Airservices has assessed as no impacts to air routes (refer Section 5).
- will not have an impact on the grid LSALT
- will not have an impact on prescribed airspace
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

Obstacle lighting risk assessment

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

Consultation

20. 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.

Summary of key recommendations

A summary of the key recommendations of this AIA is set out below.

The full list of recommendations and associated details are provided in **Section 11** 'Recommendations' at the end of this report.

1. Air route W128 LSALT should be increased by 200 ft from 5900 ft to 6100 ft AMSL. Note: Airservices has assessed no impacts to air routes (refer Section 5).
2. WWPL should engage with the operators of ALAs in close proximity to the wind farm to develop a mitigation plan, which may include suspending the relevant wind turbine's operation (dependent on wind direction and wind speed) for the period that the ALAs are in use for take-off and landing.
3. To facilitate the flight planning of aerial application operators, the location and height of WTGs and WMTs 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.
4. 'As constructed' details of WTGs including coordinates and elevations should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
5. WWPL should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Proposal, noting that there is no statutory requirement to do so.

6. Details of the final Proposal layout should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations. Specifically, details should be provided to the New South Wales Regional Airspace and Procedures Advisory Committee (rapac@casa.gov.au) for consideration by its members in relation to visual flight rules (VFR) transit routes in the vicinity of the wind farm.

7. The rotor blades, nacelles and towers of the WTGs should be painted in white, typical of most wind turbines operational in Australia.

1. INTRODUCTION

1.1. Situation

WWPL proposes to construct and operate the WWF, a renewable energy development located to the north and east of Walcha in the Northern Tablelands of NSW.

WWPL is seeking SSD Consent under Division 4.7 of Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act) for WWF.

ERM is preparing an Environmental Impact Statement (EIS) for an SSD application for WWF.

WWF is located approximately 75 km north-east of Tamworth and approximately 35 km south of Armidale within both WSC and USC LGAs. The proposed proposal is roughly bounded by Thunderbolts Way to the west, the Oxley Highway to the south, the Oxley Wild Rivers National Park to the east, and the Salisbury Plains to the north.

The proposal boundary extends around an area of approximately 24,100 ha and is at an elevation of approximately 1100 m to 1300 m (above sea level), comprised of hills and ridgelines rising out of the Walcha Plateau.

The proposal is proposed to consist of up to 119 wind turbine generators (WTGs) with a combined maximum installed capacity of up to 700 megawatts (MW).

The maximum tip height of the WTG will be up to 230 m AGL.

The proposal would also include:

- an internal electrical reticulation network (both overhead and underground)
- 3 on-site substations
- new and upgraded access roads
- temporary construction facilities (including concrete batching plants)
- operation and maintenance buildings.

Large-scale battery storage is also proposed for the proposal to support stabilising the supply of electricity to the National Electricity Market (NEM).

It is also proposed to include approximately 50 km of new 330kV OHTL running through the wind farm and continuing north-west from the proposal site. This new transmission line would connect to the existing grid network operated by TransGrid at a new switchyard which would be constructed approximately 7 km south of Uralla, NSW.

ERM has engaged Aviation Projects to prepare an AIA to assess the potential aviation safety impacts associated with the Proposal to support the proposed SSD application and formally consult with aviation agencies. The SSD application will be submitted to DPE for approval.

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

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

1.2. Purpose and Scope

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

The assessment specifically responds to the:

- Aviation Safety considerations included in the Secretary's Environmental Assessment Requirements (SEARS)
- *Environmental Planning and Assessment Act 1979*
- National Airports Safeguarding Framework (NASF) Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*.

Assistance will be provided in support of stakeholder consultation and engagement in preparing the assessment and negotiating acceptable mitigation to identified impacts.

1.3. Methodology

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

- confirmed the scope and deliverables with ERM
- review project SEARs
- reviewed client material
- conducted a site visit on 10 June 2020 to properly investigate aviation safety aspects of the proposal
- reviewed relevant regulatory requirements and information sources
- prepared a draft AIA and supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified. The draft AIA report includes an AIS and a qualitative risk assessment to determine need for obstacle lighting and of applicable aspects for client review and acceptance before submission to external aviation regulators
- 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*
- consulted with relevant Council(s), Part 173 procedure designers and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable)
- consulted with stakeholders to negotiate acceptable outcomes (if required)
- finalised the AIA report for client acceptance when response received from stakeholders

1.4. Aviation Impact Statement

The 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 Proposal site
- Nominate all instrument approach and landing procedures at these aerodromes
- Review the potential effect of the Proposal 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 Proposal site and review potential impacts of Proposal 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 Proposal site is located

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

Material provided by ERM for preparation of this assessment included:

- ERM, Winterbourne Wind Farm Layout, Freeze design.*kmz,*
- ERM, Winterbourne Wind Farm Turbine Co-ordinates, *Turbines XYZ.xlsx*
- ERM, Winterbourne Wind Farm, Project Boundary, *Project Boundary.kmz*
- ERM, Winterbourne Wind Farm, 0526676 EIS_Project Description D03_Clean.docx
- Issued SEARs (SSD-10471) dated 17 September 2020

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2. BACKGROUND

2.1. Site overview

An overview of the Proposal site relative to the regional cities of Armidale and Tamworth is provided in Figure 1 (source: ERM, Google Earth).

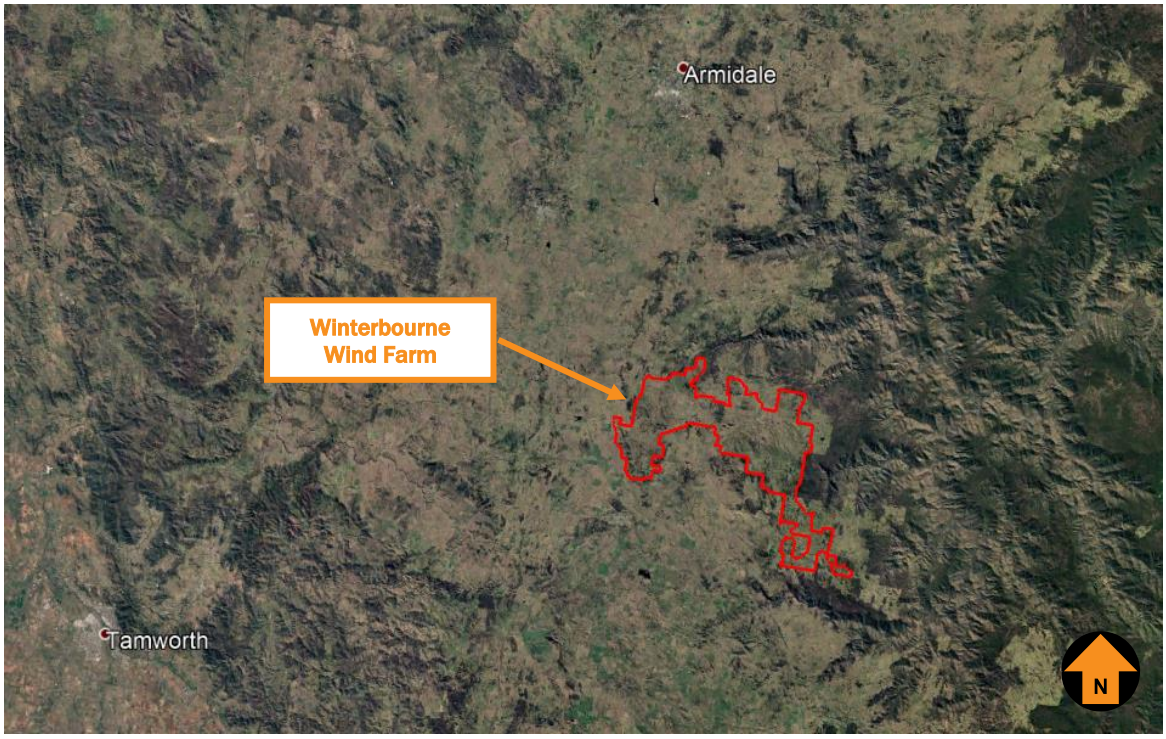

Figure 1 Proposal site overview

2.2. Proposal description

The proposed WWF is located approximately 75 km north-east of Tamworth and 35 km south of Armidale within the LGAs of WSC and USC.

The Winterbourne Wind Farm Project involves the construction and operation of a wind farm with up to 119 wind turbine generators (WTG), together with associated and ancillary infrastructure.

The Project design has been revised and refined in response to the identification and assessment of environmental constraints, constructability requirements, and consideration of the outcomes of Agency, landowner, and community consultations.

The Project consists of the following key components:

- up to 119 WTGs, each with:
    - a generating capacity of approximately 6.2 MW;
    - three blades mounted to a rotor hub (hub height of 149 m) on a nacelle above a tubular steel tower, with a blade tip height (blade length plus hub height) of up to 230 m AGL;
    - a gearbox and generator assembly housed in the nacelle; and
    - adjacent hardstands for use as crane pads, assembly and laydown areas;
- highest wind turbine is B130 with ground elevation of 1329 m AHD and overall height of 1564 m (5132 ft AMSL)
- decommissioning of 4 temporary meteorological monitoring masts and installation of up to 2 permanent meteorological monitoring masts for power testing. The permanent monitoring masts will be located close to a WTG location with a maximum height of approximately 149 m AGL, equivalent to the hub height of the installed WTGs;
- two 33/330 kV electrical substations, including control room, transformers, circuit breakers, switches and other ancillary equipment;
- an operations and maintenance facility;
- a battery energy storage system (BESS) of up to 100 MW/200 MWh capacity (two hours of storage);
- aboveground and underground 33 kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substations (generally following site access tracks);
- a 330 kV single or double circuit twin conductor overhead transmission line (transmission line) route of approximately 50 km connecting the two substations to a new electrical switchyard (including circuit breakers, switches and other ancillary equipment), located approximately 7 km south of Uralla and adjacent to TransGrid's 330 kV Tamworth to Armidale transmission line (Line 85);
- internal access tracks (combined total length of approximately 113 km) connecting the WTGs and associated Project infrastructure with the public road network; and
- upgrades to roads and intersections required for the delivery of oversize and overmass WTG components, transformers and associated construction-phase materials and vehicular movements.

Table 1 Project Components and Approximate Dimensions

Project Components and Infrastructure	Approximate Dimensions	Quantity
WTGs		
Rotor diameter	162 m	119 WTGs
Blade length	Blade length of 79.3 m. Distance from the centrepoint of the hub to the tip of the blade equals 81 m	
Uppermost blade tip	230 m	
Tower (hub) height	149 m	
WTG hardstand	0.70 ha per WTG required for construction 0.26 ha per WTG after rehabilitation	
Ancillary Infrastructure		
100 MW/200 MWh Battery energy storage system (BESS)	100 m x 100 m	1
33/330 kV Substation	100 m x 100 m	2
O&M Facility including carpark	50 m x 40 m	1
New 330 kV transmission line	Towers approximately 40 m high, spaced approximately 500 m (subject to terrain) or monopoles approximately 50 m high, spaced approximately 250 m (subject to terrain), within 60 m easement	50 km
Underground and/or overhead 33 kV cables	Trenching for underground electrical cabling will be	324 km

Project Components and Infrastructure	Approximate Dimensions	Quantity
	approximately 0.6 m wide per circuit by 1.0 m deep. Note: Where ground conditions are not suitable for open cut trench installation, overhead single circuit electricity lines will be installed using concrete poles.	
Switchyard	160 m x 120 m	1
New internal access tracks and drainage	Approximately 15 m wide formation including 5.5 m roadway plus shoulders and drainage as required	113 km
Permanent meteorological masts (with concrete footings for mast and guy wires)	Sensor height at 149 m on approximately 3 m x 3 m concrete foundation	Up to 2

Table 2 Indicative WTG Model Specifications

Feature	Specifications
Model	Vestas V162-6.2MW
Power regulation	Pitch regulated with variable speed
Operating data Rated power Cut-in wind speed Cut-out wind speed Wind class Standard operating temperature range	 6,200kW 3m/s 25m/s IEC S -20 to 45 degrees Celsius
Sound power Maximum	 104.8 dB(A)
Rotor Rotor diameter Swept area Aerodynamic brake	 162 20,612m^2 Full blade feathering with 3 pitch cylinders
Tip height	230 m
Hub height	149 m
Electrical Frequency Converter	 50/60Hz Full scale
Gearbox Type	 Two planetary stages

Refer to Figure 2 for the Proposal site within the boundaries of WSC and USC areas (source: WWPL, NSW Spatial Map Viewer).

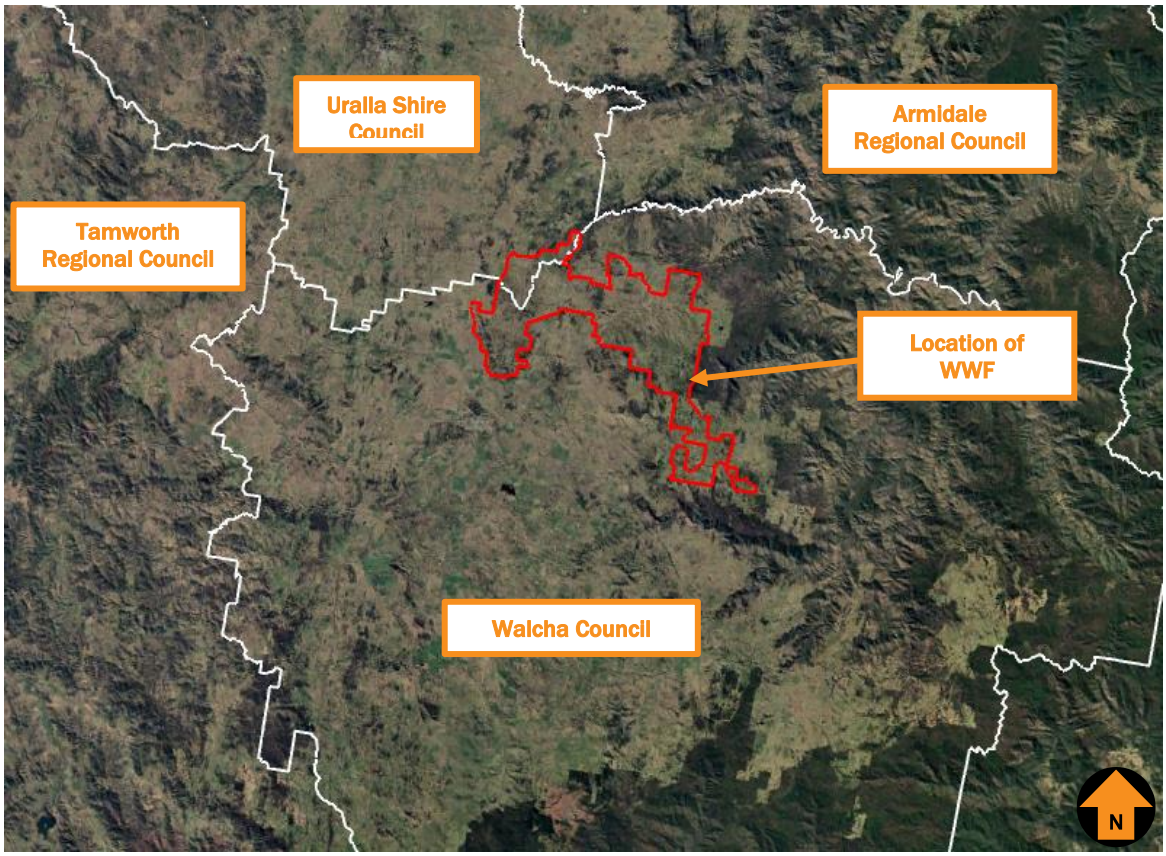

Figure 2 Proposal site relative to LGAs

3. EXTERNAL CONTEXT

3.1. Planning context

WWPL seeks to increase wind power production while protecting individuals, communities and the environment from adverse impacts from wind farms by complying with the NSW *Wind Energy Guideline for State significant wind energy developmen*t (2016).

The role of the NSW DPE is to coordinate the planning process according to the applicable regulations, and in partnership with individual people, community groups, businesses and industry groups, other organisations, local councils, and State and Commonwealth Government agencies. The legal framework includes the *Environmental Planning and Assessment Act 1979* and *Environmental Planning and Assessment Regulation 2000*. Development projects such as wind farms in NSW must submit a development application for approval by the Minister for Planning.

3.2. National Airports Safeguarding Framework

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

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

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

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 Proposal site including recreation, commercial, civil (including for agricultural purposes) and military operations.

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

3.3. Walcha Council

The *Walcha Local Environment Plan 2012* (Walcha LEP, current version dated 14 July 2021) does not include any planning provisions for airfields, aerodromes, airstrips, or airports. Additionally, the Walcha LEP does not contain any conditions for wind farms and associated infrastructure.

3.4. Uralla Shire Council

The *Uralla Local Environment Plan 2012* (Uralla LEP, current version dated 14 July 2021) does not include provisions for airfields, aerodromes, airstrips, or airports. Additionally, the Uralla LEP does not contain any conditions for wind farms and associated infrastructure.

3.5. Aircraft operations at non-controlled aerodromes

Civil Aviation Advisory Publications (CAAP) provide guidance, interpretation and explanation on complying with the Civil Aviation Regulations 1988 (CAR) or Civil Aviation Orders (CAO). CAAP 166-01 v4.2 – *Operations in the vicinity of non-controlled aerodromes* – provides guidance with respect to CAR 166. The purpose of this CAAP is to support Common Traffic Advisory Frequency (CTAF) procedures. It provides guidance on a code of conduct (good airmanship) to allow flexibility for pilots when flying at, or in the vicinity of, non-controlled aerodromes.

CAAP 166-01 v4.2 paragraph 2.1.4 states the following:

> *2.1.4 CASA strongly recommends the use of 'standard' traffic circuit and radio broadcast procedures by radio-equipped aircraft at all non-controlled aerodromes. These procedures are described in the Aeronautical Information Publication (AIP) and Visual Flight Rules Guide (VFRG), and discussed in Section 5 of this CAAP (Standard traffic circuit procedures) and Section 7 (Radio broadcasts).*

The standard circuit consists of a series of flight paths known as *legs* when departing, arriving or when conducting circuit practice. Illustrations of the standard aerodrome traffic circuit procedures are provided in Figure 3 and Figure 4.

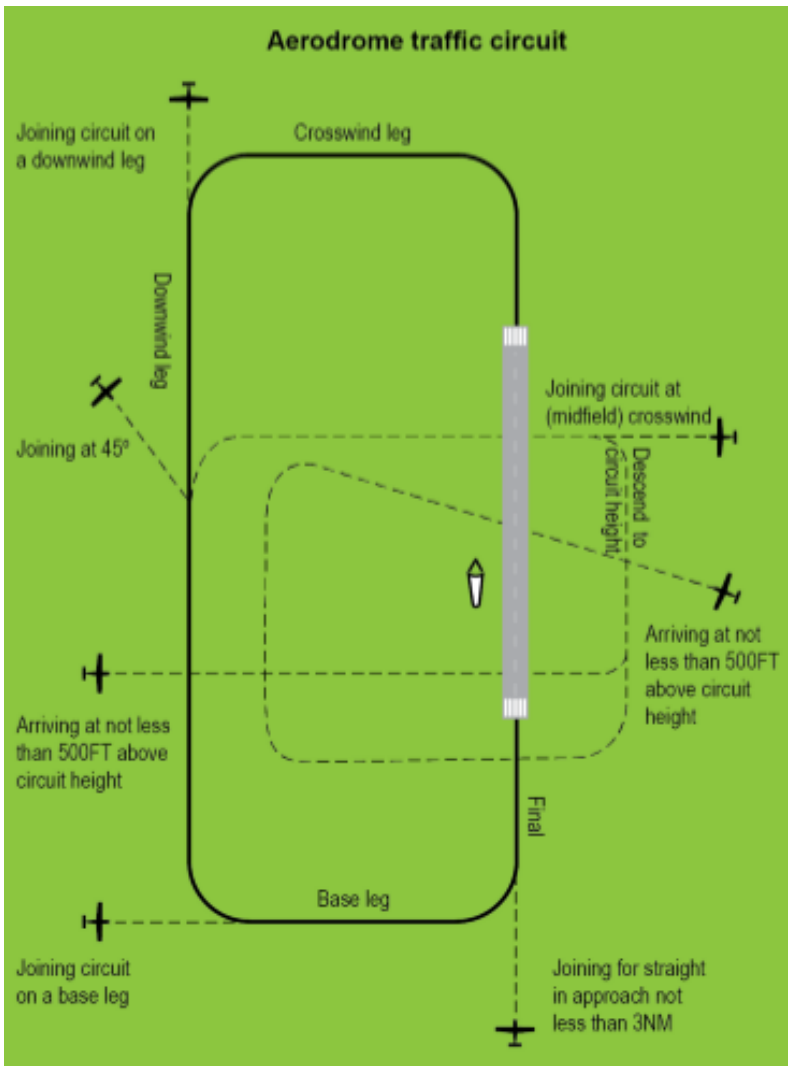

Figure 3 Aerodrome standard traffic circuit, showing arrival and joining procedures

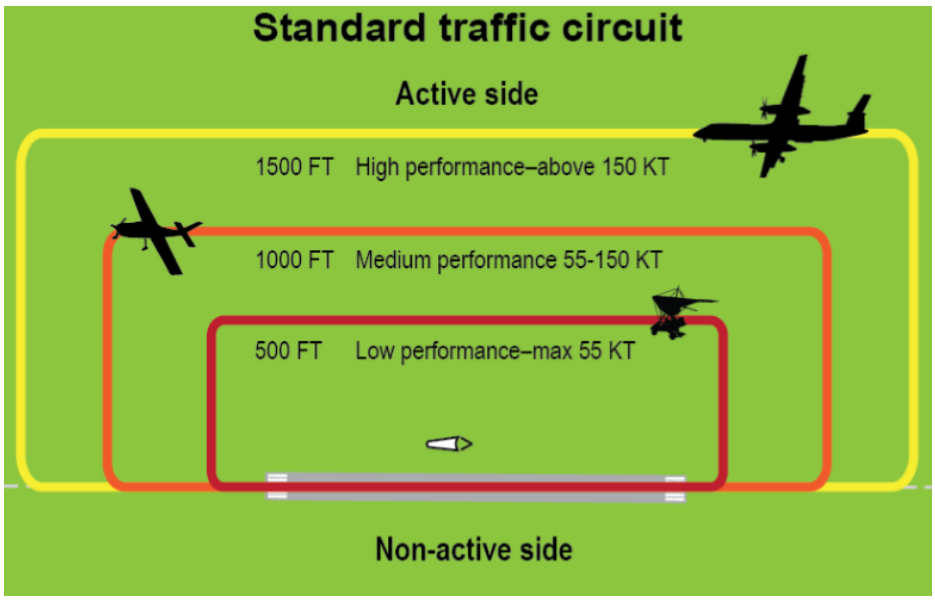

Figure 4 Lateral and vertical separation in the standard aerodrome traffic circuit

CAAP 166-01 v4.2 paragraph 5.4.1 makes reference to a distance that is "normally" well outside the circuit area and where no traffic conflict exists, which is at least 3 nm (5556 m). The paragraph is copied below:

> *5.4 Departing the circuit area*
>
> *5.4.1 Aircraft should depart the aerodrome circuit area by extending one of the standard circuit legs or climbing to depart overhead. However, the aircraft should not execute a turn to fly against the circuit direction unless the aircraft is well outside the circuit area and no traffic conflict exists. This will normally be at least 3 NM from the departure end of the runway, but may be less for aircraft with high climb performance. In all cases, the distance should be based on the pilot's awareness of traffic and the ability of the aircraft to climb above and clear of the circuit area.*

3.6. Rules of flight

3.6.1. Flight under Day Visual Flight Rules (VFR)

According to Aeronautical Information Publication (AIP) the meteorological conditions required for visual flight in the applicable (Class G) airspace at or below 3000 ft AMSL or 1000 ft AGL whichever is the higher are: 5000 m visibility, clear of clouds and in sight of ground or water.

Civil Aviation Regulation (1988) 157 (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 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas, and 1000 ft AGL over built up areas.

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

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

3.6.2. Night VFR

With respect to flight under the VFR at night, Civil Aviation Regulations (1988) 174B states as follows:

> *The pilot in command of an aircraft must not fly the aircraft at night under the V.F.R. at a height of less than 1000 feet above the highest obstacle located within 10 miles of the aircraft in flight if it is not necessary for take-off or landing.*

3.6.3. Instrument Flight Rules (Day or night) (IFR)

According to CAR 178, 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.

Note: 1000 ft = 304.7 m, 10 miles = 16.1 km.

3.7. Aircraft operator characteristics

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

Operations conducted under VFR are required to remain in visual meteorological conditions (VMC) (at least 5,000 m horizontal visibility at a similar height of the wind turbines) and clear of the highest point of the terrain by 500 ft vertical distance and 600 m horizontal distance. In VMC, the wind turbines will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. VFR operators will most likely avoid the Proposal site once wind turbines are erected.

Flight under day VFR is conducted above 500 ft (152.4 m) above the highest point of the terrain within a 600 m radius (300 m for helicopters) unless the operation is approved to operate below 500 ft above the highest point of the terrain.

It is expected that the wind turbines will be sufficiently visually conspicuous to pilots conducting VFR operations within the vicinity of the Proposal to enable appropriate obstacle avoidance manoeuvring.

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

3.8. Passenger transport operations

Regular public transport (RPT) and passenger carrying charter operations are generally operated under the IFR.

3.9. Private operations

Private operations are generally conducted under day or night VFR, with some IFR. Flight under day VFR is conducted above 500 ft AGL.

3.10. Military operations

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

The Department of Defence advised during consultation that it has no objections to the Project. Refer to Section 5 for a detailed response from the Department of Defence.

3.11. Aerial application operations

Aerial application operations including such activities as fertiliser, pest and crop spraying are generally conducted under day VFR below 500 ft AGL: usually between 6.5 ft (2 m) and 100 ft (30.5 m) AGL.

There is a medium rate of aerial application operations in the area.

Due to the nature of the operations conducted, aerial application pilots are subject to rigorous training and assessment requirements in order 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.

The impact of the proposed turbines on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the Proposal was assessed and described in Section 5 and Section 6.

3.12. Aerial Application Association of Australia.

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.

3.13. 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 undertaken by Aviation Projects, and subject to the results of consultation with AAAA and any further consultation with local aerial application operators, it is reasonable to conclude that safe aerial application operations would be possible on properties within the Proposal site and neighbouring the Proposal site, subject to final turbine locations and by implementing recommendations provided in this report.

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.

To facilitate the flight planning of aerial application operators, details of the proposal, including location and height information of wind turbines, wind monitoring towers 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.

3.14. Aerial firefighting

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

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

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

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

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

The developer or operator should ensure that:

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

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

3.15. Emergency services - 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.

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 Section 5 for detailed responses from emergency services stakeholders.

4. INTERNAL CONTEXT

4.1. Wind farm description

The proposed WWF is situated in an area comprised mainly of farming properties.

The Proposal site is located east of Thunderbolts Way and north of the Oxley Highway.

Figure 5 shows a view looking east from Mirani Road towards the western boundary of the proposed WWF.

Figure 5 Looking east towards the western boundary of the proposed WWF

Figure 6 shows a view looking east from Blue Mountain Road towards the eastern boundary of WWF.

Figure 6 Eastern view from Blue Mountain Road

Figure 7 shows a view from Winterbourne Road looking to the south-east towards WWF.

Figure 7 Winterbourne Road looking to the south east at WWF site

Figure 8 shows a view from Moona Road looking to the south west towards WWF.

Figure 8 Moona Road looking to the south-west at WWF site

Figure 9 shows a view from Oxley Highway looking to the north-east towards WWF.

Figure 9 Oxley Highway looking to the north-east at WWF site

At the intersection of Hazeldene and Winterbourne roads, there is an existing telecommunication tower (not associated with the project) which has a height of approximately 20 m AGL. Refer to Figure 10.

Figure 10 Existing telecommunication facility at the intersection of Hazeldene and Winterbourne roads

4.2. Wind turbine description

The maximum blade tip height of the proposed wind turbines will be up to 230 m AGL.

The maximum ground elevation for the proposed wind turbine B130 is 1329 m AHD, which results in a maximum overall height of 1564 m AHD (5132 ft AMSL) including 5 m error budget.

Figure 11 shows the Proposal layout identifying the highest wind turbine B130 (source: ERM, Google Earth).

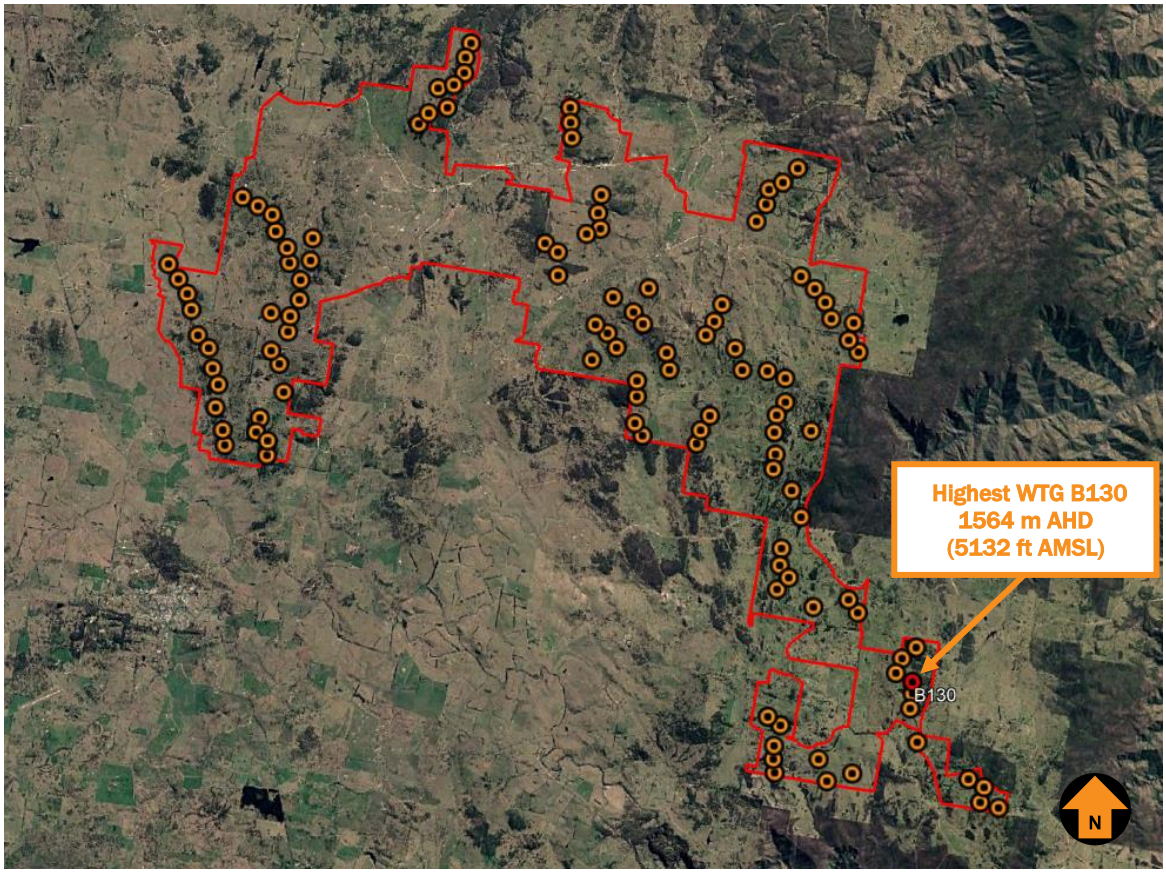

Figure 11 WWF layout and highest wind turbine

'Micrositing' of turbines and wind monitoring towers means an alteration to the siting of a turbine or wind monitoring towers by not more than 100 m and any consequential changes to access tracks and internal power cable routes. The potential micrositing of the turbines and wind monitoring towers 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 turbine position. The micrositing of the turbines and wind monitoring towers is not likely to result in a change in the maximum overall blade tip height of WWF.

The coordinates and ground elevations of WWF wind turbines are listed in **Annexure 3.**

4.3. Wind monitoring tower description

The Project includes the commissioning and decommissioning of 4 temporary meteorological monitoring masts (met mast) for power testing and installation of up to 2 permanent met masts.

Each met mast will be located close to a WTG location and will have a maximum height of approximately 149 m (489 ft) AGL, equivalent to the hub height of the installed WTGs. The permanent met masts assist in verifying the performance of the WTGs during operation of the Project.

The met masts consist of a buried concrete base foundation and guy wires which are attached to buried anchor points. The WMTs are guyed at several levels in 3 directions and the guy wires have aviation markers located near the top of the WMTs.

The highest overall ground level for the existing WMT 3 is approximately 1307 m AHD (+ 10 m), resulting in a maximum overall height of 1419 m AHD (4656 ft AMSL). Refer to Figure 12 for the location of the temporary WMTs in white triangles and permanent WMTs within WWF site (source: WWPL, Google Earth).

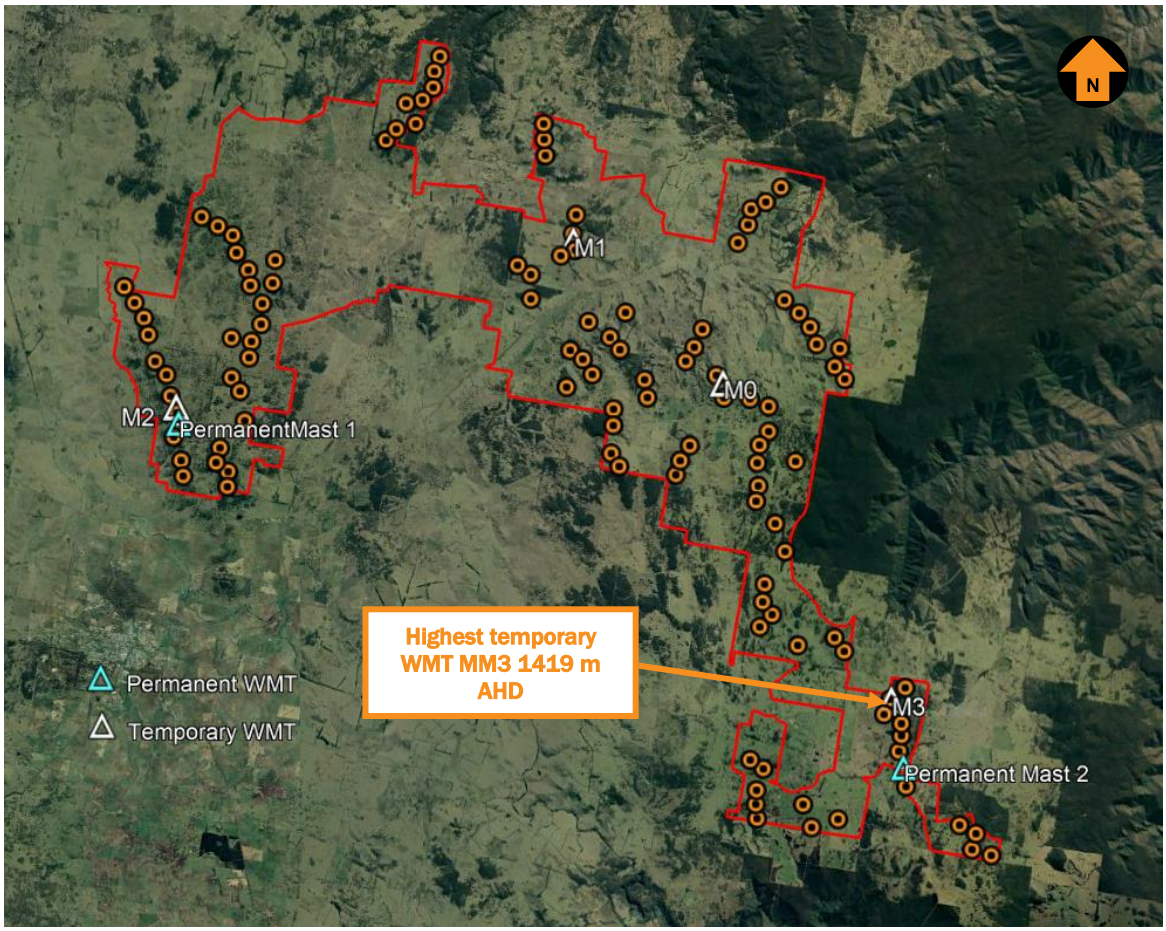

Figure 12 WMTs locations within Proposal site

The details including coordinates and ground elevations of the existing WMTs are listed in Table 3 (source: WWPL).

Table 3 Existing WMT details

Details	*WMT 0*	*WMT 1*	*WMT 2*	*WMT 3*
WMT ID	M0	M1	M2	M3
Location	30°54'19.37"S 151°47'54.50"E	30°51'47.99"S 151°44'50.10"E	30°54'43.56"S 151°36'41.65"E	30°59'51.86"S 151°51'20.84"E
Error budget (m)	10 m	10 m	10 m	10 m
Ground elevation at site m AHD (GPS data)	1296 m AHD	1149 m AHD	1217 m AHD	1307 m AHD
Height of tower AGL	90 m (295 ft)	102 m (335 ft)	102 m (335 ft)	102 m (335 ft)
WMT tip height AHD	1396 m AHD (4580 ft AMSL)	1261 m AHD (4137 ft AMSL)	1329 m AHD (4360 ft AMSL)	1419 m AHD (4656 ft AMSL)
Lighting	Nil	Nil	Nil	Nil
Marking	3 orange marker balls	3 orange marker balls	3 orange marker balls	3 orange marker balls
Design	Steel lattice	Steel lattice	Steel lattice	Steel lattice
Construction date	2009	February 2020	February 2020	February 2020
Reported to Airservices Australia	2009	11 March 2020	11 March 2020	11 March 2020

The details of the WMTs were reported to Airservices Australia for entry into Vertical Obstruction Database.

Figure 13 shows the final installation of WMT 1 (source: WWPL).

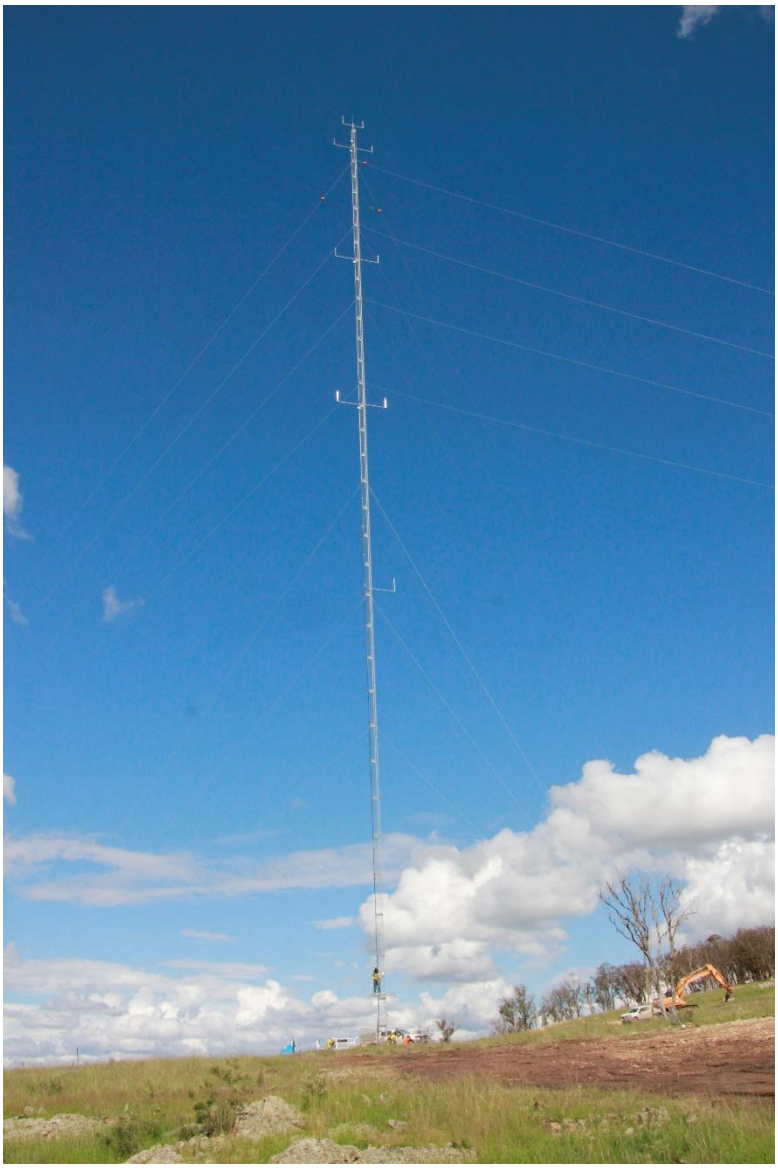

Figure 13 WMT 1 installed onsite

4.4. Overhead transmission line

A 330 kV single or double circuit, three phase, twin conductor bundle overhead transmission line connection is proposed to connect the Project to a new switchyard approximately 7 km south of Uralla, NSW, with a length of approximately 50 km.

The indicative design of the overhead 330 kV Transmission Line is:

- Approximately 40 m high, single circuit lattice steel tower, spaced approximately 500 m apart, subject to terrain and final design;
- towers generally require concrete footings for each of the four legs and a disturbance area of approximately 30 m in diameter during construction;
- twin aluminium conductor bundles attached to ceramic insulators in the centre and the ends of the tower cross arm;
- each conductor bundle will include orange balls for visual identification and an earth shield wire/s, protecting the line from lightning strikes; and
- 60 m wide easement with unformed access tracks up to 3 m wide (equivalent to a farm track) to facilitate operational access by TransGrid (for maintenance, repair and hazard reduction).

Figure 14 shows the design of the main 330kV overhead transmission line in yellow line and the existing 330kV transmission line from Armidale to Tamworth operated by TransGrid in red line (source: ERM).

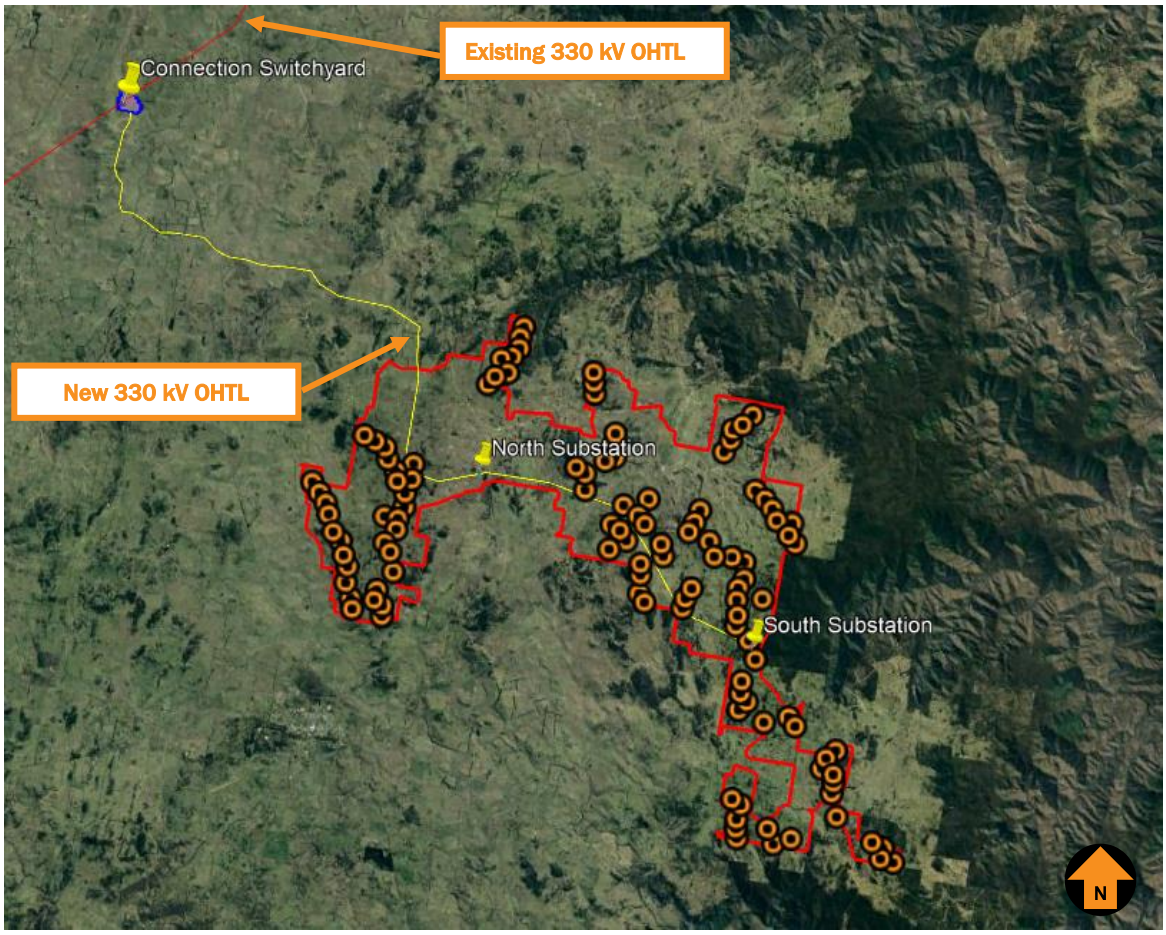

Figure 14 Electrical Reticulation Network

5. CONSULTATION

The stakeholders consulted include:

- Airservices Australia
- aircraft operators – Corporate Air/Link Airways, Fleet Helicopters, REX, Superair, QantasLink
- aerodrome operators (Armidale Regional Council)
- Department of Defence
- Local Land Services
- NSW National Parks and Wildlife Service (Oxley Wild Rivers National Park)
- NSW Rural Fire Service
- Royal Flying Doctor Service
- Uralla Shire Council
- Walcha Council
- Westpac Life Saver Rescue Helicopter Service.

Details and results of the consultation activities are provided in Table 4.

Table 4 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Aerial Operator (Superair)	1 October 2020 Email to Superair	2 October 2020 Email from Mr David Boundy (Manager) 24 November 2020 Face to face meeting at Aviation Projects office in Taringa QLD	During initial consultation Aviation Projects informed Superair about the Project. In an email response Mr Boundy advised the following: *Based on the map supplied to us by Aviation Projects showing the approx. position of the wind turbines, if we take a radius of 2 klms from any turbine we have 6 agricultural airstrips we operate off. If we go out to 4 klm radius, we have a further 4 airstrips and then 6 klms another 2 airstrips. So in a radius of 6 klms we have 12 airstrips we operate off.* *This gives you some idea of the huge impact these turbines have on our operations. As far as Superair is concerned I wish wind turbines where never invented.* *These turbines impact our operations heavily in several areas.* *1;- Safety;- our operations are from ground level to 100 feet. Goes without saying these turbines are in our direct flight paths as we fly a straight line grid pattern every 20 meters guided by GPS.* *2;- Productivity:- because of then turbines we cannot treat some of our customers properties as efficiently as before which adds costs.* *3:- Accuracy:- if we have to fly over the turbines we are releasing fertilizer from a height that is not conducive to a good spread quality.* *4:- Economic impact:- due to the difficulties we face as an aerial operator and if we need to increase the cost of the application to our*	Provide details of WTG and WMT locations and heights to aerial application operators prior to construction – **to be completed**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			clients due to the placement of the wind turbines, some clients will look at alternative application of fertilizer. This being ground spread. So through no fault of Superair we lose clients and therefore income. *Superair has been involved with several wind farm developments over the last 10-12 years and believe me not all positive. The consultants come into my office, tell us what we want to hear, but once the turbines are up then all the promises are long forgotten.* *There are only 2 things that Superair wants to see in the agreements/contracts with the landholder is:-* *1:- When we have done risk assessments on these wind farms the one thing that is paramount to safe operations is that Superair will not carry out any agricultural operations with the blades turning. This needs to be in the agreements with the landholders. Over the years the wind turbine people say this wont be an issue but once the turbines are in place they are reluctant to have a person available on the days we need to operate to make sure the blades wont start or aren't turning during ag operations.* *2;- if the wind turbines decrease the productivity of the aircraft and Superair has to pass on increased costs to the landholders then this cost is reimbursed by the wind turbine company. Again this needs to be in the agreement/contract.* *One could argue that this is not part of the Aviation Projects scope, but it directly relates to safety. If a pilot in under increased stress to*	

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			produce the same hourly return for the aircraft as before the wind turbines are there then he will be lowering safety margins in an attempt to produce the same outcome. Further discussion with Mr Boundy in person revealed that the status of the identified ALAs was unknown. Mr Boundy suggested that the application of super within a wind farm was possible although highly undesirable, and the wind turbine blades should not be rotating. Superair principally applies superphosphate but does some other aerial application activities, generally not involving pesticides or herbicides.	
Airservices Australia	1 October 2020 Email to Airport Developments	30 October 2020 Email from Mr William Zhao (Advisor Airport Development)	During initial consultation Aviation Projects informed Airservices Australia about the Project. In an email response dated 30 October 2020, Mr Williams Zhao (Advisor Airport Development) advised the following: ***Airspace Procedures*** *With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1332.4m (4732ft) AHD, the wind farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Armidale Airport.* *The wind farm will not affect any published air route LSALTs.*	Once construction commences, complete Vertical Obstacle Notification Form – **to be completed**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			Note: procedures not designed by Airservices at Armidale Airport were not considered in this assessment. ***Communications/Navigation/Surveillance (CNS) Facilities*** *This wind farm, to a maximum height of 1332.4m (4732ft) AHD, will not adversely impact the performance of any Airservices Precision/Non-Precision Navigation Aids, Anemometers, HF/VHF/UHF Communications, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.* ***Summary*** *Based on the above assessment, Airservices view is that the proposed wind farm would not have an impact on the safety, efficiency or regularity of existing, or future air transport operations into or out of Armidale Airport.*	
Aircraft operator (Corporate Air/Link Airways)	1 October 2020 Email to Corporate Air 29 October 2020 Email to Link Airways	N/A	During initial consultation Aviation Projects informed Corporate Air/Link Airways about the Project. A follow up email was sent on 29 October 2020, no response was received.	N/A

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Aircraft operator (Fleet Helicopters)	1 October 2020 Email to Fleet Helicopters	12 October 2020 Email from Mr Mike Watson (Chief Executive Officer)	During initial consultation Aviation Projects informed Fleet Helicopters about the Project. In an email response Mr Watson advised the following: *The windfarm will directly impact on our operations in the area as 95% of our flying is conducted as low-level aerial work and for day VFR helicopters most short distance ferries are conducted below 1000 feet so below the wind tower height.* *In saying that short of the towers not being built there is nothing that we can do about it other than be aware and alter our operations accordingly when we work in that area.*	Ensure Project is marked on flight planning charts – **to be completed once construction commences** No additional actions required
Aircraft Operator (QantasLink)	1 October 2020 Email to QantasLink	2 October 2020 Email from Captain Adrian Young (Acting COO and AOC Accountable Manager)	During initial consultation Aviation Projects informed QantasLink about the Project. In an email response Mr Young advised the following: *Based on the review, we can confirm that there are no adverse impact to our operations.*	No further actions required
Aircraft Operator (REX)	1 October 2020 Email to REX	13 October 2020 Email from Mr Robert Noble (Manager Flight	During initial consultation Aviation Projects informed REX about the Project. In an email response the following from Mr Noble was advised: *We have assessed the proposal and see no immediate significant impact on our operations to either Tamworth or Armidale. The proposed changes to the LSALT of the airways will also have no*	No further actions required

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
		Operations Engineering)	*significant impact on our operations other than administrative changes to our navigation logs.*	
Armidale Regional Council (Aerodrome operator)	1 October 2020 Email to Armidale Regional Council	7 October 2020 Email received from Mr Billy Gleeson-Barker (Acting Manager Armidale Regional Airport)	During initial consultation Aviation Projects informed the Armidale Regional Council about the Project. In an email response Mr Gleeson-Barker advised the following: *We have reviewed and see no issues that would impact YARM.*	No further actions required.
CASA	CASA has advised that it will only review assessments referred to it by a planning authority or agency.			No further actions required.
Department of Defence	1 October 2020 Email to Department of Defence	22 October 2020 Letter from Mr Charles Mangion (Director – Land Planning & Regulation)	During email consultation Department of Defence was informed about the Project. In a letter response Department of Defence advised: *Defence has conducted an assessment of the proposed wind farm for potential impacts on the safety of military flying operations as well as possible interference to Defence communications and radar.* *The proposed turbines meet the requirements for reporting of tall structures. There is an ongoing need to obtain and maintain accurate information about tall structures so that this information can be marked on aeronautical charts. Marking tall structures on aeronautical charts assists pilot navigation and enhances flight safety. Airservices Australia (ASA) is responsible for recording*	Once construction commences, complete Vertical Obstacle Notification Form – **to be completed**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			the location and height of tall structures. The information is held in a central database managed by ASA and relates to the erection, extension, or dismantling of tall structures, the top of which is above: *a. 30 metres AGL, that are within 30 kilometres of an aerodrome; and* *b. 45 metres AGL elsewhere.* *The proposed structures will meet the above definition of a tall structure. Defence therefore requests that the applicant provide ASA with "as constructed" details. The details can be emailed to ASA at vod@airservicesaustralia.com.* *Defence understands this assessment is yet to be considered by CASA. If CASA determines that obstacle lighting is to be provided, it should be compatible with persons using night vision devices. If LED lighting is proposed, the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometres. Defence has no objection to the proposed wind farm provided that the project complies with the above conditions.*	
Local Land Services	8 October 2020 Email to Local Land Services	Nil	During initial consultation Aviation Projects informed Local Land Services about the Project. A follow up email was sent on 29 October 2020, no response was received.	N/A
National Parks and Wildlife Service	1 October 2020 Email to NSW National Parks	17 November 2020	Manager New England Area, Northern Inland Branch, NSW National Parks and Wildlife Service replied:	Consult RFS and Fleet Helicopters – complete.

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
(Oxley Wild Rivers National Park)	and Wildlife Service		I understand you have had discussions locally about this project and the potential impacts it may have on NPWS aviation operations. Firstly I feel it would be very important to seek local RFS and private aviation companies (such as Fleet Helicopters) advice on these matters. I offer the following feedback from a local NPWS management point of view. There are three main considerations that should to be addressed by the proponent; 1. Fire operations. I've done a spatial analysis on fire history in the direct vicinity, 87 wildfires over the past 42 years so roughly two wildfires per year. This is a very fire prone area, bush fire occurrence in the direct vicinity of the proposed development is almost certain and at frequent intervals. NPWS regularly heavily rely on helicopters and fixed wing aircraft to aid in wildfire suppression in this area. Operations will include water bucketing from helicopters, remote firefighter insertion and retrieval, mapping and monitoring and bombing by fixed wing aircraft from the single engine air tractor size to the large air tanker size. Helipads and water points on the surrounding land (next to or within the planned development) are often used. Such aviation support is often critical in successful suppression of wildfire and paramount to ensure crew safety. Whilst there is acknowledgement of components of these matters there is no outline of how bushfire aviation operations could be managed in this specific area. This	Consider need for obstacle lighting – refer to Section 9. Provide details of WTG and WMT locations and heights to aerial application operators prior to construction – **to be completed**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			Impact Assessment should address these matters at the site specific level as the potential impacts of such a development will vary between locations. For example, a flight exclusion zone in this immediate area may significantly affect operations on the NPWS and private property interface which is an important area when it comes to these operations. Consequences may result in very long-term operational issues, impact NPWS ability to control wildfire on NPWS estate and/or defend NPWS estate from fire encroaching, result in long-term financial impacts due to aircraft inefficiencies (long ferries and the use of alternate water points) and significantly compromise fire crew safety. 2. Pest operations. The proposal may impact on current landscape scaled pest control, particularly wild dog and fox aerial baiting. There has been a lot of work over the years developing a coordinated aerial baiting programme which includes public and private land. Private landholders see the value in such work because it reduces stock losses. Aerial baiting is an attractive proposition for these people for a few reasons, ease of operation and the low financial cost to landholders being the main two. Losing this option in the immediate area may compromise best practice management because the alternate ground baiting is more time consuming and costly hence less likely to	

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			happen. Aerial baiting operations also rely on helipads on private land to ensure efficiencies in flight time, if these helipads were not available the cost of these operations will increase if they continue on adjoining land. 3. Pilot safety. Internally NPWS does manage a fleet of aircraft and a team of specialist staff as well as engaging contract aircraft and pilots a lot of who are not local to the area. I note the incident investigations within all considered tower lighting. One investigation found the light was not working the others didn't have a clear outcome. The recommendation within is that these proposed towers are not to be lit. The investigations also had inclement weather as being a contributing factor to these incidents. A parallel between inclement weather and fire conditions can be drawn. Considering the nature of the bushfire prone landscape and the flight hazard posed by these towers (even not rotating) any insurance of pilot safety (such as safety lighting) should be strongly considered.	
NSW RFS	1 October 2020 Email to NSW Rural Fire Service	29 October 2020 Email from Inspector Bernie O'Rourke (Supervisor, Operations Aviation,	During initial consultation Aviation Projects informed NSW Rural Fire Service about the Project. In an email response Mr O'Rourke advised the following: *We have no comments on the proposed wind farm. Wind farms will be treated like any other potential hazard to aircraft operations.*	No further actions required.

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
		Response and Coordination		
RFDS	1 October 2020 Email to Royal Flying Doctor Service	13 October 2020 Email from Mr Justin Marr (General Manager Aviation, RFDS South Eastern Section)	During initial consultation Aviation Projects informed Royal Flying Doctor Service about the Project. In an email response Mr Marr advised the following: *I have been advised by my team there are no issues from a RFDS South Eastern perspective.*	No further actions required.
Uralla Shire Council	1 October 2020 Email to Uralla Shire Council	2 November 2020 Email from Mr Matt Clarkson (A/Director Infrastructure and Development)	During initial consultation Aviation Projects informed Uralla Shire Council about the Project. In an email response Mr Clarkson advised the following: *Council has reviewed the Aviation Impact Assessment for Winterbourne Wind Farm and raises no issues with the assessment.*	No further actions required.
Walcha Council	1 October 2020 Email to Walcha Council	19 October 2020 Email from Mr Peter Murray (Director Infrastructure)	During initial consultation Aviation Projects informed Walcha Council about the Project. In an email response Mr Murray advised the following: The only comments we would like to tender are: *1. Correct "Walcha Shire Council" to "Walcha Council".* *2. That the owners of the aircraft landing areas ALA1 and ALA2 are contacted directly regarding potential impacts of the proposal and provided an opportunity to comment.*	1. Updated 2. **To be completed by proponent** 3. Noted No further actions required

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			3. The potential effect on aviation is outside the scope of Walcha Local Environmental Plan.	
Westpac Life Saver Rescue Helicopter Service	1 October 2020 Email to Westpac Life Saver Rescue Helicopter Service	17 November 2020	Executive Assistant to the Chief Pilot and Operations Manager replied: Please find our comments on the proposed windfarm below : Disagree with para 24 (see below). NVG compatible obstruction lights need to be installed to provide operators like us an opportunity to see the WTG/WMT hazards. Seeing an unlit structure in low light conditions may prove extremely difficult, particularly noting our min NVD vis requirements of 5000m and we can fly around at 500' AGL and their towers are going to be up to 750' AGL. • Please forward the risk assessment regarding the proposal not to put obstacle lighting on the towers to me at your earliest convenience. Obstacle lighting risk assessment 24. Aviation Projects has undertaken a safety risk assessment of the Proposal and concludes that WTGs and WMTs will not require obstacle lighting to maintain an acceptable level of safety to aircraft. Our LLIFR LSALTS (YSTW to YCFS & YSTW to YPMQ) will have to be raised considerably. Currently on the YSTW to YCFS route in particular the leg YWCH to BLR has a current LSALT of 6000', this will have to be raised to 6300' based on Wind Turbine B130	The risk assessment requested was contained in the original email – complete. Consideration of LLIFR LSALTS – raising the LSALTS will provide a safe operating environment, provided the relevant obstacle data is available in advance of their construction – Proposed mitigation is to provide details of WTG and WMT locations and heights to Westpac Rescue Helicopter Service prior to construction – **to be completed** Alternatively, the flights can plan to go around the wind farm, which may increase flight time, but should not impact safety.

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			(planned elevation of 5208' AMSL). The YSTW – YPMQ route will be effected to, particularly the leg YWCH to PMQ (current LSALT of 5800') will have to be raised to 6300' based again on Wind Turbine B130. Raising these LSALTs may compromise our ability to get over the ranges to the east of Tamworth to respond to an incident especially in winter.	

6. AVIATION IMPACT STATEMENT

6.1. Nearby certified aerodromes

The Proposal site is located within 30 nm (55.56 km) of Armidale Airport (YARM), which is a certified airport.

Tamworth Regional Airport (YSTW) is located outside of the 30 nm (55.56 km) radius and will not be impacted by the Proposal in terms of issues associated with airspace protection.

The location of the Proposal site relative to Armidale Airport and Tamworth Regional Airport is shown in Figure 15 (source: Google Earth).

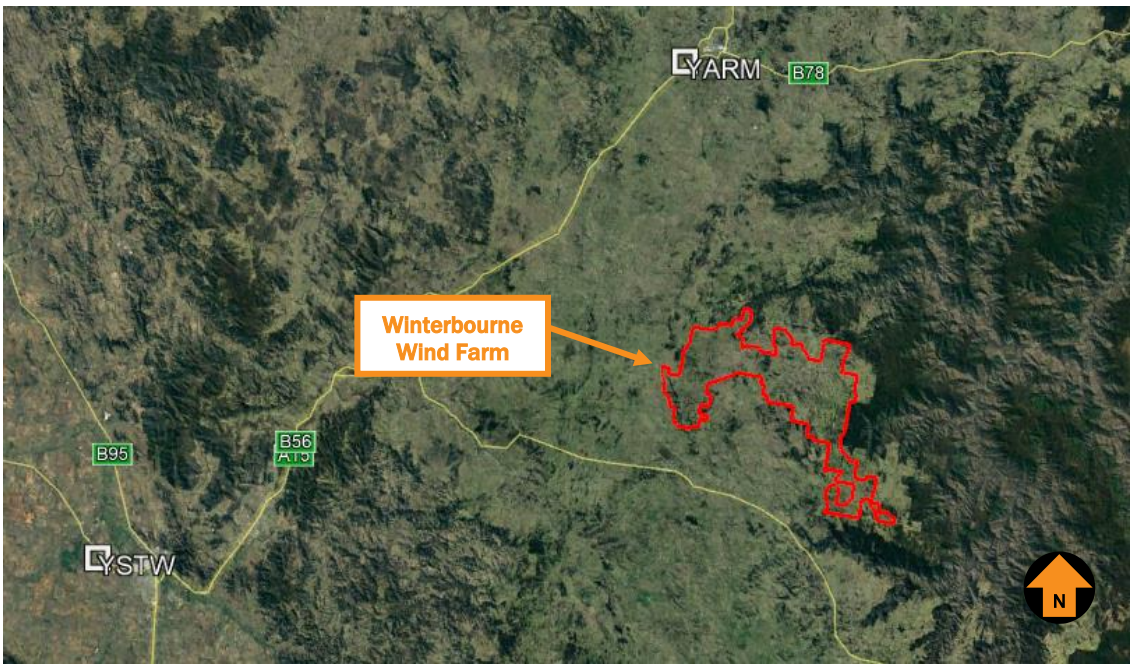

Figure 15 Proposal site relative to nearby certified airports

Figure 16 shows buffer areas for Armidale Airport (10 nm and 25 nm) and for Tamworth Regional Airport (25 nm) MSAs, which include additional 5 nm buffer areas (source: WWPL, Google Earth).

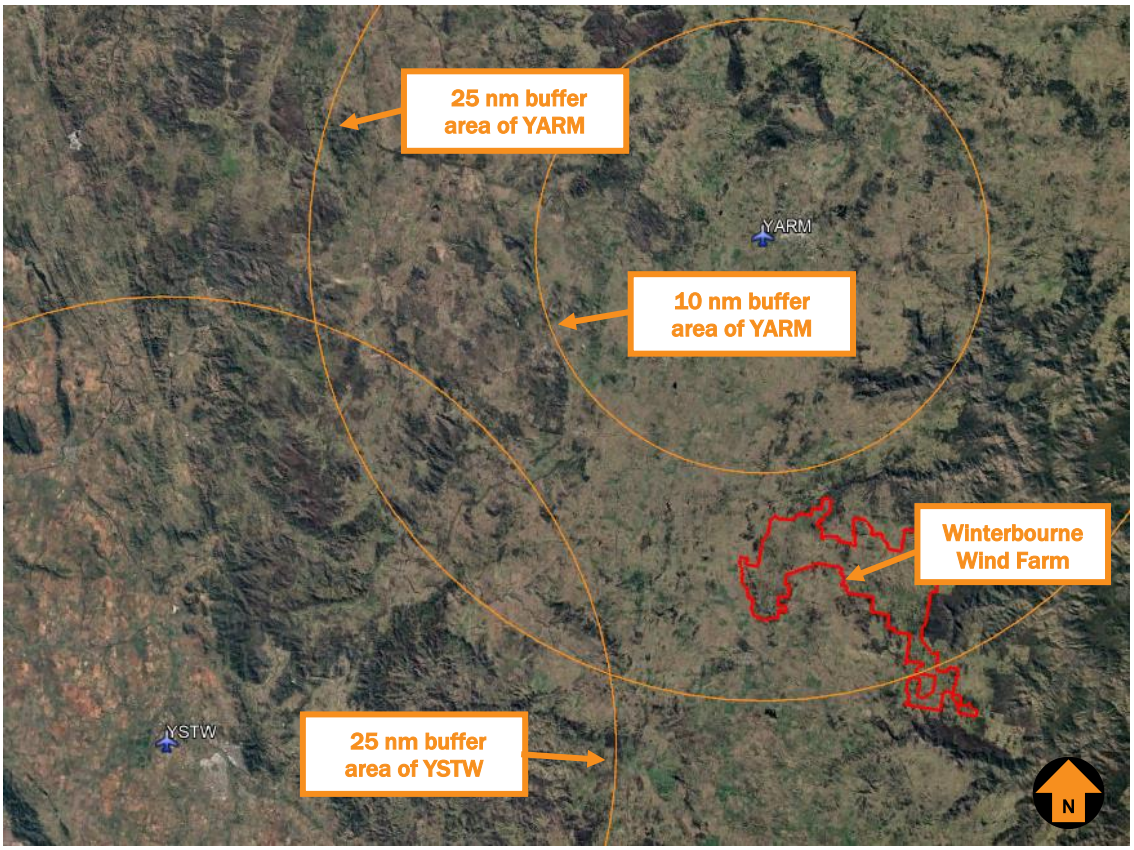

Figure 16 Armidale Airport and Tamworth Regional Airport buffer areas

6.2. Armidale Airport

Armidale Airport (YARM) is a certified, code 3, non-precision approach runway, operated by Armidale Regional Council, with a published aerodrome elevation of 1084 m AHD (3556 ft AMSL) (source: Airservices Australia, FAC, 17 June 2021).

Armidale Airport has two runways:

- runway 05/23 sealed surface with a length of 1738 m, width 30 m and runway strip 150 m; and
- runway 09/27 unrated/gassed gravel with a length of 1116 m, width 30 m and runway strip 90 m.

Figure 17 shows the Armidale Airport (YARM) runway layout (source: AsA, Aerodrome Chart, dated 17 June 2021).

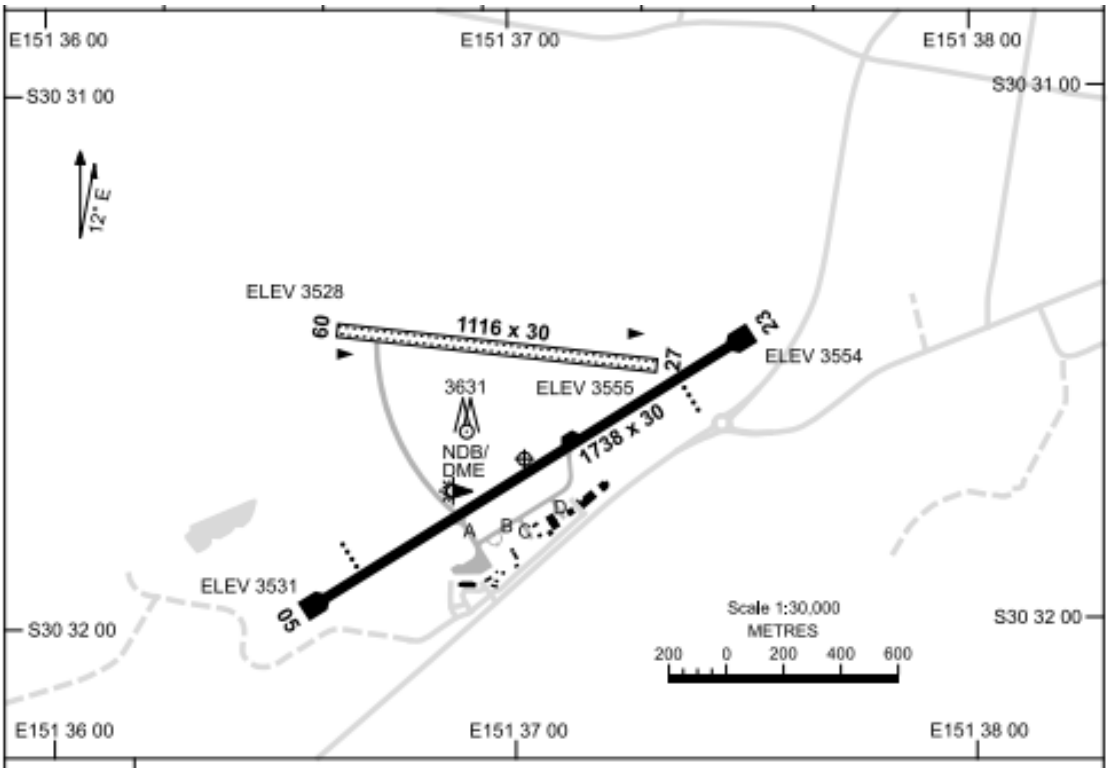

Figure 17 Armidale Airport (YARM) runway layout

Armidale Airport's aerodrome reference point (ARP) coordinates published in Airservices Australia's Designated Airspace Handbook (DAH) are Latitude 30°31'41"S and Longitude 151°37'02"E.

Armidale Airport has aerodrome lighting (including MIRL CAT 1, RTIL and PAPI) and radio navigation and landing aids (a non-directional (radio) beacon NDB and distance measuring equipment (DME)).

6.3. Instrument procedures

A check of the AIP via the Airservices Australia website showed that Armidale Airport is served by non-precision terminal instrument flight procedures, as per Table 5 (source: Airservices Australia, effective 17 June 2021).

Procedure charts for Armidale Airport are designed by Airservices Australia.

Table 5 Armidale Airport (YARM) aerodrome and procedure charts

Chart name	*Effective date*
AERODROME CHART	17 June 2021 (Am 167)
DME or GNSS ARRIVAL	17 June 2021 (Am 167)
NDB RWY 05	17 June 2021 (Am 167)
NDB RWY 23	17 June 2021 (Am 167)
RNAV-Z GNSS RWY 05	17 June 2021 (Am 167)
RNAV-Z GNSS RWY 23	17 June 2021 (Am 167)

6.4. PANS-OPS surfaces

An image of the minimum safety altitude (MSA) published for Armidale Airport is shown in Figure 18.

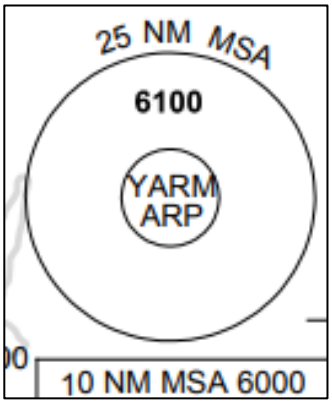

Figure 18 MSA at Armidale Airport

The Manual of Standards 173 *Standards Applicable to Instrument Flight Procedure Design* (MOS 173), requires that a minimum obstacle clearance (MOC) of 1000 ft below the published MSA is maintained.

Obstacles within 10 nm MSA (+ 5 nm buffer) and within 25 nm MSA (+ 5 nm buffer) of Armidale Airport's ARP define the height at which an aircraft can fly when within 10 nm and 25 nm.

The Proposal is located outside the 10 nm MSA of Armidale Airport but within the 25 nm MSA of Armidale Airport.

A close up of the proposed WTGs located within the horizontal extent of the 25 nm MSA buffer (+ 5 nm buffer) of Armidale Airport is shown in Figure 19 (source: WWPL, Google Earth).

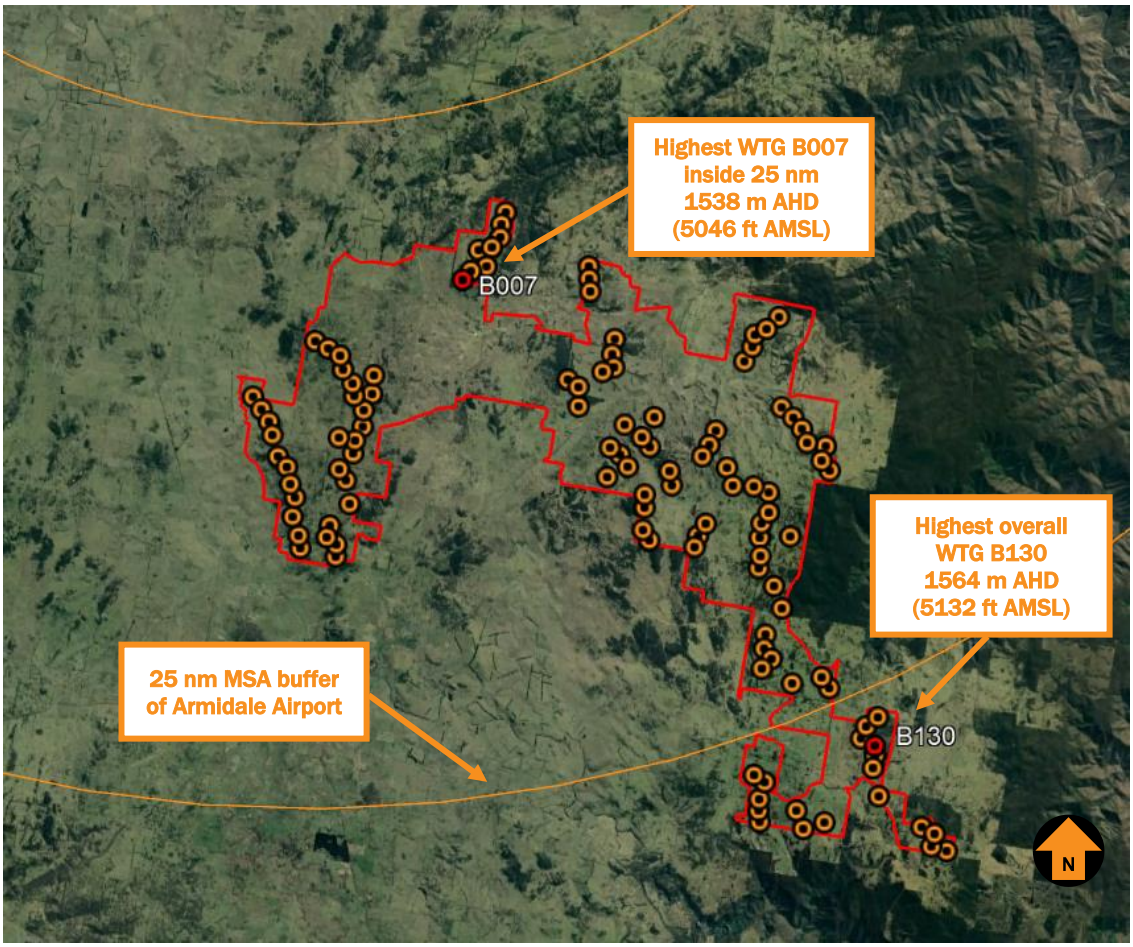

Figure 19 Armidale Airport (YARM) 25 nm MSA

The highest WTG which is located inside of the horizontal extent of the 25 nm MSA of Armidale Airport (+ 5 nm buffer area) is B007.

An impact analysis of Armidale Airport's MSA is provided in Table 6.

Table 6 Armidale Airport MSA impact analysis

MSA	*Minimum altitude*	*MOC*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
10 nm	6000 ft AMSL (1829 m AHD)	5000 ft AMSL (1524 m AHD)	Nil (outside the controlling altitude)	No impact	Nil
25 nm	6100 ft AMSL (1859 m AHD)	5100 ft AMSL (1554 m AHD)	Highest WTG (B007) within 25 nm MSA is below the controlling altitude by approximately 54 ft AMSL	No impact	Nil

The highest WTG, which is B007, is located inside of the horizontal extent of the 25 nm MSA of Armidale Airport (+ 5 nm buffer area). The maximum overall height for wind turbine B007 is approximately 1538 m AHD (5046 ft AMSL) (including 5 m error budget). As a result, the B007 will be approximately 16 m (54 ft) below the 5100 ft MOC. Therefore, the 25 MSA of 6100 ft AMSL will not be impacted.

Note: the WTG heights include a 5 m allowance for variance in site elevation.

The Proposal will not impact instrument procedures of Armidale Airport.

6.5. Circling areas

All turbines are located beyond the horizontal extent of category A, category B and category C circling areas at Armidale Airport.

The maximum horizontal distance that category C circling area may extend for an aerodrome in Australia is 4.2 nm (7.8 km) from the threshold of each usable runway.

The closest proposed wind turbine B001 is located approximately 32 km (17 nm) south from Armidale Airport's runway 05 threshold Therefore, the Proposal is located outside the horizontal extent of circling areas at Armidale Airport and will have no impact.

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 wind turbine B001 is located approximately 33 km (18 nm) south from Armidale Airport's ARP. Therefore, WWF is located outside the horizontal extent of any OLS and will not impact the OLS of Armidale Airport.

6.7. Nearby aircraft landing areas published via AIP/OzRunways

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

A search on OzRunways, which sources its data from Airservices Australia (AIP) and Aircraft Owners and Pilots Association (AOPA) Australia Airfield Directory, returned with 6 nearby ALAs to the Proposal site. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

Given the proposed WTGs are located outside a nominal 3 nm buffer of YWCH (Walcha), OZKEV (Kelvin), (OZSGH) Strathleigh, (OZWSK) Wilsons Creek, YWMM (Wollomombi ALA) and OZJEO (Jeogla), these ALAs will not be impacted by the Proposal.

Figure 20 shows the location of nearby ALAs identified in published aeronautical data relative to the Proposal site and a nominal 3 nm buffer (in pumpkin colored circle) from identified ALAs (source: AIP, Google Earth).

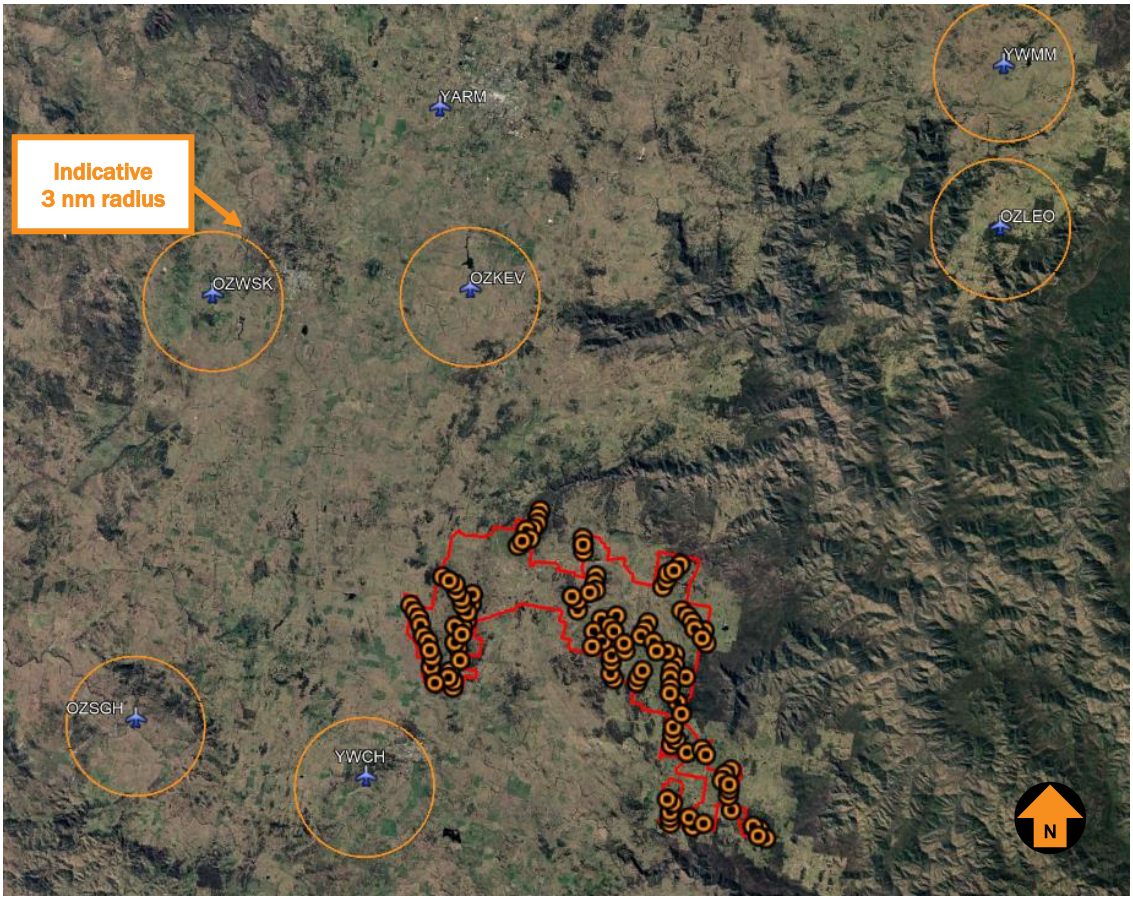

Figure 20 Proposal site relative to published ALAs

6.8. Other identified ALAs

Superair and other official sources provided identification of other ALAs in the vicinity of the Project site. These ALAs are depicted in Figure 21. The majority of these identified ALAs are Involved Landowner ALAs.

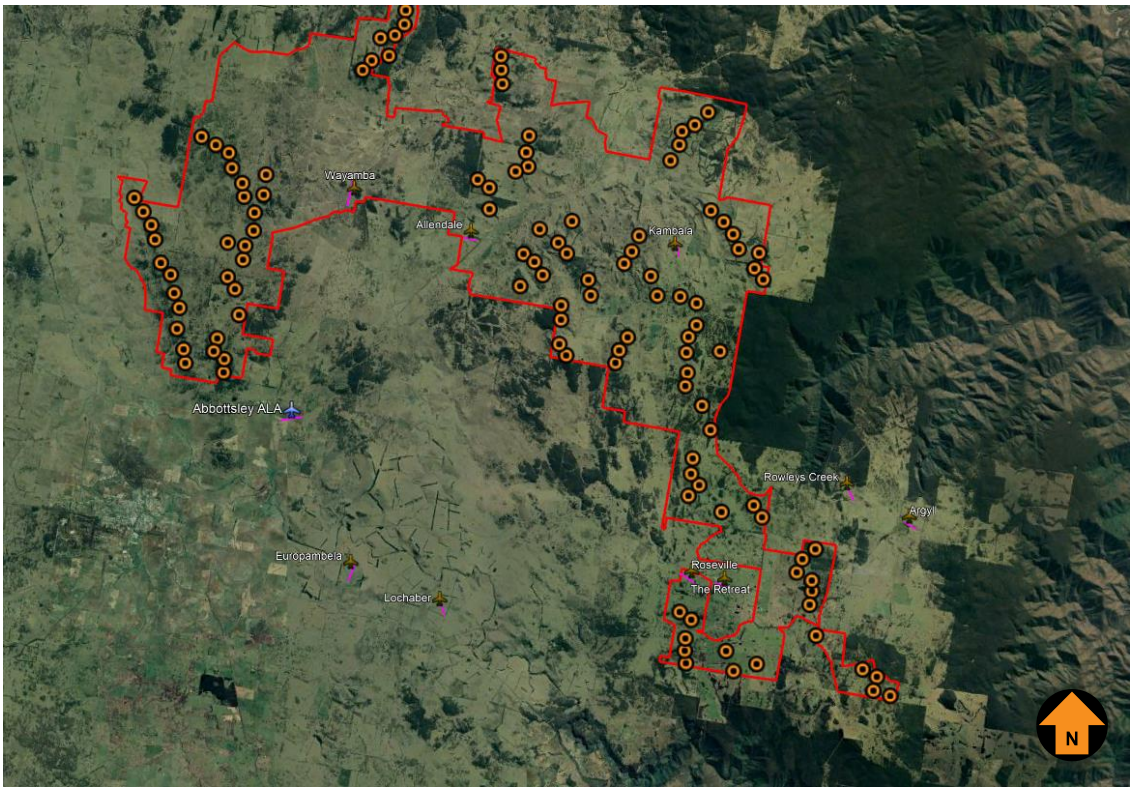

Figure 21 Other identified ALAs

As stated earlier, an area of interest within a 3 nm radius of an ALA is used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA. Involved Landowners consist of the following ALAs: Abbottsley ALA, Wayamba ALA, Alendale ALA, Kambala ALA, Roseville ALA, and The Retreat ALA.

The two Non-Involved Landowners which are further assessed in this AIA are Rowleys Creek ALA and Argyll ALA which are north-east of WTG B127. Both these ALAs are within the 3 nm area of interest of WTG B127. Figure 22 refers to the location of these Non-Involved ALAs in relation to WWF.

Figure 22 Non-Involved Landowners in relation to the Project

As a means of providing guidance to ALA operators, CASA previously had published recommended practices in its Civil Aviation Advisory Publication (CAAP) 92-1(1) *Guidelines for aeroplane landing areas*. This CAAP has been repealed however the information used to define approach and take-off surfaces is still useful.

The purpose of the CAAP 92-1(1) was to provide guidance as follows:

> *These guidelines set out factors that may be used to determine the suitability of a place for the landing and taking-off of aeroplanes. Experience has shown that, in most cases, application of these guidelines will enable a take-off or landing to be completed safely, provided that the pilot in command:*
>
> *a. has sound piloting skills; and*
>
> *b. displays sound airmanship.*

A copy of CAAP 92-1(1) Figure 2A – *Single engine and Centre-Line Thrust Aeroplanes not exceeding 2000 kg MTOW (day operations),* which shows the physical characteristics applicable to the circumstances, is provided in Figure 23 Guide for approach and take-off surfaces (source: CAAP 92-1(1) Guidelines for aeroplane landing areas).

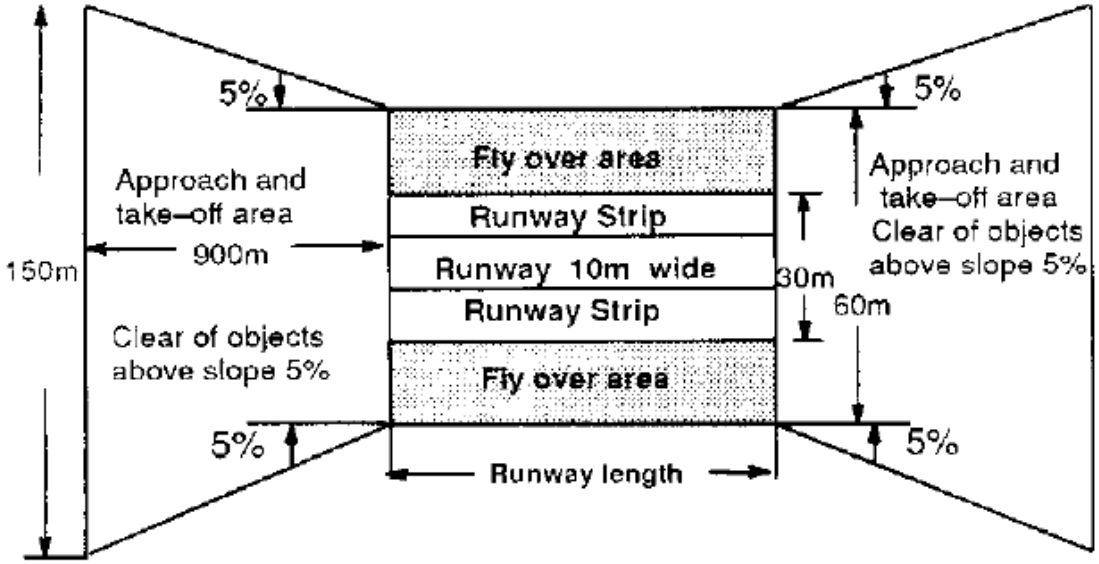

Figure 23 Guide for approach and take-off surfaces

The approach and take-off surfaces for each runway end commence at the runway end (threshold) at a distance of 30 m either side of the runway centreline and diverge at a rate of 5% to a distance of 900 m. The surfaces increase in height at a rate of 5%, or 5 m in every 100 m.

All identified ALAs are sufficiently located away from the Project site as to be not of a concern to their operation.

6.9. Rowleys Creek and Argyll ALA

Rowleys Creek ALA lies 2 km to the north-east of B127 and Argyll ALA lies approximately 3.6 km to the east of B127. A 1 nm ring which would depict an area of a standard flight circuit is shown in Figure 24. Note that aerial applicators would unlikely operate to standard circuit areas; aerial applicators operate within a much tighter radius of their respective ALAs.

Figure 24 Rowleys Creek and Argyll ALA

Both ALAs circuit area(s) are not affected by the closest WTG B127. It is unlikely the Project will impact operations at these ALAs if they are still in operational use.

6.10. Potential Wake Turbulence

National Airports Safeguarding Framework (NASF) Guideline D provides guidance regarding WTG wake turbulence states:

> *Wind farm operators should be aware that wind turbines may create turbulence which noticeable up to 16 rotor diameters from the turbine. In the case of one of the larger wind turbines with a diameter of 125 metres, turbulence may be present two kilometres downstream. At this time, the effect of this level of turbulence on aircraft in the vicinity is not known with certainty. However, wind farm operators should be conscious of their duty of care to communicate this risk to aviation operators in the vicinity of the wind farm…*

For the purpose of the wake turbulence analysis, a 160 m rotor diameter has been used.

Based on this scenario, the effects of wake turbulence may be noticeable at 2560 m from the WTGs. This distance is indicated in the red circles in Figure 25.

Inside the red circles represent possible wake turbulence conditions. When the prevailing wind has a westerly component, WTGs located in the eastern side of the Project area may impose possible wake turbulence into Rowleys Creek circuit area and to a lesser extent Argyll ALA circuit area.

In strong westerly winds, the circuit direction to both ALAs could kept to the eastern side of the ALA to avoid any potential wake turbulence impacts.; noting that aerial spraying takes place when wind is calm. Turbulence would be negligible in light wind conditions when operations at these ALAs is likely to occur.

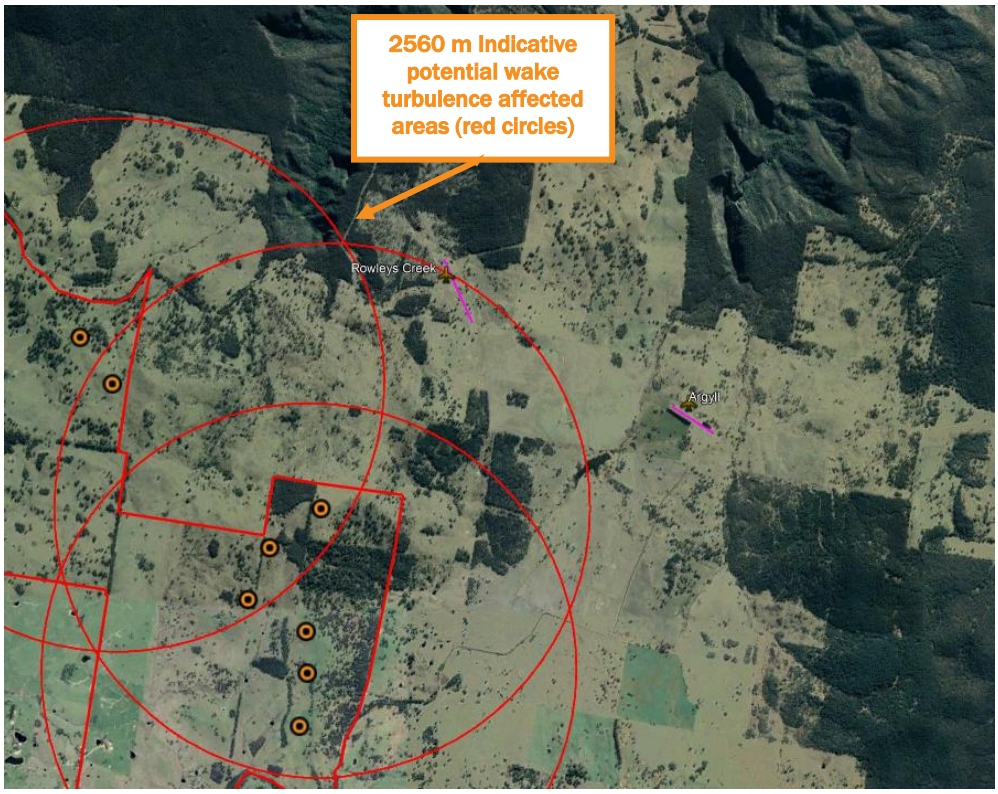

Figure 25 Potential wake turbulence to the Non-Involved Landowner ALAs

6.11. Non-Involved nearby landowner ALA analysis summary

The details of all WWF nearby Non-Involved Landowner ALAs are provided in Table 7.

Table 7 WWF Non-Involved Landowner ALAs

ALA Name	*ICAO code*	*Status*	*Distance from the Proposal site*	*Location relative to the Proposal site*	*Nearest WTG*	*Impact on the OLS*	*Impact on flight circuit(s)*
Rowleys Creek	Nil	uncertified	2 km (1.1 nm)	North-east	B127	Nil	Possible wake turbulence impacts in stronger westerly component winds (based on a western circuit at the ALA)
Argyll	Nil	Uncertified	3.6 km (1.95 nm)	East	B127	Nil	Possible wake turbulence impacts in stronger westerly component winds (based on a western circuit at the ALA)
Walcha	YWCH	uncertified	10.7 km (5.7 nm)	South-west	B039	Nil	Nil
Kelvin (OZKEV)	Nil	uncertified	18 km (9.7 nm)	North	B001	Nil	Nil
Strathleigh (OZSGH)	Nil	uncertified	24.2 km (13 nm)	South-west	B022	Nil	Nil
Wilsons Creek (OZWSK)	Nil	uncertified	28.5 km (15.4 nm)	North-west	B011	Nil	Nil

The details of identified WWF Involved Landowner ALAs are provided in Table 8.

Table 8 WWF Involved Landowner ALAs

ALA Name	*ICAO code*	*Registration status*	*Nearest WTG*	*Impact on the OLS*	*Impact on flight circuit(s)*
Wayamba	Nil	uncertified	B160	Nil	May be subject to wake turbulence impacts in stronger westerly winds
Allendale	Nil	uncertified	B049	Nil	May be subject to wake turbulence impacts in northerly and easterly winds
Kambala	Nil	Uncertified	B092	Nil	May be subject to wake turbulence impacts in easterly, southerly and westerly winds
Roseville	Nil	Uncertified	B138	Nil	May be subject to wake turbulence impacts in southerly winds
Abbottsley ALA	Nil	uncertified	B039	Nil	May be subject to wake turbulence impacts in stronger north-west winds
The Retreat ALA	Nil	Uncertified	B139	Nil	May be subject to wake turbulence impacts in north-west winds

Aerial spraying takes place when wind is calm. Possible wake turbulence would be negligible in light wind conditions when operations at these ALAs is likely to occur.

6.12. Air routes and 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 Proposal site is located in the area with 2 grid lowest safe altitudes of 1951 m AHD (6400 ft AMSL) with a MOC surface of 1646 m AHD (5400 ft AMSL) and of 2011 m AHD (6600 ft AMSL) with a MOC surface of 1707 m AHD (5600 ft AMSL).

The highest wind turbine is B130, with a maximum overall height of 1564 m AHD (5132 ft AMSL) and is below the LSALT MOC of 5400 ft AMSL and 5600 ft AMSL.

Therefore, the proposal will not affect the grid LSALTs of 6400 ft AMSL and 6600 ft AMSL.

Figure 26 provides the grid LSALTs and air routes in proximity to the Proposal site (source: WWPL, OzRunways, ERC Low National, 17 June 2021).

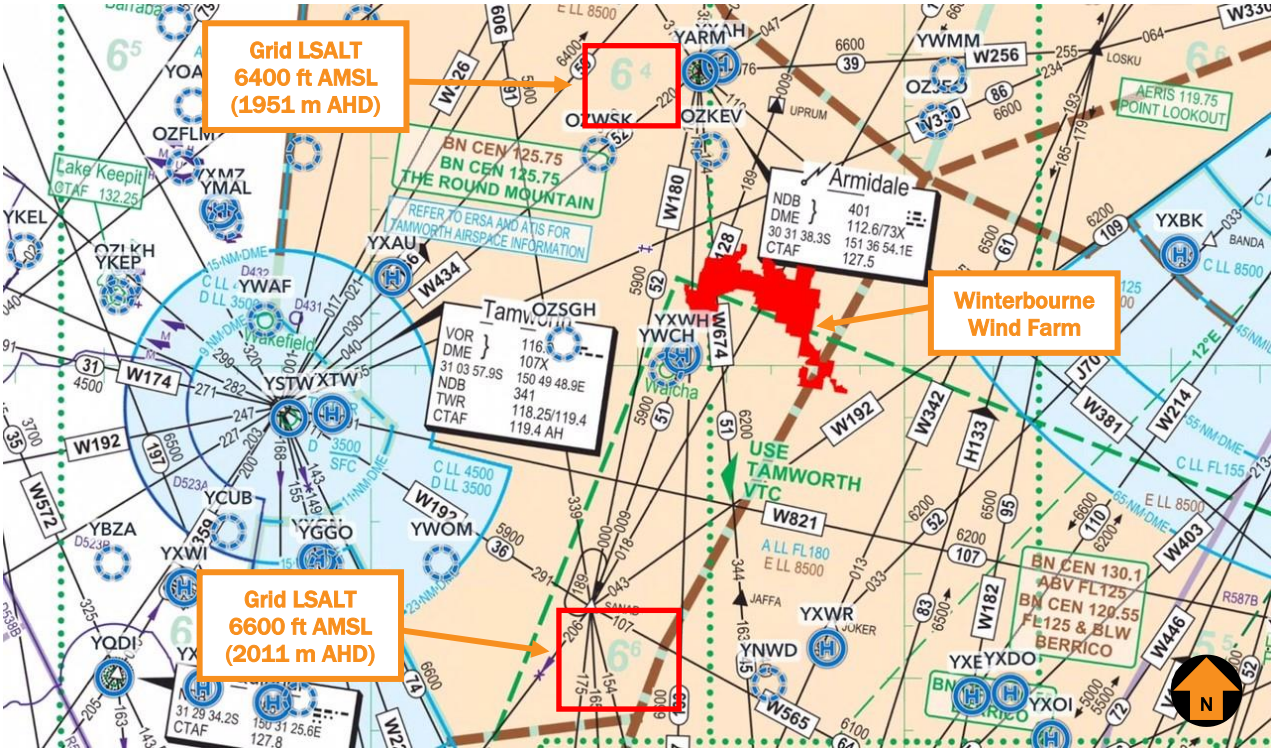

Figure 26 Air routes in proximity to the Proposal site

An impact analysis of the surrounding air routes is provided in Table 9.

Table 9 Air route impact analysis

Air route	Waypoint pair	Route LSALT	MOC	Impact on airspace design	Potential solution	Impact on aircraft ops
H98	GAMBDL and SANAD	6600 ft AMSL 2011 m AHD	5600 ft AMSL 1708 m AHD	Nil	Nil	Nil
W128	UPRUM and SANAD	5900 ft AMSL 1798 m AHD	4900 ft AMSL 1493 m AHD	WTG B007 is the highest in the vicinity and will impact the MOC by 146 ft	Increase route LSALT by 200 ft from 5900 ft to 6100 ft to accommodate WTGs within a 5 nm buffer area of this air route (Note: Airservices has assessed as 'no impact' – Refer Section 5)	N/A
W180	YARM and SANAD	5900 ft AMSL 1798 m AHD	4900 ft AMSL 1493 m AHD	Nil	Nil	N/A
W192	YCFS and SANAD	6200 ft AMSL 1890 m AHD	5200 ft AMSL 1585 m AHD	Nil	Nil	Nil
W330	LOSKU and YSTW	6600 ft AMSL 2011 m AHD	5600 ft AMSL 1708 m AHD	Nil	Nil	Nil
W347	YARM and MATLA	6600 ft AMSL 2011 m AHD	5600 ft AMSL 1708 m AHD	Nil	Nil	Nil
W674	YARM and JAFFA	6200 ft AMSL 1890 m AHD	5200 ft AMSL 1585 m AHD	Nil	Nil	Nil

Note: MOC is the height above which obstacles would impact on LSALTs or air routes.

Note – W180 air route has been plotted with a 5 nm buffer. WTGs B23-B30 and WTGs B011-B014 fall within this 5 nm buffer area of W180. Figure 27 refers.

B011 is the highest WTG at 4872 ft which is below W180 MOC of 4900 ft. W180 air route is not impacted by the Project.

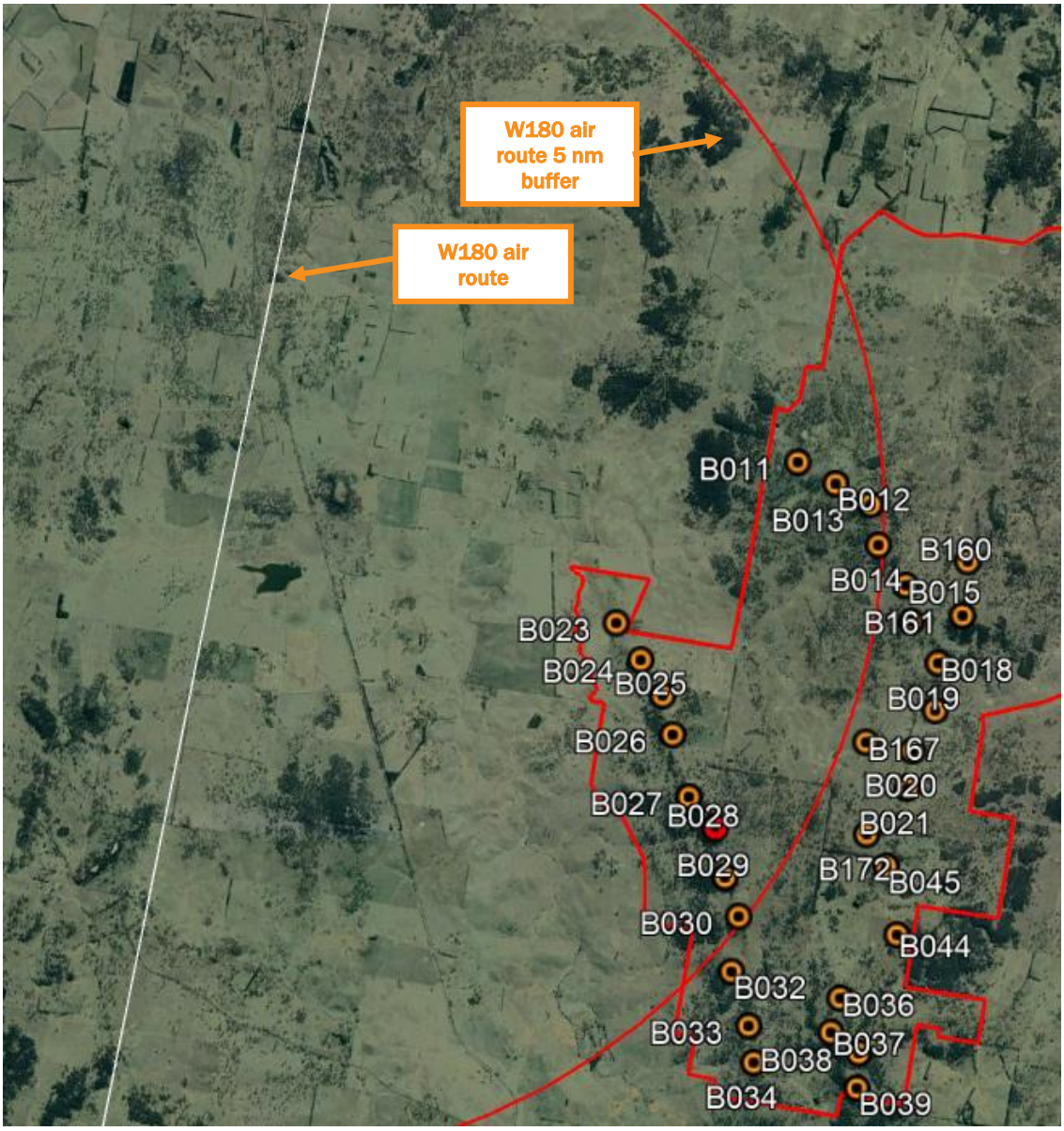

Figure 27 W180 air route buffer area

6.13. Airspace

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

Therefore, the Proposal will not impact controlled airspace.

6.14. Aviation facilities

The following aviation facilities were identified in proximity to WWF:

- NDB and DME at Armidale Airport located approximately 33 km (18 nm) to the north-west from WWF.

The proposed WWF will not penetrate any protection areas associated with NDB and DME at Armidale Airport.

6.15. Radar

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

With respect to aviation radar facilities, the closest radar is the Round Mountain Route Surveillance Radar (RSR) which is located approximately 60 km (32 nm) north-east of the Proposal site.

The proposal 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 WWF will impact the Round Mountain RSR.

Note: Route Surveillance Radar (RSR) and Secondary Surveillance Radar (SSR) is the same radar system.

6.16. Bureau of Meteorology

With respect to the Bureau of Meteorology (BoM) radars, the closest weather radar is the Namoi Black Jack Mountain DWSR 8502S 2° S-band Doppler radar located at Black Jack Mountain near Gunnedah approximately 183 km (99 nm) north west of WWF (source: BoM, NSW radar information).

Therefore, it is unlikely that WWF will impact the Doppler radar located at Black Jack Mountain.

6.17. 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.

6.18. AIS summary

Based on the proposal layout and overall turbine blade tip height limit of 230 m AGL, the blade tip elevation of the highest wind turbine, which is WTG B130, will not exceed 1564 m AHD (5132 ft AMSL) and:

- will not penetrate any OLS surfaces of Armidale Airport
- will not penetrate PANS-OPS surfaces
- will have an impact on nearby designated air route (W128). Note: Airservices has assessed no impacts to air routes (refer Section 5)
- will not have an impact on the grid LSALT
- will not have an impact on prescribed airspace
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

6.19. Assessment recommendations

Based on the information contained within this section and the analysis conducted, the following recommendations are made:

- air route W128 LSALT should be increased by 200 ft from 5900 ft to 6100 ft AMSL

Note: Airservices has assessed as no impacts to air routes (refer Section 5).

The list of wind turbines (obstacles), showing coordinates and elevation data that are applicable to this AIS, is provided in Annexure 3.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 9 it has been concluded that aviation lighting is not required for WTGs and WMTs, but relevant lighting standards and guidelines are summarized in **Annexure 5.**

Refer to Section 4.3 for additional information regarding the existing WMTs.

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 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, with a further 154 aircraft involved in serious incidents (an incident with a high probability of becoming an accident). In 2019 there was 35 fatalities from 22 fatal accidents**.** There have been no fatalities in scheduled commercial air transport in Australia since 2005.

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

A breakdown of aircraft and fatalities by general aviation sub-categories is provided in Table 10 (source: ATSB).

Table 10 Number of fatalities by GA 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 28 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.

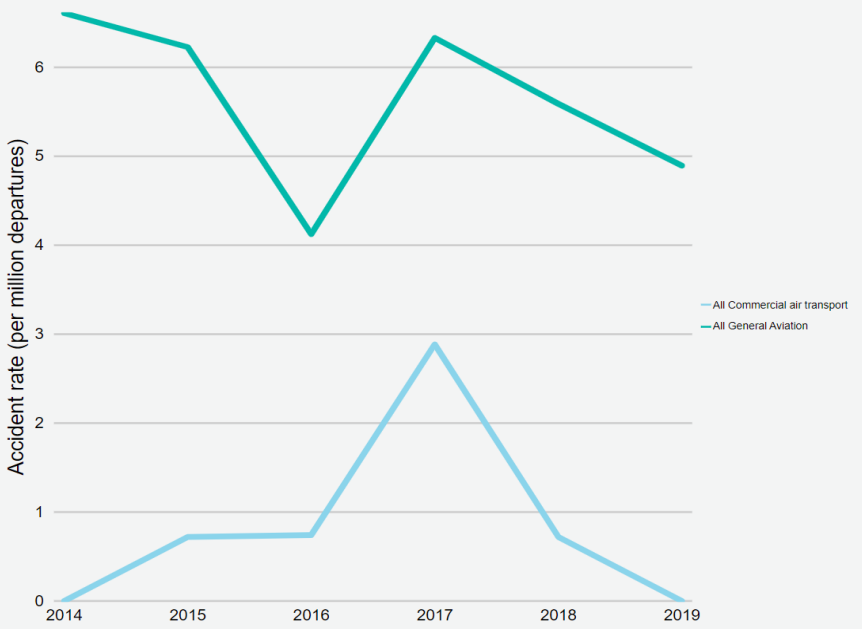

Figure 28 Fatal Accident Rate (per million departures) by Operation Type

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

In 2019, there were 1,760,000 landings, and 1,320,000 hours flown by VH-registered general aviation aircraft in Australia, with 8 fatal accidents and 17 fatalities. Based on these results, in 2019 there were 4.9 fatal accidents per million departures and 6.4 fatal accidents per million hours flown. A summary of fatal accidents from 2010-2019 by GA sub-category is provided in Table 11 (source: ATSB).

Table 11 Fatal accidents by GA sub-category – 2010 -2019

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

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 wind turbine or a wind monitoring tower.

Of the 20,529 incidents, serious incidents, and accidents in GA operations in the 10-year period, 1404 (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

To provide some perspective on the likelihood of a VFR aircraft colliding with a wind turbine, a summary of the four accidents that involved an aircraft colliding with a wind turbine, and the relevant factors applicable to this assessment, is incorporated in this section.

Based on the statistic of the Global Wind Energy Council (GWEC) report of 2021, there is 743 GW of wind power 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.

Of the four known accidents, one was caused by 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 overhead a wind farm, and the aircraft struck a wind turbine on its descent. This accident is not applicable to the circumstances under consideration.

There have been two accidents involving collision with a wind turbine during the day.

Only one of these (Melle, Germany 2017) resulted in a single fatality, as the result of a collision with a wind turbine steel lattice mast at a very low altitude during the day with good visibility and no cloud. If the mast was solid and painted white, then it more than likely would have been more visible than if it was equipped with an obstacle light.

In the other case (Plouguin, France, 2008), the pilot decided to descend below cloud in an attempt to find the destination aerodrome. The aircraft was in conditions of significantly reduced horizontal visibility in fog where the top of the turbine was obscured by cloud. The turbines became visible too late for avoidance manoeuvring and the aircraft made contact with two turbines. The aircraft was damaged but landed safely.

In both cases, it is difficult to conclude that obstacle lighting would have prevented the accident.

The other fatal accident occurred at night in instrument meteorological conditions (IMC) and is not applicable to the circumstances under consideration.

There is one other accident mentioned in a database compiled by an anti-wind farm lobby group, which suggests a Cessna 182 collided with a wind turbine 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 but suggests that the accident was caused by IFR 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 is made of wind turbines or a wind farm.

A summary of the four accidents is provided in Table 12.

Table 12 Summary of accidents involving collision with a wind turbine

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
1	Diamond DA320-A1 D-EJAR Collided with a wind turbine 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	Turbine 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 wind turbine tower, at night in IMC. The wind turbine 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 wind turbine 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 wind turbine. Contributing to the accident was the inoperative obstruction light on the wind turbine, which prevented the pilot from visually identifying the wind turbine.	An operational obstacle light may have prevented the accident

ID	Description	Date	Location	Fatalities	Flight rules	Turbine 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 wind turbines. After sighting the turbines, he was unable to avoid them. The tip of the left wing struck the first turbine blade, followed by the tip of the right wing striking the second turbine. 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 wind turbines 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	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
4	VariEze N25063 The aircraft collided with a wind turbine 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 proposed Winterbourne Wind Farm and WMTs.

Based on an extensive review of accident statistics data (see summary in Section 8 above) and input from stakeholders, five (5) identified risk events associated with wind turbines and WMTs relate to aviation safety, and are listed as follows:

1. potential for an aircraft to collide with a wind turbine, controlled flight into terrain (CFIT)
2. potential for an aircraft to collide with a wind monitoring tower (CFIT)
3. potential for a pilot to initiate manoeuvring in order to avoid colliding with a wind turbine or monitoring tower resulting in collision with terrain
4. potential for the hazards associated with the Proposal to invoke operational limitations or procedures on operating crew
5. effect of obstacle lighting on neighbours.

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. 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.

A fifth identified risk event associated with WTGs and WMTs is the potential visual impact associated with obstacle lighting (if fitted) on surrounding residents.

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 level of risk to an acceptable level.

A summary of the level of risk associated with the Proposal, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Tables 13 to 17.

Table 13 Aircraft collision with wind turbine

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

Discussion

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

There have been four reported occurrences worldwide of aircraft collisions with a component of a wind turbine 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 wind turbine:

- GA VFR aircraft operators generally do not 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 wind turbine.

Refer to the discussion of worldwide accidents at Section 8.

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

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

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

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

The proposal is clear of the OLS of any aerodrome.

Consequence

If an aircraft collided with a wind turbine, 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 wind turbines 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 wind turbine 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 proposal is clear of the OLS 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 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The proposed turbines will be a maximum of 230 m (755 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 77 m (253 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 wind turbines.
- If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The wind turbines are typically coloured white so they should be visible during the day.
- The 'as constructed' details of wind turbines 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 turbines 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

Recommended Treatments

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

- Details of WWF 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 New South Wales 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 wind turbine rotor blades prior to the commencement of the subject aircraft operations within the WWF 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 wind turbine resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 - Tolerable**.

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

In the circumstances, the level of risk under the proposed treatment plan is considered **as low as reasonably practicable (ALARP)**.

It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of WWF.

Residual Risk	7 - Tolerable

Table 14 Aircraft collision with wind monitoring tower

Risk ID:	2. Aircraft collision with a wind monitoring tower (CFIT)
Discussion An aircraft collision with a WMT would result in harm to people and damage to property. There are 4 existing temporary WMTs, however they are not a component of the Proposal. The WMTs have been constructed of steel lattice and are at a maximum of 100 m (328 ft) AGL in height. The towers are steel lattice masts (at or below the wind turbine hub height) and have been installed at different locations around WWF. The WMTs have high visibility aviation marker balls up on the top-level guy wires. The location of the existing temporary WMT locations and other applicable details have been reported to Airservices Australia. 2 Permanent WMTs will be installed up to a height of 149 m AGL. There are only a few instances of aircraft colliding with a WMT, but they were all during the day with good visibility, and no instance was in Australia. There is a relatively low rate of aircraft activity in the vicinity of the wind farm. There are no known aerial 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. If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing: a) whether the object or structure will be a hazard to aircraft operations; and b) whether it requires an obstacle light that is essential for the safety of aircraft operations	
Consequence If an aircraft collided with a WMT, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.	
Consequence	Catastrophic
Untreated Likelihood There are a few occurrences of an aircraft colliding with a WMT, but all were during the day with good visibility when obstacle lighting would arguably be of no effect, and none were in Australia. It is assessed that collision with a wind monitoring tower without obstacle lighting that would be effective in alerting the pilot to its presence is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.	
Untreated Likelihood	Possible

Current Treatments

- The WMT locations have been reported to CASA and Airservices Australia.
- 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 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The WMTs are at a maximum height of 100 m (328.1 ft) AGL, which will be 52 m (172 ft) below the minimum height of 500 ft AGL for an aircraft flying at this height.
- In the event that descending cloud forces an aircraft lower than 152.4 m 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.
- The towers are constructed from grey steel.
- Since the towers will be higher than 100 m AGL, there is a statutory requirement to report them to CASA.

Level of Risk

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

Current Level of Risk	8 - Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Recommended Treatments

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

- Details of the existing WMTs were reported to Airservices Australia when they were constructed.
- The WMTs have been marked with aviation marker balls and consideration was made to 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.* • Details of the existing WMTs on the WWF site have been communicated to local and regional aerodrome and aircraft operators before, during and following construction.	
Residual Risk With the additional recommended treatments, the likelihood of an aircraft colliding with a WMT resulting in multiple fatalities and damage beyond repair will be **Unlikely**. The consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision, given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. Only if a WMT exceeds 150 m AGL in height and is not in relatively close proximity to a wind turbine. In the circumstances, the level of risk under the proposed treatment plan is considered **ALARP**. **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the WMTs, without obstacle lighting on the WMTs of WWF.**	
Residual Risk	7 - Tolerable

Table 15 Harsh manoeuvring leading to controlled flight into terrain

Risk ID:	3. Harsh manoeuvring leads to controlled flight into terrain (CFIT)
Discussion An aircraft colliding with terrain as a result of manoeuvring to avoid colliding with a wind turbine 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 proposal is clear of the OLS of any aerodrome. Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The proposed turbines will be a maximum of 230 m (755 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 77 m (253 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL. Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines. If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective. Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night). Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. ***Assumed risk treatments*** • The wind turbines are typically coloured white so they should be visible during the day • The 'as constructed' details of wind turbines 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 turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines 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 wind turbine is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.	

Untreated Likelihood	Possible

Current Treatments (without lighting)

- The proposal is clear of the OLS of any aerodrome.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas.
- The proposed turbines will be a maximum of 230 m (755 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 77 m (253 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL.
- Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines.
- If cloud descends below the turbine 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 wind turbines are typically coloured white, typical of most wind turbines operational in Australia, so they should be visible during the day.
- The 'as constructed' details of wind turbines 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 turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines to CASA.

Level of Risk

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

Current Level of Risk	8 – Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Ensure details of the Proposal 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, WWPL may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the WWF area.
Residual Risk With the additional recommended treatments, the likelihood of ground collision resulting from manoeuvring to avoid a wind turbine resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. In the circumstances, the level of risk under the proposed treatment plan is considered **ALARP**. **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a wind turbine, without obstacle lighting on the turbines of WWF.**

Residual Risk	7 - Tolerable

Table 16 Effect of Proposal on operating crew

Risk ID:	**4. Effect of the Proposal 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 WWF.	
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 proposal is clear of the OLS of any aerodrome. • Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. • The proposed turbines will be a maximum of 230 m (755 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 77 m (253 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL. • 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 wind turbines. • 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 wind turbines. • If cloud descends below the turbine 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 wind turbines are typically coloured white so they should be visible during the day.
- The 'as constructed' details of wind turbines 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 turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines 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 - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.

Risk Decision	Accept, conduct cost benefit analysis

Proposed Treatments

Given the current treatments and the limited scale and scope of flying operations conducted within the vicinity of the Proposal, 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 wind turbine.

However, the following treatments, which can be implemented at little cost, will provide an additional margin of safety:

- Ensure details of WWF 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, WWPL may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for such aircraft operations in the vicinity of WWF.

Residual Risk

Notwithstanding the current level of risk is considered **Tolerable**, the additional recommended treatments 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 WTGs and WMTs of WWF.

Residual Risk	5 - Tolerable

Table 17 Effect of obstacle lighting on neighbours

Risk ID:	**5. Effect of obstacle lighting on neighbours**
Discussion This scenario discusses the consequential impact of a decision to install obstacle lighting on the wind farm. Installation and operation of obstacle lighting on wind turbines 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 are higher than 150 m (492 ft) AGL, the wind turbines 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 wind turbines or WMTs are higher than 150 m (492 ft) AGL, they must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.	
Level of Risk The level of risk associated with an Almost certain likelihood of a Moderate consequence is 8.	
Current Level of Risk	8 - Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Recommended Treatments

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

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 wind turbines 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.

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**

10. CONCLUSIONS

The results of this study are summarised as follows:

10.1. Proposal description

The proposed WWF is located approximately 75 km north-east of Tamworth and 35 km south of Armidale within the LGAs of WSC and USC.

The Winterbourne Wind Farm Project involves the construction and operation of a wind farm with up to 119 wind turbine generators (WTG), together with associated and ancillary infrastructure.

The Project design has been revised and refined in response to the identification and assessment of environmental constraints, constructability requirements, and consideration of the outcomes of Agency, landowner, and community consultations.

The Project consists of the following key components:

- up to 119 WTGs, each with:
    - a generating capacity of approximately 6.2 MW;
    - three blades mounted to a rotor hub (hub height of 149 m) on a nacelle above a tubular steel tower, with a blade tip height (blade length plus hub height) of up to 230 m AGL;
    - a gearbox and generator assembly housed in the nacelle; and
    - adjacent hardstands for use as crane pads, assembly and laydown areas;
- highest wind turbine is B130 with ground elevation of 1329 m AHD and overall height of 1564 m (5132 ft AMSL)
- decommissioning of 4 temporary meteorological monitoring masts and installation of up to 2 permanent meteorological monitoring masts for power testing. The permanent monitoring masts will be located close to a WTG location with a maximum height of approximately 149 m AGL, equivalent to the hub height of the installed WTGs;
- two 33/330 kV electrical substations, including control room, transformers, circuit breakers, switches and other ancillary equipment;
- an operations and maintenance facility;
- a battery energy storage system (BESS) of up to 100 MW/200 MWh capacity (two hours of storage);
- aboveground and underground 33 kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substations (generally following site access tracks);
- a 330 kV single or double circuit twin conductor overhead transmission line (transmission line) route of approximately 50 km connecting the two substations to a new electrical switchyard (including circuit breakers, switches and other ancillary equipment), located approximately 7 km south of Uralla and adjacent to TransGrid's 330 kV Tamworth to Armidale transmission line (Line 85);

- internal access tracks (combined total length of approximately 113 km) connecting the WTGs and associated Project infrastructure with the public road network; and
- upgrades to roads and intersections required for the delivery of oversize and overmass WTG components, transformers and associated construction-phase materials and vehicular movements.

10.2. Regulatory requirements

The following regulatory requirements apply:

- With respect to MOS 139 Chapter 8 Division 10 8.109, the proposed wind turbines and wind monitoring towers must be reported to CASA if they are considered a hazardous obstacle
- Wind turbines and wind monitoring towers must be marked in accordance with respect to MOS 139 Chapter 8 Division 10 8.110
- Wind turbines must be lit in accordance with MOS 139 Chapter 9 Division 4 9.3 and 9.31, unless an aeronautical study assesses they are of no operational significance.

10.3. Planning considerations

The Proposal as proposed satisfies the following planning documents

- *Walcha Local Environment Plan 2012* (Walcha LEP, current version dated 14 July 2021)
- *Uralla Local Environment Plan 2012* (Uralla LEP, current version dated 14 July 2021).

10.4. 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.

10.5. Aviation Impact Statement

Based on the Proposal layout and overall turbine overall blade tip height limit of 230 m AGL, the blade tip elevation of the highest wind turbine, which is B130, will not exceed 1564 m AHD (5132 ft AMSL) and:

- will not penetrate any OLS surfaces
- will not penetrate PANS-OPS surfaces
- **will have an impact on nearby designated air route (W128).** Note: Airservices has assessed as no impacts to air routes (refer Section 5).
- will not have an impact on the grid LSALT
- will not have an impact on prescribed airspace
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

10.6. Aircraft operator characteristics

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

WWPL may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the wind turbine rotor blades prior to the commencement of the subject aircraft operations within the Proposal site.

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

10.7. Hazard lighting and marking

The following conclusions apply to hazard marking and lighting:

- With respect to MOS 139 Chapter 8 Division 10 8.109, the proposed wind turbines and wind monitoring towers must be reported to CASA if they are considered a hazardous obstacle. Wind turbines and wind monitoring towers must be marked in accordance with respect to MOS 139 Chapter 8 Division 10 8.110.
- Wind turbines must be lit in accordance with MOS 139 Chapter 9 Division 4 9.3 and 9.31, unless an aeronautical study assesses they are of no operational significance.
- **Aviation Projects has assessed that the proposed WWF will not require obstacle lighting to maintain an acceptable level of safety to aircraft.**
- CASA has advised that it will only review assessments referred to it by a planning authority or agency.
- With respect to marking of turbines, a white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- There are 4 temporary WMTs at a height of up to 100 m (328 ft) AGL. The WMTs have been reported to Airservices Australia. Two permanent WMTs will be installed at a maximum height of 149 m AGL.
- Considerations have made in marking the existing temporary WMTs, which has been completed according to the requirements set out in MOS 139 Section 8 Division 10 Obstacle Markings (as modified by the guidance in NASF Guideline D).

10.8. Summary of risks

A summary of the level of residual risk associated with the proposed WWF with the Recommended Treatments implemented, is provided in Table 18.

Table 18 Summary of Risks

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

11. RECOMMENDATIONS

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

Designated air routes

To accommodate the WTGs at 230 m AGL, the following mitigations to designated air routes are proposed:

Air route W128 LSALT should be increased by 200 ft from 5900 ft to 6100 ft AMSL. Note: Airservices has assessed as no impacts to air routes (refer Section 5).

Notification and reporting

1. 'As constructed' details of WTGs including coordinates and elevations should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
2. Department of Defence should be consulted if there is any subsequent modification in the wind turbine height or scale of development, using the following email address: land.planning@defence.gov.au;
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of WWF, 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.
4. Details of WWF should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations. Specifically, details should be provided to the New South Wales Regional Airspace and Procedures Advisory Committee (rapac@casa.gov.au) for consideration by its members in relation to VFR transit routes in the vicinity of the wind farm.
5. To facilitate the flight planning of aerial application operators, details of WWF, including location and height information of wind turbines, wind monitoring towers and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Operation

6. Whilst not a statutory requirement, WWPL should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of WWF.

Marking of turbines

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

Lighting of turbines

8. **Aviation Projects has assessed that the proposed WWF will not require obstacle lighting to maintain an acceptable level of safety to aircraft.**

Micrositing

9. The potential micrositing of the turbines and wind monitoring towers 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 turbine and wind monitoring tower positions. Providing the micrositing is within 100 m of the turbines and wind monitoring towers is likely to not result in a change in the maximum overall blade tip height of WWF. No further assessment is likely to be required from micrositing and the conclusions of this aviation impact assessment would remain the same.

Triggers for review

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

ANNEXURES

1. References
2. Definitions
3. Turbine coordinates and heights
4. Risk Assessment Framework
5. CASA Regulatory Requirements – Lighting and Marking

ANNEXURE 1 – REFERENCES

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

- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures and En Route Supplement Australia dated 09 September 2021
- Airservices Australia, Designated Airspace Handbook, effective 17 June 2021
- Bureau of Meteorology, NSW/ACT Radar Sites Table and Information, http://www.bom.gov.au/australia/radar/nsw_radar_sites_table.shtml
- 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*, dated 13 August 2020
- Civil Aviation Safety Authority, Advisory Circular (AC) 139-08 v2.0: *Reporting of Tall Structures*, dated March 2018
- 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
- Department of Planning and Environment, NSW Government, *NSW Wind Farm Guideline for State significant wind energy development*, December 2016
- Department of Planning and Environment, NSW State Government, Wind Energy: Visual Assessment Bulletin – For State significant wind energy development, December 2016
- 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 17 June 2021
- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*
- *Walcha Local Environment Plan 2012* (Walcha LEP, current version dated 14 July 2021)
- *Uralla Local Environment Plan 2012* (Uralla LEP, current version dated 14 July 2021).

ANNEXURE 2 – DEFINITIONS

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

Term	*Definition*
Obstacles	All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.
Runway	A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.
Runway strip	A defined area including the runway and stopway, if provided, intended: a. to reduce the risk of damage to aircraft running off a runway; and b. to protect aircraft flying over it during take-off or landing operations.
Safety Management System	A systematic approach to managing safety, including organisational structures, accountabilities, policies and procedures.

ANNEXURE 3 – TURBINE COORDINATES AND HEIGHTS

Source: 210802_Winterbourne_L40 TurbineXYZ.xlsx

WTG ID	Lat	Long	Easting	Northing	Elevation (m AGL)
B001	-30.809	151.702	375828	6590869	1085.834015
B002	-30.813	151.7	375652	6590371	1128.067749
B003	-30.818	151.7	375618	6589834	1163.291016
B004	-30.822	151.696	375275	6589423	1177.397522
B005	-30.823	151.69	374739.024	6589303.865	1186.262726
B006	-30.831	151.687	374432	6588438	1286.591736
B007	-30.834	151.684	374100	6588076	1303.225983
B011	-30.856	151.621	368111.417	6585525.499	1249.745972
B012	-30.859	151.626	368647	6585231	1239.596497
B013	-30.861	151.631	369137	6584946	1240.795227
B014	-30.867	151.632	369258.786	6584380.911	1217.682251
B015	-30.872	151.637	369652.26	6583822.948	1214.917755
B016	-30.876	151.637	369731.076	6583321.092	1260.713013

WTG ID	Lat	Long	Easting	Northing	Elevation (m AGL)
B018	-30.882	151.641	370123	6582740	1199.174774
B019	-30.888	151.641	370091.165	6582073.798	1164.843475
B020	-30.893	151.638	369781	6581508	1170.189484
B021	-30.897	151.637	369712	6580984	1183.633759
B023	-30.876	151.594	365589.761	6583241.382	1138.394979
B024	-30.881	151.598	365940.5	6582729.024	1165.000977
B025	-30.886	151.601	366255	6582233	1176.523529
B026	-30.891	151.602	366405	6581690	1185.494019
B027	-30.898	151.605	366643	6580825	1210.434479
B028	-30.902	151.609	367018	6580394	1203.287262
B029	-30.909	151.61	367163.134	6579706.89	1220.253265
B030	-30.913	151.612	367362.24	6579161.963	1211.464478
B032	-30.921	151.611	367272.752	6578380.355	1174.999023
B033	-30.927	151.613	367523	6577620	1168.517487
B034	-30.932	151.614	367601	6577111	1184.289734
B036	-30.924	151.627	368798.75	6578040.75	1234.999349

WTG ID	Lat	Long	Easting	Northing	Elevation (m AGL)
B037	-30.928	151.625	368676.553	6577561.904	1244.596008
B038	-30.931	151.63	369072.405	6577273.085	1240.62854
B039	-30.935	151.629	369053.003	6576781.177	1239.707977
B044	-30.916	151.635	369592	6578929	1172.428497
B045	-30.907	151.634	369428	6579887	1184.856232
B046	-30.87	151.728	378440	6584091	1169.276764
B047	-30.873	151.733	378880	6583793	1160.06076
B048	-30.88	151.733	378894	6583005	1133.97699
B051	-30.855	151.749	380341	6585758	1139.775726
B052	-30.861	151.747	380240	6585140	1125.649261
B053	-30.866	151.748	380324	6584604	1151.998993
B054	-30.867	151.743	379855	6584419	1154.28125
B056	-30.847	151.819	387034.332	6586730.295	1132.376302
B057	-30.852	151.813	386533	6586241	1184.558014
B060	-30.854	151.808	386061	6586007	1146.581268
B061	-30.858	151.807	385968	6585507	1107.195496

WTG ID	Lat	Long	Easting	Northing	Elevation (m AGL)
B062	-30.863	151.804	385648.582	6584921.052	1087.426453
B063	-30.88	151.82	387183	6583063	1149.861755
B064	-30.884	151.825	387660	6582642	1176.625244
B065	-30.888	151.828	388015	6582186	1213.10202
B066	-30.893	151.831	388232	6581633	1220.154755
B068	-30.895	151.839	388996	6581504	1236.384491
B069	-30.9	151.837	388829	6580914	1247.618988
B070	-30.904	151.84	389165	6580513	1249.634216
B071	-30.906	151.745	380089	6580147	1216.464996
B072	-30.902	151.754	380924	6580571	1214.939758
B073	-30.895	151.746	380194	6581346	1189.716003
B074	-30.898	151.751	380608	6581057	1205.133484
B076	-30.887	151.753	380784	6582284	1166.333221
B078	-30.891	151.76	381488	6581778	1210.673218
B079	-30.895	151.763	381814	6581381	1242.661011
B081	-30.904	151.772	382630	6580415	1206.03125

WTG ID	Lat	Long	Easting	Northing	Elevation (m AGL)
B082	-30.909	151.773	382731	6579838	1197.784485
B083	-30.884	151.765	381990.962	6582600.999	1118.340729
B086	-30.889	151.792	384507	6582082	1189.129486
B087	-30.894	151.789	384243	6581492	1213.379272
B088	-30.898	151.786	383962	6581030	1230.180267
B092	-30.903	151.796	384964	6580578	1276.489746
B093	-30.909	151.799	385212	6579852	1282.853027
B100	-30.923	151.787	384128	6578295	1241.164246
B101	-30.927	151.784	383821	6577802	1226.023468
B102	-30.932	151.783	383689	6577341	1211.978729
B105	-30.909	151.808	386072	6579831	1251.585999
B107	-30.912	151.814	386685	6579594	1239.308228
B108	-30.919	151.814	386692.937	6578781.825	1237.27948
B109	-30.923	151.811	386401.446	6578340.873	1242.40802
B110	-30.928	151.823	387581.499	6577821.116	1246.082458
B111	-30.928	151.81	386332	6577759	1241.999969

WTG ID	Lat	Long	Easting	Northing	Elevation (m AGL)
B112	-30.935	151.811	386377	6577011	1250.571747
B113	-30.939	151.81	386307.887	6576514.579	1242.442993
B115	-30.946	151.816	386941	6575797	1228.262238
B116	-30.954	151.82	387272	6574897	1237.971497
B118	-30.964	151.813	386619.169	6573826.924	1245.895233
B119	-30.969	151.812	386565.878	6573252.826	1260.294739
B120	-30.973	151.815	386875	6572842	1254.359985
B121	-30.976	151.811	386483	6572440	1243.273743
B122	-30.979	151.837	388916.317	6572121.434	1282.422689
B123	-30.983	151.84	389233.119	6571683.636	1289.125
B124	-30.981	151.824	387721.222	6571856.005	1263.226257
B127	-30.994	151.861	391240	6570525	1302.220245
B128	-30.997	151.856	390760	6570151	1306.405518
B129	-31.002	151.854	390556	6569657	1295.313507
B130	-31.004	151.859	391120	6569366	1329.150757
B131	-31.008	151.86	391132	6568970	1310.873993

WTG ID	Lat	Long	Easting	Northing	Elevation (m AGL)
B132	-31.012	151.859	391059	6568461	1267.397247
B138	-31.015	151.808	386216	6568123	1269.570526
B139	-31.018	151.813	386653	6567836	1245.040497
B140	-31.024	151.81	386442	6567135	1228.068024
B141	-31.028	151.81	386426	6566677	1202.276489
B142	-31.032	151.811	386479	6566208	1188.088501
B144	-31.028	151.826	387968	6566691	1230.535248
B145	-31.035	151.829	388261	6565947	1205.784027
B146	-31.032	151.838	389118	6566222	1214.523254
B149	-31.023	151.861	391317	6567314	1259.921265
B151	-31.034	151.879	393062.998	6566093.971	1308.312775
B152	-31.036	151.885	393594	6565827	1314.531738
B153	-31.041	151.884	393480	6565306	1288.225769
B154	-31.043	151.89	394106	6565126	1313.668488
B160	-30.869	151.646	370523.226	6584164.398	1158.595011
B161	-30.876	151.645	370453.716	6583408.305	1207.577718

WTG ID	Lat	Long	Easting	Northing	Elevation (m AGL)
B167	-30.892	151.631	369125.027	6581617.042	1176.193756
B168	-30.912	151.761	381631.231	6579451.644	1184.303019
B169	-30.917	151.761	381630.987	6578922.999	1179.134247
B170	-30.925	151.761	381578	6578013	1149.761963
B171	-30.929	151.763	381841.901	6577595.013	1182.387238
B172	-30.903	151.631	369147	6580330	1198.962524
B173	-30.829	151.737	379245	6588702	1143.62149
B174	-30.833	151.738	379266	6588197	1138.037994
B175	-30.838	151.738	379313.619	6587679.461	1134.96932
B176	-30.829	151.694	375067	6588639	1221.746002

ANNEXURE 4 - RISK ASSESSMENT 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 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) - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.
0-4/5	**Broadly Acceptable Risk**	Managed by routine procedures, and can be accepted with no action.

ANNEXURE 5 – 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 Obstacle Lighting and Their Use:

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

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

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

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

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

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

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

6. *High-intensity obstacle lights:*

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

b. *must be flashing white lights.*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Advisory Circular 139-08 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 wind turbines 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 wind turbines, which is copied below:

6.2.4 Wind turbines

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

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

Note 2. — See 4.3.1 and 4.3.2

Markings

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

Lighting

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

a) to identify the perimeter of the wind farm;

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Section 4.3 Objects outside the OLS states the following:

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

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

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

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

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

Light characteristics

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

The characteristics of the obstacle lights should be in accordance with the applicable standards in 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.*

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

Visual impact of night lighting

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

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

- To minimise the visual impact on the environment, some shielding of the obstacle lights is permitted, provided it does not compromise their operational effectiveness;

- Shielding may be provided to restrict the downward component of light to either, or both, of the following:
    - such that no more than 5% of the nominal intensity is emitted at or below 5 degrees below horizontal; and
    - such that no light is emitted at or below 10 degrees below horizontal;
- If a light would be shielded in any direction by an adjacent object or structure, the light so shielded may be omitted, provided that such additional lights are used as are necessary to retain the general definition of the object or structure.
- If flashing obstacle lighting is required, all obstacle lights on a wind farm should be synchronised so that they flash simultaneously; and
- A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the rotor blades of light from the obstacle lights, without compromising the daytime visibility of the overall turbine.

Marking of turbines

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 wind turbines should be painted a shade of white, unless otherwise indicated by an aeronautical study.

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

Wind monitoring towers

The details of the WMTs were introduced in **Section 4.3** of this report.

Consideration could 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 wind monitoring towers to painted in alternating contrasting bands of colour. Examples of effective measures can be found in the Manual of Standards for Part 139 of the Civil Aviation

Safety Regulations 1998. In areas where aerial agriculture operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers

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

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