



AVIATION IMPACT ASSESSMENT

**WHITE ROCK WIND FARM
STAGE 2 MODIFICATION APPLICATION**

Prepared for White Rock Wind Farm Pty Ltd

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ACRONYMS

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

UNITS OF MEASUREMENT

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

EXECUTIVE SUMMARY

Introduction

White Rock Wind Farm Pty Ltd (WRWFPL) is preparing an additional Modification Application (MOD 6) for White Rock Wind Farm (WRWF) (the Project). Project Approval MP10_160 (MOD 3) was approved on 1 April 2016. The application for an alternative grid connection has been updated and was submitted as Modification Application (MOD 4) in December 2016, was on public exhibition from 24 January 2017 to 21 February 2017 and approved on 31 May 2017.

WRWFPL engaged Aviation Projects to prepare an Aviation Impact Assessment and a review of whether aviation safety lighting is required to be installed on selected Stage 2 turbines to support a further Modification Application (MOD 6) for a modified Stage 2 of the White Rock Wind Farm (WRWF) development.

The Aviation Impact Assessment will review potential impacts of the WRWF on aviation safety in respect of relevant requirements of air safety regulations and procedures and in respect of consultation with relevant regulators.

Project description

The WRWF consists of the following:

- WRWF (MOD 3) approval confirmed details for Stage 1 involving 70 wind turbine generators (WTGs), which are currently under construction, with an overall WTG maximum tip height slightly less than 150 m above ground level (AGL);
- Stage 1 includes two permanent wind monitoring towers (WMT) with heights of approximately 90 m (295.3 ft) AGL marked with orange marker balls and top section of the WMT powdered in alternating colours and details have been advised to RAAF AIS;
- Stage 2 includes five additional WMT to 100 m height, three temporary and two permanent WMT;
- WMTs are steel lattice masts with height up to approximately the proposed wind turbine hub height;
- Stage 2 (MOD 6) proposes to use a larger Goldwind GW140 turbine as the indicative machine specification, with a maximum blade length of 85 m, a blade diameter of 140 m, hub height up to 130 m and a maximum tip height of 200 m AGL; and
- Stage 2 (MOD 6) proposes a review of turbine spacing and the addition of new turbine sites, resulting in a revised total of up to 48 WTG sites and an overall total of up to 118 turbines.

Conclusions

Regulatory requirements

- With respect to MOS 139 7.1.5.1, the proposed wind turbines and wind monitoring towers must be reported to CASA if they will be higher than 110 m AGL.
- With respect to MOS 139 7.1.5.2, the wind turbines must be regarded as an obstacle if they are higher than 150 m AGL, unless CASA assesses otherwise. Obstacle monitoring includes the PANS-OPS surface which extends beyond the OLS of the aerodrome.

- With respect to MOS 139 9.4.1.2 (b), the wind turbines will need to be lit if they will be outside the OLS and above 110 m AGL, unless an aeronautical study assesses they are of no operational significance.

Consultation

- An appropriate and justified level of consultation is being undertaken with relevant parties.

Aviation Impact Statement

- Stage 2 (MOD 6) proposes a revised wind farm layout and overall turbine height of up to 200 m AGL, the highest WTG, which is WTG91, will not exceed 1596 m AHD (5236ft AMSL) and:
 - will not penetrate any OLS surfaces;
 - WTG 91 infringes the 25 nm MSA 6200 ft minimum obstacle clearance (MOC) of 1000 ft by 36 ft and WTG95 by 20 ft (Glen Innes and Inverell Airports), which could be mitigated by reducing WTG maximum height or raising the MSA;
 - WTG 91 does not infringe the grid LSALT 6300 ft AMSL protective surface;
 - no other PANS-OPS surfaces are impacted;
 - is wholly contained within Class G airspace;
 - is not inside designated (danger, restricted or prohibited) airspace; and
 - is not inside clearance zones associated with aviation navigation aids and communication facilities.
- Airservices Australia advised procedures are currently being amended which will result in the WRWF causing no impact to airspace procedures designed by Airservices. These changes are expected to become effective on 24 May 2018.
- The Airport Group advised airspace procedures designed by TAG173 of the Airport Group will be amended which will result in the WRWF causing no impact to airspace procedures.

Aircraft operator characteristics

- There is a relatively low rate of aircraft activity in the vicinity of the wind farm site.
- There are no known aerial agriculture operations conducted at night in the vicinity of the wind farm site.
- The wind farm will be clear of the obstacle limitation surfaces at Glen Innes Airport and Inverell Airport.
- Aircraft will be required to navigate around the Project site in low cloud conditions where aircraft need to fly at 500 ft AGL.
- Although there is no requirement to do so, the Proponent 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 Project area.

- Wind turbines 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.

Hazard lighting and marking

- With respect to MOS 139 7.1.5.1, the proposed wind turbines must be reported to CASA if they will be higher than 110 m AGL. With respect to MOS 139 7.1.5.2, the GW140 model wind turbines must be regarded as obstacles since they are higher than 150 m AGL, unless CASA assesses otherwise.
- There are currently two permanent WMTs in WRWF (Stage 1) with heights of approximately 90 m (295.3 ft) AGL. The current towers are marked with orange marker balls. WRWF (Stage 2) will have up to five additional WMTs; three temporary and two permanent, with heights of 100 m AGL.
- With respect to MOS 139 9.4.1.2 (b), the wind turbines will need to be lit if they are higher than 110 m AGL, unless an aeronautical study assesses they are of no operational significance.
- **Aviation Projects assesses that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of the Project.**
- Consultation with CASA regarding aviation hazard lighting has been undertaken during preparation of the impact assessment. CASA recommended that the 200 m high wind turbines be lit with steady red medium intensity lighting at night as per *NASF Guideline D – Managing Wind Turbine Risk to Aircraft*.
- MOS 139 section 9.4.3.4A provides a standard, and NASF Guideline D provides guidance for obstacle lighting on a wind turbine of a wind farm, if lighting is required, to be fitted with medium intensity obstacle lighting.
- 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.
- If CASA determines that obstruction lighting is to be provided, Department of Defence requires lighting 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 655 to 930 nanometres.
- Although there is no obligation to do so, consideration should be given to marking any wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D). This was done for the two permanent WMT installed as part of WRWF Stage 1.
- In respect of the overhead power line route, it is prudent to consider potential adverse impacts on aerial application operations. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Section 8.10 Obstacle Markings; specifically:

8.10.2.8 Wires or cable obstacles must be marked using three-dimensional coloured objects such as spheres and pyramids, etc; of a size equivalent to a cube with 600 mm sides, spaced 30 m apart.

Risk assessment

- A summary of the level of risk associated with the proposed Modification Application (MOD 6) for WRWF Stage 2, under the proposed treatment regime is provided in Table E1.

Table E1 Risk assessment summary

<i>Risk Element</i>	<i>Consequence</i>	<i>Likelihood</i>	<i>Risk</i>	<i>Actions Required</i>
Aircraft collision with wind turbine	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with monitoring tower	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings, specifically 8.10.2.6 and 8.10.2.8. Any wind monitoring towers that exceed a height of 150 m AGL should be lit with a high intensity white flashing obstacle light during the day and a low intensity steady red light at night, until such time as a wind turbine is constructed within close proximity to the WMT (nominally 900 m). Communicate details of wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes following construction.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Effect on crew	Minor	Possible	5	Acceptable without obstacle lighting (ALARP) Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights	Moderate	Likely	7	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact.

Recommendations

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

Notification and reporting

1. 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to Airservices Australia, at vod@airservicesaustralia.com

Condition C12 of the Project Approval (MOD 4) requires:

C12 Prior to the commencement of construction and operation, the Proponent shall provide the following information to the Civil Aviation Safety Authority, Airservices Australia, Royal Australian Air Force - Aeronautical Information Services, as well as all known users of privately owned local airfields:

- (a) "as constructed" coordinates in latitude and longitude of each wind turbine generator;*
 - (b) final height of each wind turbine generator in Australian Height Datum; and*
 - (c) ground level at the base of each wind turbine generator in Australian Height Datum.*
2. Department of Defence should be consulted if there is any subsequent modification in the wind turbine locations, height or scale of development.
 3. Any obstacles above 110 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
 - a. The planned operational timeframe and maximum height of the crane; and
 - b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

Operation

4. Although not a mandatory requirement, the Proponent should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project. The Proponent may consider developing procedures such as, for example, stopping the rotation of the wind turbine rotor blades prior to the commencement of the subject aircraft operations within the Project area.

Marking of turbines

5. The rotor blades, nacelle and the supporting mast of the wind turbines should be painted white.

Lighting of turbines

6. Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.
7. The Proponent may consider other factors in its decision as to whether obstacle lights should be installed.

Marking of wind monitoring towers

8. Consideration should be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D).

Marking of overhead transmission lines and poles

9. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Section 8.10.2.8. Note that the new transmission lines that are proposed will not adversely affect aircraft operations.

Micrositing

10. Alteration to the siting of a turbine or WMTs will not be more than 100 m and micrositing will address any consequential changes to access tracks and internal power cable routes. The potential micrositing of the turbines and WMTs have been taken into account in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the nominal turbine position. The micrositing of the turbines and WMTs is likely to not result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this aviation impact assessment would remain the same.

Triggers for review

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

1. INTRODUCTION

1.1. Situation

White Rock Wind Farm Pty Ltd (WRWFPL) is preparing a Modification Application for White Rock Wind Farm (WRWF) (the Project). Project Approval MP10_160 (MOD 3) focused on WRWF Stage 1 was approved on 1 April 2016. WRWF (MOD 4) addressed an alternative grid connection at 330 kV was approved on 31 May 2017.

WRWFPL engaged Aviation Projects to prepare an Aviation Impact Assessment and a review of whether aviation safety lighting is required to be installed on selected Stage 2 turbines to support a further Modification Application (MOD 6) for a modified Stage 2 of the WRWF development.

The Aviation Impact Assessment will review potential impacts of the WRWF on aviation safety in respect of relevant requirements of air safety regulations and procedures and in respect of consultation with relevant regulators.

1.2. Background

On 10 July 2012, project application MP10_160 was approved by the Minister for Planning and Infrastructure for WRWFPL (the Proponent) to develop WRWF in the general area from Grahams Valley Road to the Gwydir Highway, approximately 20 km west of Glen Innes in the Glen Innes Severn and Inverell local government areas, New South Wales (NSW). The initially approved wind farm comprising turbines and associated infrastructure, included connection to the existing Glen Innes to Inverell 132kV transmission line and permanent WMTs. WRWF (MOD 4) approval provides for alternative grid connection at 330 kV.

The project is being constructed in two stages. Stage 1 involving 70 WTG is under construction.

1.3. Purpose and Scope

The purpose of this task is to provide an aviation impact assessment and obstacle lighting risk assessment for the proposed Modification Application (MOD 6) for Stage 2 of the Project.

The assessment must utilise appropriate assessment methods, classifications and/or criteria that are applicable for Environmental Impact Assessment (EIA) in 2017 and that the Department of Planning and Environment (DPE) and referral agencies would expect a proponent to apply.

The assessment documentation is to address relevant guidelines and criteria as would be expected by DPE and Aviation Safety regulators to be applied for a modification application (MOD 6) to be lodged in 2017. The assessment will consider the need for aviation safety lighting and seek advice of aviation safety authorities. The assessment will address both construction and operation of the modified wind farm, as relevant and where relevant include consultation with air safety regulators.

Project Approval MP 10_160 (MOD 4) (as modified in accordance with the Notice of Modification (MOD 4) for project approval MP10_160 dated 31 May 2017) provides conditions for the approved Project. These conditions inform the relevant guidelines and criteria that will likely be expected by DPE.

1.4. Methodology

In undertaking this task, the following activities were undertaken:

1. confirmed the scope and deliverables via teleconference;
2. reviewed client material;
3. reviewed relevant regulatory requirements and information sources;
4. prepared a first draft report for client review and acceptance, consisting of a preliminary aviation impact assessment for the purposes of consulting with relevant stakeholders. This assessment includes an Aviation Impact Assessment (AIS) and qualitative risk assessment to determine the need of obstacle lighting and an obstacle lighting design specifying obstacle lighting plan and specifications (if obstacle lighting is required). The risk assessment completed following the guidelines in Standards Australia AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines.
5. consult with relevant stakeholders (e.g. Airservices Australia, CASA, The Airport Group (TAG), Department of Defence, aerodrome operators and aircraft operators). Includes preparation of correspondence, telephone consultation as applicable and consolidation of responses; and
6. finalised the assessment report for client acceptance when responses from relevant stakeholders are received; and
7. finalise the assessment for submission.

1.5. Report structure

This report is structured around the following areas of consideration:

- Introduction;
- Background;
- External context
- Internal context;
- Consultation;
- Aviation Impact Statement;
- Aircraft operator characteristics;
- Hazard lighting and marking;
- Risk assessment;
- Conclusions; and
- Recommendations.

1.6. Stakeholders

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

- Agricultural Association of Australia;
- Air Ambulance NSW;
- Airservices Australia;
- aerodrome operators or non-regulated aerodromes within the vicinity of the Project;
- aircraft operators;
- Civil Aviation Safety Authority;
- Department of Defence;
- Department of Planning and Environment;
- Glen Innes Severn Shire Council;
- Goldwind Australia Pty Ltd;
- Local ALA owners;
- Inverell Shire Council;
- NSW Rural Fire Service;
- Royal Flying Doctor Service;
- White Rock Wind Farm Pty Ltd; and
- other stakeholders where noted.

1.7. Material reviewed

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

- Aviation Projects, *Obstacle Lighting Risk Assessment White Rock Wind Farm, February 2015*;
- Epuron, *White Rock Wind Farm Submission Report*, November 2011;
- Epuron, *Environmental Assessment: Section 10.1 Health, Safety & Additional Issues - Aviation*, dated April 2011;
- Epuron, *Wind Farm Infrastructure, Projects: White Rock Wind Farm*, dated 6 August 2013;
- GWA, *Goldwind Australia – Request for Proposal – White Rock Wind Farm – Risk Assessment*, dated 21 November 2014;
- GWA, Project Approval, Application No. MP 10_0160, dated 10 July 2012;
- GWA, *White Rock Wind Farm Locations 119 Turbine Layout for ASA*, dated 12 December 2014.

- GWA, White Rock Wind Farm Stage 2 Layout, *WRWF_S2_WTG_LAYOUT19_48WTG.kml*, received 3 July 2017;
- GWA, White Rock Wind Farm elevations, *170629_WRWF_WTG_Elevations.xlsx*, received 3 July 2017;
- GWA, WRWF Stage 2 – Request for Proposal Brief – Environmental Assessment – Aviation Safety, September 2016;
- GWA, White Rock Wind Farm MP10_160 MOD 3 Environmental Assessment Report, Document No. WR-PM-REP-0007, December 2015, prepared for White Rock Wind Farm Pty Ltd;
- GWA, White Rock Wind Farm MP10_160 Modification Application No. 4 Environmental Assessment Report, Document No. WR-PM-REP-0017, December 2016, prepared for White Rock Wind Farm Pty Ltd;
- GWA, White Rock Wind Farm Infrastructure Map (Stage 1 & 2), 20 September 2016, Preliminary Stage 2;
- Minister for Planning and Infrastructure (NSW State Government), Section 75J of the Environmental Planning and Assessment Act 1979, *Project Approval, Application Number: MP 10_0160, White Rock Wind Farm Pty Ltd (Proponent)*, dated 10 July 2012;
- Minister for Planning and Infrastructure (NSW State Government), Notice of Modification, Section 75W of the Environmental Planning and Assessment Act 1979, Schedule 1: *The project approval (10_0160) for the White Rock Wind Farm Project, granted by the Minister for Planning and Infrastructure*, 10 July 2015, Schedule 2: *Modification Application for changes to construction and operation infrastructure dated December 2015 and supporting documents dated March 2016 (MOD 3)*; and
- Minister for Planning and Infrastructure (NSW State Government), Notice of Modification, Section 75W of the Environmental Planning and Assessment Act 1979, Schedule 1: *The project approval (10_0160) for the White Rock Wind Farm Project, granted by the Minister for Planning and Infrastructure*, 31 May 2017, Schedule 2: *Modification Application for the alternative transmission line alignment and substation dated January 2017, including associated response to submissions and supplementary information related to additional vegetation clearing, dated 21 April 2017 (MOD 4)*; and
- Various GIS data and wind turbine coordinates of the Project contained in a folder titled *170512_WRWF_WTG_Elevations*, received 12 May 2017.

1.8. References

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

- Aerial Agricultural Association of Australia, *National Windfarm Operating Protocols*, May 2014;
- Aerial Agricultural Association of Australia, *Powerlines Policy*, dated March 2011;
- Aerial Agricultural Association of Australia, *Windfarm Policy*, dated March 2011;
- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures, and En Route Supplement Australia dated 25 May 2017;
- Airservices Australia, Designated Airspace Handbook, effective 25 May 2017;
- AS/NZS ISO 31000:2009 *Risk management—Principles and guidelines*, Standards Australia;

- Clean Energy Council, *Best Practice Guidelines – For Implementation of Wind Energy Projects in Australia*, 2013, Aircraft Safety;
- Civil Aviation Safety Authority, *Civil Aviation Regulations 1998 (CAR)*, as amended;
- Civil Aviation Safety Authority, *Civil Aviation Safety Regulations 1998 (CASR)*, Statutory Rules No. 237, 1998, Complication No. 73, Registered 06 October 2016;
- Civil Aviation Safety Authority, *Manual of Standards Part 139 – Aerodromes*, version 1.14: dated January 2017;
- Civil Aviation Safety Authority, Advisory Circular (AC) 139-8(0): Reporting of Tall Structures, dated April 2005;
- Department of Planning and Environment, NSW State Government, *Wind Energy Guideline – For State significant wind energy development*, December 2016;
- Department of Planning and Environment, NSW State Government, *Wind Energy Framework – Standard Secretary’s Environmental Assessment Requirements*, December 2016;
- Department of Planning and Environment, NSW State Government, *Wind Energy: Visual Assessment Bulletin – For State significant wind energy development*, December 2016;
- Department of Infrastructure and Regional Development (Australian Government), *National Airports Safeguarding Framework Guideline D: Managing the risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*, dated June 2013;
- Department of Land and Property, NSW Government, *NSW Globe – An initiative of Land and Property Information*.
- 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 (WAC and ERC) extracts, dated 25 May 2017; and
- other references as noted.

2. BACKGROUND

2.1. Project Approval (Stage 1)

On 10 July 2012, project application MP10_160 was approved by the Minister for Planning and Infrastructure for WRWFPL (the Proponent) to develop WRWF in the general area from Maybole Road to the Gwydir Highway, approximately 20 km west of Glen Innes in the Glen Innes Severn and Inverell local government areas, New South Wales (NSW). The wind farm and associated infrastructure, included connection to the existing Glen Innes to Inverell 132kV transmission line and permanent monitoring masts.

Project Approval MP 10_160 (MOD 3) (as modified in accordance with the Notice of Modification (MOD 3) for project approval MP10_160 dated 1 April 2016) provides conditions for the approved Project and focused on details for Stage 1. WRWF (MOD 4) was approved on 31 May 2017. The MOD 2 approval conditions inform the relevant guidelines and criteria that will likely be expected by the DPE. Conditions C11 to C13 (Aviation Obstacles and Hazards), and C29 (Night Lighting) of Project Approval MP 10_160 (MOD 4) allows an alternative grid connection at 330 kV end varies some approval conditions are copied below:

Aviation Obstacles and Hazards

C11. Prior to the commencement of construction, the Proponent shall consult with:

- (a) aerodrome operators that have an aerodrome located within 30 kilometres of the boundaries of the site, to determine any impact on Obstacle Limitation Surfaces at such aerodromes;*
- (b) AirServices Australia, to determine potential impacts on instrument approach procedures at aerodromes, navigational aids, communications and surveillance facilities; and*
- (c) Aerial Agriculture Association Australia, to determine potential hazards to aerial application and related operations.*

Mitigation measures for each of the potential impacts and hazards identified in condition C11 (a) to (c) above, shall be determined in consultation with the respective groups identified in this condition, prior to the commencement of construction.

C12. Prior to the commencement of construction and operation, the Proponent shall provide the following information to the Civil Aviation Safety Authority, Airservices Australia, Royal Australian Air Force - Aeronautical Information Services, as well as all known users of privately owned local airfields:

- (a) "as constructed" coordinates in latitude and longitude of each wind turbine generator;*
- (b) final height of each wind turbine generator in Australian Height Datum; and*
- (c) ground level at the base of each wind turbine generator in Australian Height Datum.*

C13. Should increases to the costs of aerial agricultural spraying on any non-associated property surrounding the site be attributable to the operation of the project, the Proponent shall fully fund to the affected landowner, the reasonable cost difference between pre-construction aerial agricultural spraying and the increased cost, as agreed between the relevant parties.

Night Lighting

C29. With the exception of aviation hazard lighting implemented in accordance with the requirements of this condition, no external lighting other than low intensity security night lighting is permitted on site unless otherwise agreed or directed by the Secretary, or required by Civil Aviation Safety Authority.

Prior to the commencement of construction, the Applicant shall consult with the Civil Aviation Safety Authority on the need for aviation hazard lighting in relation to the wind turbines. Any aviation hazard lighting shall be implemented in a manner that minimises visual intrusion to surrounding non-associated residences as far as reasonable and feasible.

2.2. Project staging

The project will be constructed in two stages.

Construction of WRWF Stage 1 involves 70 wind turbines, and associated facilities including tracks, grid connection facilities and collections circuits. Stage 1 construction commenced in May 2016 and conforms with Project Approval MP10_160 (MOD 3). It is expected to be operational in late 2017 or early 2018 and will export the electricity generated via an existing 132kV transmission line between Glen Innes and Inverell.

Stage 2 will follow Stage 1 at a time still to be confirmed and subject to further planning approval. Planning undertaken for WRWF Stage 2 requires variations to the Project Approval, as sought under MOD 6.

The proposed modification (MOD 6) involves extension of the existing approved project area to include additional neighbouring properties to the south west of the current WRWF project area (Willis property at western end of Kellys Road, Maybole). Figure 1 provides the WRWF locality map wind farm and alternative grid connection facilities (Source: White Rock Wind Farm MP_160 Modification Application No. 4, Environmental Assessment Report).

Infrastructure components of MOD 4 for the 330kV connection include construction and operation of the following:

- a 132kV double circuit transmission line between WRWF and the 330kV line;
- a 132kV/330kV Swan Vale Substation located adjacent the 330kV locality; and
- temporary construction facilities for the construction of 330kV grid connection facilities.

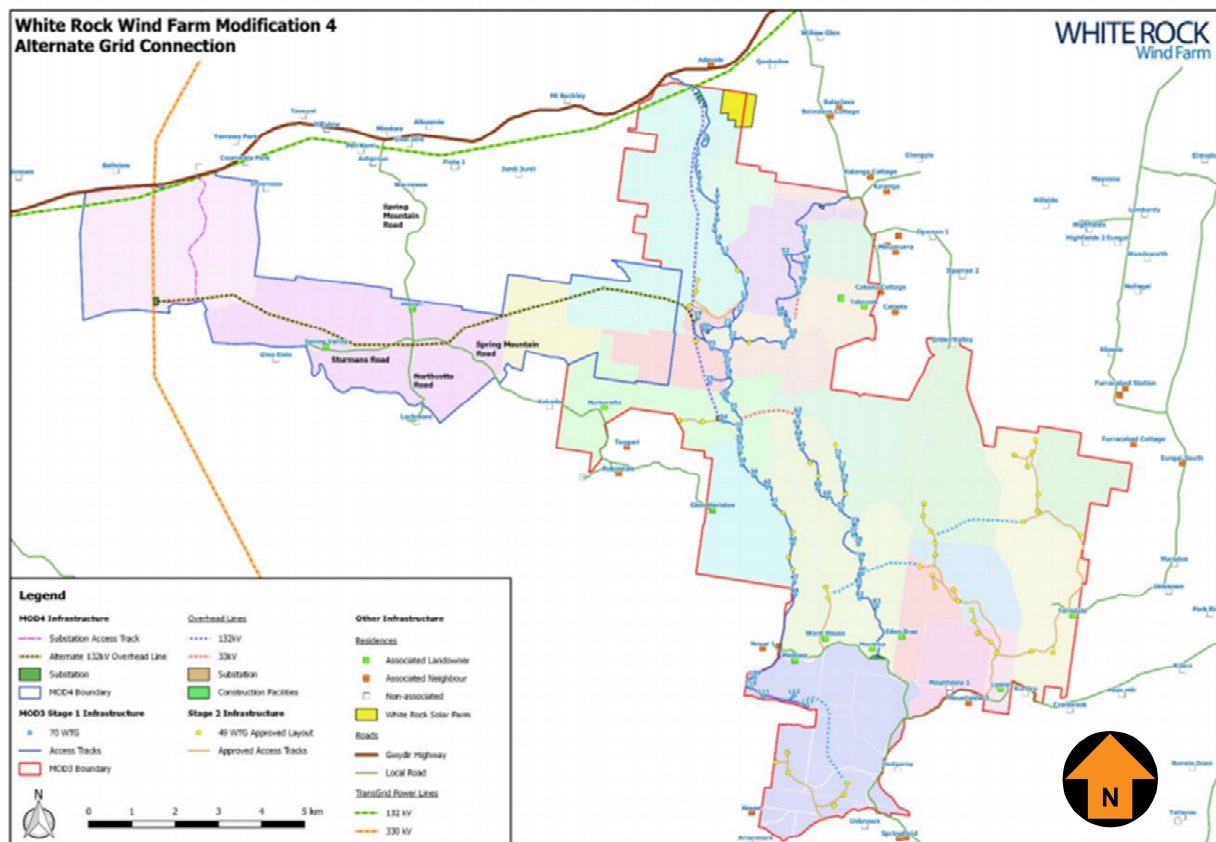


Figure 1 WRWF Locality Map - wind farm and alternative grid connection facility (MOD 4)

2.3. Proposed variations of Stage 2 (MOD 6)

The proposed variations to Stage 2 components of the development that are the subject of the modification (MOD 6) include the following:

- Modification Application (MOD 6) proposes variations to Stage 2. Many of the turbine sites from the balance of the approved wind turbines. However, Stage 2 does not use all of the approved sites;
- MOD 6 proposes a larger Goldwind turbine to be used at WRWF with the following specifications:
 - Goldwind GW140;
 - output of up to 3.57MW;
 - 85 m maximum blade length;
 - 140 m rotor diameter;
 - hub height up to 130 m; and
 - maximum tip height AGL up to 200 m;

- The larger turbine model GW140 requires a review of turbine spacing and variations for some turbine sites, omission of some sites and, proposal for some new sites beyond those allowed under the existing project approval. A total of 48 sites are now proposed for Stage 2 with the maximum height of up to approximately 200 m AGL;
- WRWFPL is confirming suitability of some turbines sites with landowners and the layout to be assessed will be confirmed at commencement of the services. Stage 2 (MOD 6) proposed variations are shown with the approved Stage 1 layout in Figure 2;
- A total of 48 turbine sites are proposed for (MOD 6) Stage 2 including 33 WTGs located at approved (MOD 3) locations (may be micrositied), with the remaining sites at new site locations within the approved project area. Some of WTG sites proposed are located on three new properties, subject to planning approvals;
- Micrositing of turbines and Wind Monitoring Towers (WMTs) means an alteration to the siting of a turbine or WMTs 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 WMTs have been taken into account 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 WMTs is likely to not result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this aviation impact assessment would remain the same;
- Implementation of alternative grid connection at 330 kV (MOD 4) including additional 13 km of 132 kV transmission line and 132 kV/330 kV substation approximately 13 km west of WRWF.
- Variation to WRWF substation components (additional 33kV/132kV transformer, gantry and switchgear); and
- Variations to access tracks and 33kV collection circuits to enable connection of the revised turbine layout to the WRWF substation.

In addition to the above changes, WRWFPL will seek variation to specific conditions of approval to enable the modified Stage 2 to be implemented in a practical and feasible way with acceptable impacts. Overall, the modification application (MOD 6) will specify the proposed project, impacts of the modified layout and design, and proposed mitigation measures.

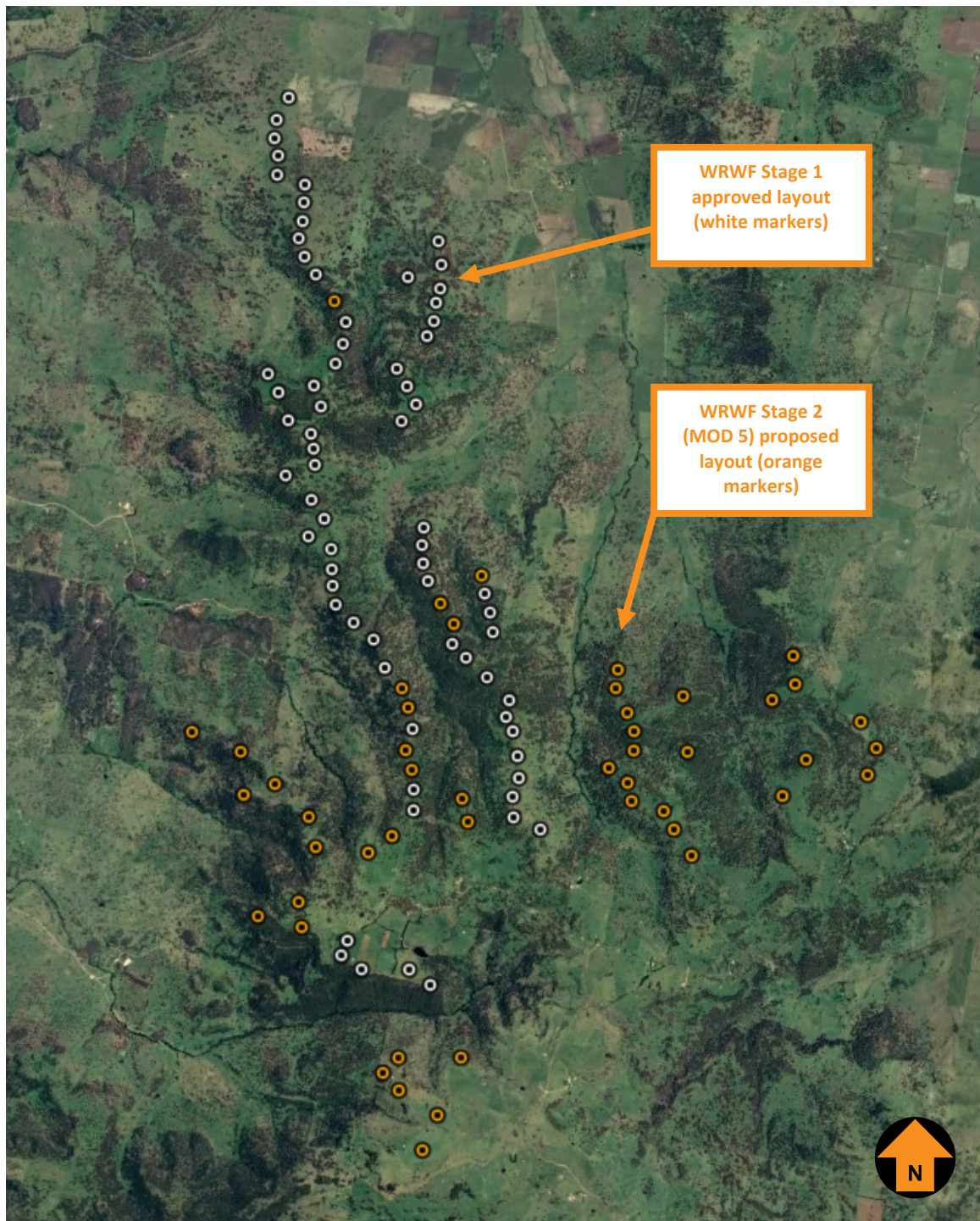


Figure 2 WRWF Stage 1 approved layout and Stage 2 (MOD 6) proposed layout

3. EXTERNAL CONTEXT

3.1. Department of Planning and Environment, NSW

The role of the Department of Planning and Environment (previously Department of Planning and Infrastructure) 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.

In December 2016, Department of Planning and Environment released the *Wind Energy Framework* stating the following:

Wind energy developers are required to work with the Civil Aviation Safety Authority and the Royal Australian Air Force Aeronautical Information Service and may be required to prepare an aeronautical impact assessment as part of the project.

The *Wind Energy Guideline for State significant wind energy development* (December 2016), section 3 Assessment issues for wind energy development states as follows:

aviation safety: *wind energy projects need to consider potential safety hazards for aircraft through intrusion of the wind turbines into the airspace; and potential effects on navigation instruments.*

The *Wind Energy: Visual Assessment Bulletin* (December 2016), Table 2 Visual Performance Objectives states as follows:

Aviation Hazard Lighting

Wind turbines located in the vicinity of an aerodrome are subject to standards imposed by the National Airports Safeguarding Framework. CASA must be notified by the proponent if a proposed wind turbine or wind monitoring tower is greater than 150 metres in height or infringes on the Obstacle Limitation Surface (OLS) of an aerodrome. CASA may determine, and subsequently advise a proponent and relevant planning authorities, whether night-lighting is required.

If such lighting is required, the CASA guidelines recommend that to minimise visual impacts “obstacle lights may be partially shielded, provided it does not compromise their operational effectiveness. Where obstacle lighting is provided, lights should operate at night, and at times of reduced visibility. All obstacle lights on a wind farm should be turned on simultaneously and off simultaneously.” The lights should be fully shielded from the view of any dwelling within.

As part of the assessment of visual impacts of wind energy projects, the Department will consider whether any obstacle lighting required is likely to result in any significant increase in visual impacts.

Objective: (applies to all visual influence zones)

- *Aviation hazard lighting (AHL) must meet the requirements of Australian Standard AS 4282-1997 and any prescribed or notified CASA requirement. Shield all AHL within two kilometres from any dwellings. Avoid strobe lighting.*

3.2. Clean Energy Council

Clean Energy Council has produced a *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia*, 2013 version. The guidelines are designed to support the existing wind farm planning and development assessment process and are not mandatory.

Guidance provided under section 3.1.2.8 Aircraft safety state as follows:

Proponents should assess potential for aircraft safety issues by noting the proximity of the site to any major airports, aerodromes or landing strips. Proponents should contact the Civil Aviation Safety Authority, Airservices Australia and the authorities responsible for the operation of such facilities in the vicinity of the proposed site. Advice should be sought on contacting agricultural aviators who may operate in the area.

In addition, proponents should obtain advice from landowners on any farming-related uses of aircraft such as aerial spraying or mustering. In such cases, the district aerodrome supervisor should be contacted for advice on the potential impact of a wind energy development on these activities.

To provide more detailed guidance for wind farm proponents, a National Airports Safeguarding Advisory Group has prepared draft "Guidelines for land use planners and developers to manage the risk to aviation safety of wind turbine installations (wind farms)/wind monitoring towers."

Guidance provided under section 3.1.2.9 Restricted areas state as follows:

Consultation with relevant authorities should be carried out to determine whether any restrictions may apply to the development of a wind farm in the proximity of ...radar used for aircraft safety.

Guidance provided under section 3.2.4.4 Other agencies state as follows:

Structures such as wind monitoring masts in the vicinity of an airfield or flight area may cause a safety hazard. It is recommended that the proponent contact the Civil Aviation Safety Authority to maximise aircraft safety.

Guidance provided under section 3.3 Detailed assessment, 3.3.2 Environmental considerations, Aircraft safety assessment state as follows:

An assessment of aircraft safety should be completed.

Guidance provided under Appendix 4: Aircraft safety state as follows:

Wind energy projects (including associated wind monitoring masts) need to be sited so as not to cause a hazard to aircraft safety; civil, military, agricultural and industrial.

[NASF Guideline D] provide comprehensive coverage of aviation safety for wind developments and should be the point of reference for wind farm proponents.

The Commonwealth agencies such as the Civil Aviation Safety Authority (CASA), Airservices Australia and Department of Defence must be notified of the locations of all wind monitoring towers and proposed wind farms. It should be noted that where turbine(s) are planned to be over 150 m above ground level or built within 30 km of a certified or registered aerodrome, CASA may be required to provide a formal assessment of the project. If the wind monitoring tower or wind turbine(s) is within 30 km of a military aerodrome, then extensive consultation will be required with the Department of Defence.

The aviation safety guidelines provide guidance on:

- *the notification process for tall structures (wind turbines and wind monitoring masts)*
- *the need for risk assessment to identify whether the wind turbines or wind monitoring masts will be considered to be hazards*
- *actions required if a wind turbine(s) or wind monitoring mast is considered to be a hazard – including the possibility that a wind turbine or monitoring mast should not be built.*
- *marking recommendations for wind monitoring masts*

Consultation with aviation stakeholders is strongly encouraged in the early stages of planning for wind farm developments. This should include:

- *early identification of any nearby licensed aerodromes*
- *consultation with any nearby aerodrome owners*
- *If potential risks to aviation are identified, a preliminary assessment by an aviation consultant of potential issues*
- *confirmation of the extent of the obstacle limitation surfaces (OLS) for any nearby aerodromes*
- *registration of all wind monitoring masts on the RAAF AIS database*
- *consultation with local agricultural pilots and nearby unlicensed airstrip owners*
- *consultation with CASA and Airservices*
- *consultation with the Department of Defence*

3.3. Civil Aviation Safety Authority

The Civil Aviation Safety Authority regulates aviation activities in Australia. Applicable requirements include the Civil Aviation Regulations 1988 (CAR), Civil Aviation Safety Regulations 1998 (CASR) and associated Manuals of Standards (MOS) and other guidance material.

Civil Aviation Safety Regulations 1998, Part 139--Aerodromes

In areas remote from an aerodrome, CASR 139.365 requires the owner of a structure (or proponents of a structure) that will be 110 m or more above ground level (AGL) to inform CASA. This is to allow CASA, under CASR 139.370, to assess the effect of the structure on aircraft operations and determine whether or not the structure will be a hazardous object because of its location, height, or lack of marking or lighting.

Manual of Standards 139--Aerodromes

Chapter 7 of MOS 139 sets out the standards applicable to Obstacle Restriction and Limitation. Section 7.1.5 deals with objects outside the obstacle limitation surfaces (OLS):

7.1.5 Objects Outside the OLS

7.1.5.1 Under CASR Part 139 any object which extends to a height of 110 m or more above local ground level must be notified to CASA.

Note: For instrument runways, obstacle monitoring includes the PANS-OPS surface which extends beyond the OLS of the aerodrome. See paragraph 7.1.1.

7.1.5.2 Any object that extends to a height of 150 m or more above local ground level must be regarded as an obstacle unless it is assessed by CASA to be otherwise.

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

Section 9.4.1 provides some general guidance on obstacle lighting:

9.4.1.2 In general, an object in the following situations would require to be provided with obstacle lighting unless CASA, in an aeronautical study, assesses it as being shielded by another lit object or that it is of no operational significance:

(b) outside the obstacle limitation surfaces of an aerodrome, if the object is or will be more than 110 m above ground level.

Section 9.4.2 provides guidance on Types of Obstacle Lighting and Their Use:

9.4.2.3 Medium intensity obstacle lights are to be used either alone or in combination with low intensity lights, where:

(a) the object is an extensive one;

(b) the top of the object is 45 m or more above the surrounding ground; or

(c) CASA determines that early warning to pilots of the presence of the object is desirable.

9.4.2.5 High intensity obstacle lights are flashing white lights used on obstacles that are in excess of 150 m in height.

The turbines will be located outside the OLS of surrounding aerodromes, will be more than 110 m AGL and will not exceed 150 m (492 ft) AGL. The risk assessment prepared for this report concluded that there will be an acceptable level of aviation safety without obstacle lighting and therefore there will be no requirement for obstacle lighting under the provisions of MOS 139 Chapter 9.

3.4. International Civil Aviation Organisation

As a contracting state to the International Civil Aviation Organization (ICAO) and signatory to the Chicago Convention on International Civil Aviation, Australia has an obligation to implement ICAO's standards and recommended practices (SARPs) as published in the various annexes to the Convention. Where these SARPs are not met, a difference must be filed.

Annex 14 to the Convention — Aerodromes, Volume 1 documents SARPs applicable to wind turbines. Section 6.4 of Annex 14 provides as follows:

6.4 Wind turbines

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

Note.— See 4.3.1 and 4.3.2.

Markings

6.4.2 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

6.4.3 Recommendation.— *When lighting is deemed necessary, medium-intensity obstacle lights should be used. In the case of a wind farm, i.e. a group of two or more wind turbines, it 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 6.3.14 [900 m], 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; and*
- d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located.*

6.4.4 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.*

Sections 4.3.1 and 4.3.2 of Annex 14 state as follows:

4.3 Objects outside the obstacle limitation surfaces

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.*

- Under the provisions of ICAO Annex 14 4.3.2 recommendation (and MOS 139 7.1.5.2), WRWF turbines would not be considered as obstacles if they are constructed to a height less than 150 m (492 ft) AGL.
- Concerning ICAO Annex 14 4.3.1 recommendation, CASA (the appropriate authority) must be consulted because the turbines are proposed to reach a height of greater than 110 m AGL.
- The following risk assessment concludes that there will be an acceptable level of aviation safety without obstacle lighting and therefore there will be no requirement for obstacle lighting under the provisions of ICAO Annex 14 section 6.4.1.

3.5. Glen Innes Airport and scope of operation

Glen Innes Airport (YGLI) is the closest registered/certified aerodrome to the WRWF, with a published aerodrome elevation of 1044.8 m (3428 ft) above mean sea level (AMSL) and with one sealed runway 14/32 (1498 m) and an unsealed runway 10/28 (1200 m) (Source: Airservices Australia, Aerodrome Chart, YGLI). The Aerodrome Reference Point (ARP) for YGLI is 29° 40' 30"S and 151° 41'22"E (Source: Airservices, Designated Airspace Handbook). Refer to Australia, Aerodrome Chart, dated 10 November 2016).

Glen Innes Airport ARP is located approximately 17.28 km from the WRWF Stage 1 approved WTG51 m and approximately 19.04 km from the WRWF Stage 2 proposed WTG12.

The main flying operations at the aerodrome are by day and includes flying training (local and visiting flying schools), emergency services (firefighting and air ambulance), recreational and private aviation uses. Findings from consulting with Glen Innes Airport staff indicate that flying operations include approximately five night operations per week, which consist of air ambulance, firefighting and flying training operations. No regular public transport operations are conducted at Glen Innes Airport.

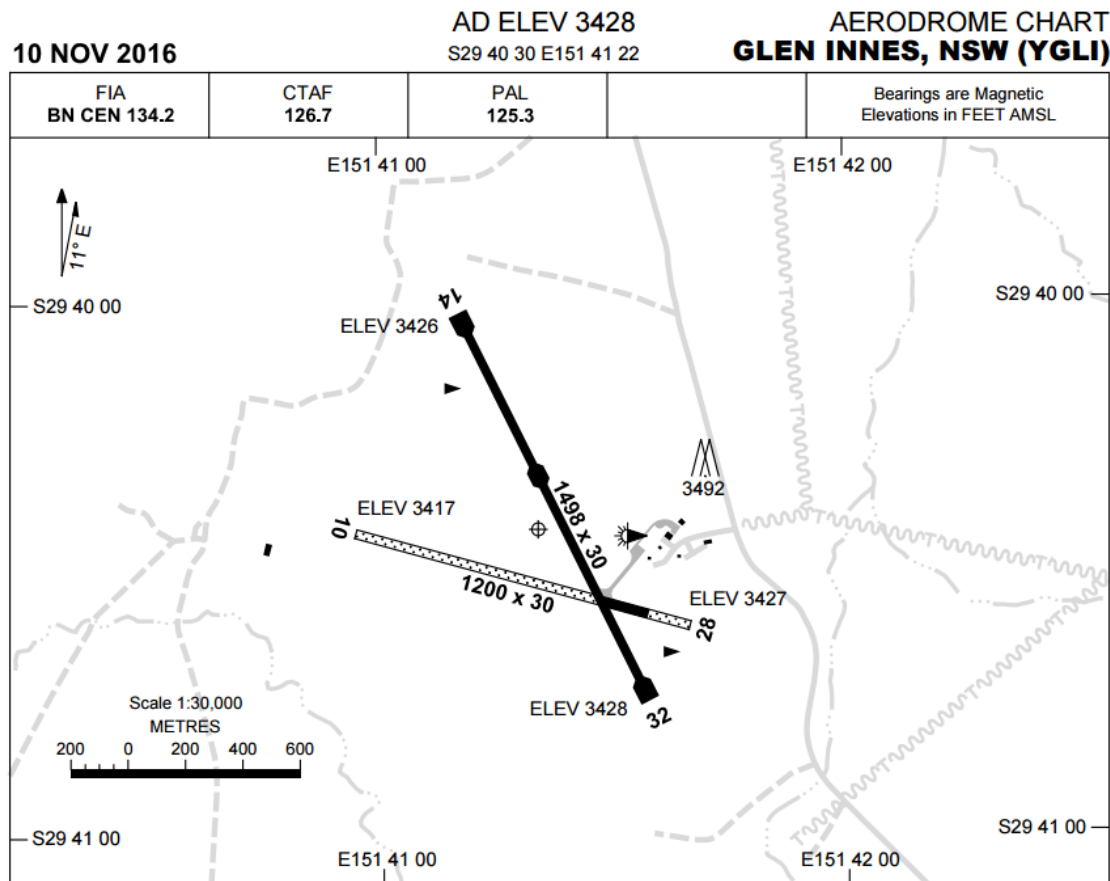


Figure 3 Glen Innes Aerodrome Chart

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. IFR (Day or night)

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.

3.7. Aircraft operator characteristics

3.7.1. Passenger transport operations

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

3.7.2. 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.

3.7.3. Aerial agriculture operations

Aerial agricultural operations including such activities as fertiliser, pest and crop spraying are generally conducted under day VFR below 500 ft AGL; usually between 60 ft (18.3 m) and 100 ft (30.5 m) AGL.

Local ALA owners that were consulted with have stated that, to the best of their knowledge, the aerial application operators have only operated during day light hours and that the operators have previously delayed or cancelled flying operations due to unsuitable meteorological conditions.

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

According to Enid McLeod (owner of McLeod ALA), half of her property is fertilised in one year and the other half of her property is fertilised in the following year. Each application takes approximately one day. Enid also notes that there is no other aircraft operation conducted at the ALA.

Jodie Burey (owner of Burey ALA) has stated that there are approximately seven aircraft operations per year, which include Super Air and Rural Air, which are for the purposes of fertilising. Jodie also noted that no night operations are conducted at her ALA.

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

The Aerial Agricultural Association of Australia (AAAA) has a formal risk management program which is recommended for use by its members.

3.7.4. Aerial fire fighting

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

Most aerial fire fighting 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.

3.7.5. Emergency services/air ambulance/RFDS

Air ambulance 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.

3.8. Nearby aerodromes

The nearby certified/registered aerodromes or aircraft landing areas are listed in Table 1.

Table 1 Nearby certified/registered aerodromes

<i>Aerodrome</i>	<i>Operator</i>	<i>Type</i>	<i>Location from the Project</i>
Glen Innes	Glen Innes Shire Council	Registered, Code 3 Instrument non-precision	Approximately 17 km from WRWF Stage 2 proposed WTG51 (located south west from Glen Innes Airport ARP in no circling area)
Inverell	Inverell Shire Council	Registered Code 3 Instrument non-precision	Approximately 37 km from WRWF Stage 2 proposed WTG129 (located east from Inverell Airport ARP)

A site overview showing the location of Glen Innes Airport and Inverell Airport with respect to WRWF and surrounding aeronautical features, extracted from the World Aeronautical Chart, dated 2 March 2017, is provided in Figure 4.

The ARP for Glen Innes is used as the reference point for the 25 nm minimum safe altitude (MSA) protection surface (which extends out to 30 nm (25 nm plus a 5 nm buffer) from the reference point). Figure 5 shows the Inverell Airport and Glen Innes Airport 30 nm radius line, which locates the WRWF within both airport's 30 nm protection surface (Source: Goldwind, WRWF Stage 1 and Stage 2 WTG locations and Google Earth).

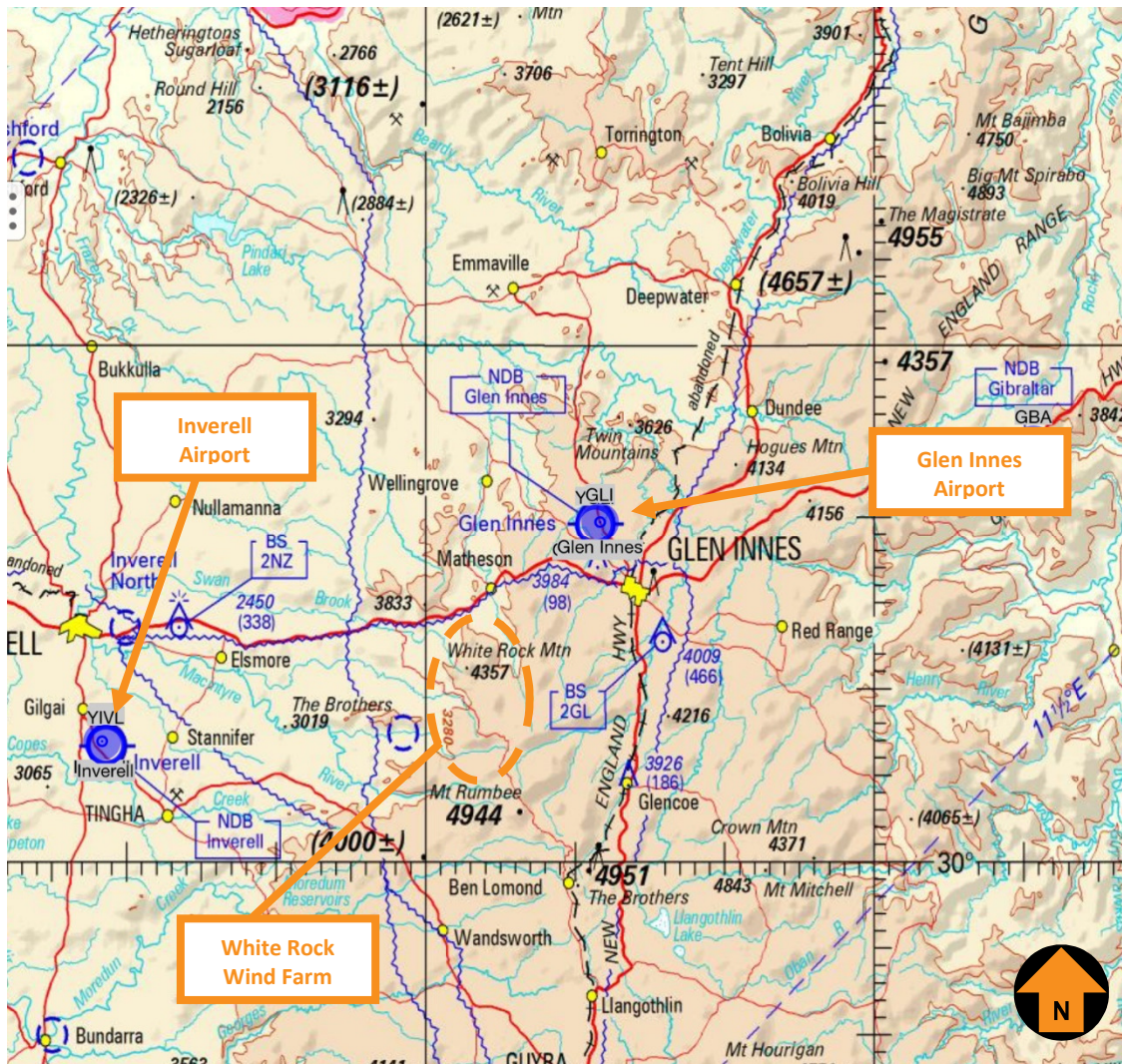


Figure 4 Glen Innes and Inverell Airports and White Rock Wind Farm surrounding aeronautical features

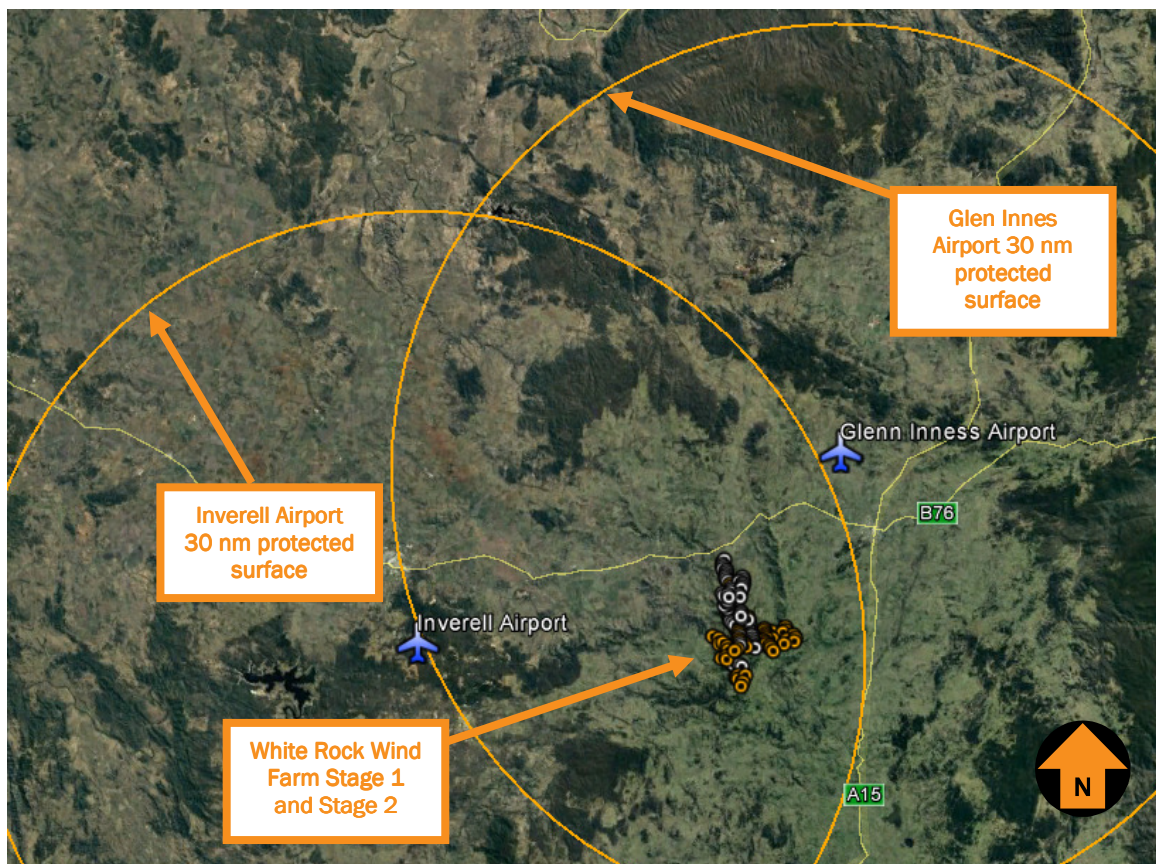


Figure 5 Inverell Airport and Glen Innes 30 nm radius line

3.9. Nearby aircraft landing areas

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 166-1(3) – *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 166-1(3) provides the following guidance:

3.4 CASA [Civil Aviation Safety Authority] 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 6 of this CAAP (Standard traffic circuit procedures) and Section 7 (Radio broadcasts).

...

6.4.1 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.

Based on the guidance provided above, aircraft landing areas within 3 nm of a wind turbine are further analysed.

Figure 6 shows Stage 1 and Stage 2 WTG layout and nearby aircraft landing areas.

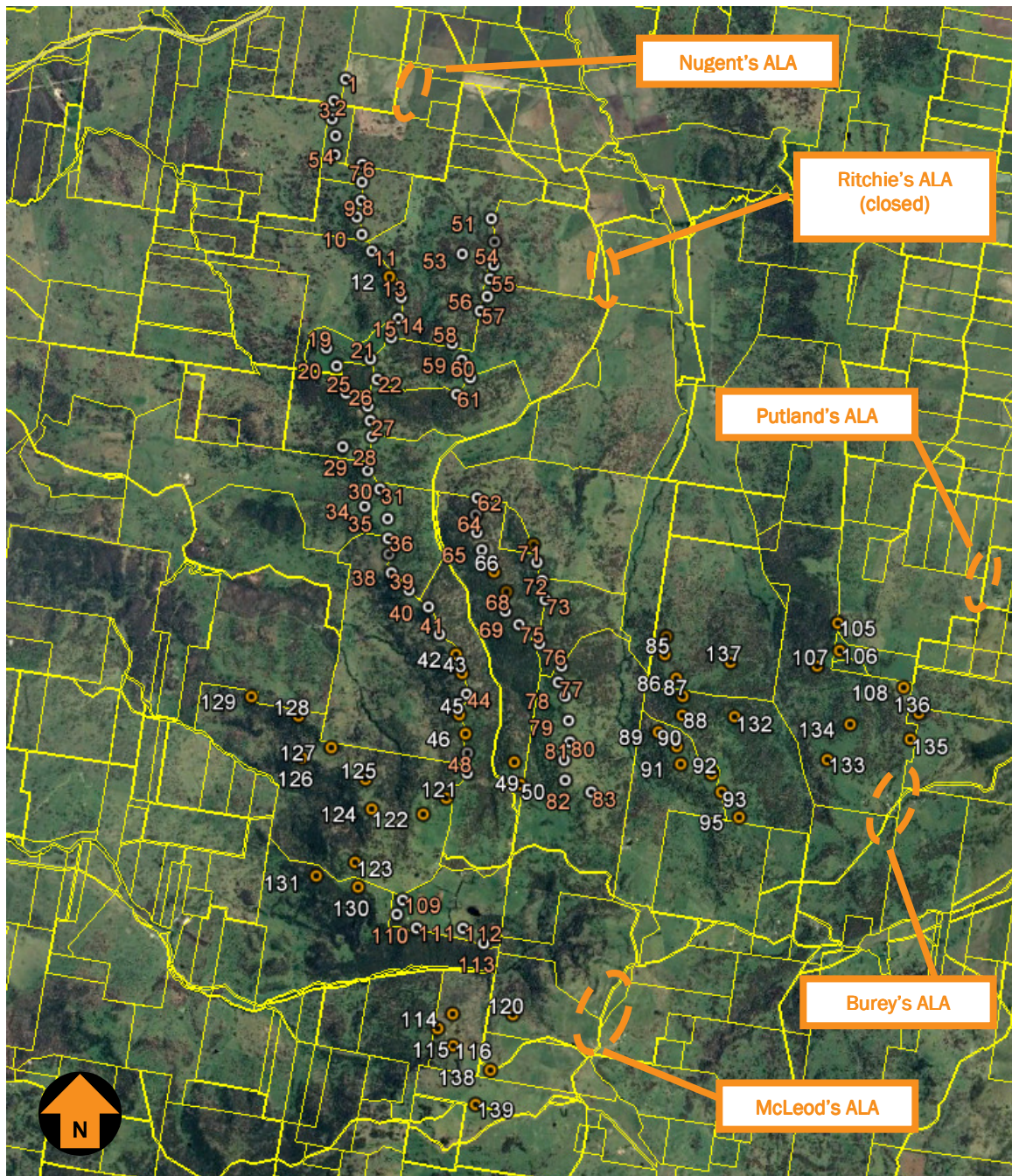


Figure 6 White Rock Wind Farm layout and nearby airport landing areas

4. INTERNAL CONTEXT

4.1. Wind farm description

WRWF in the general area from Grahams Valley Road to the Gwydir Highway, approximately 20 km west of Glen Innes Township in the Glen Innes Severn Shire and 40 km east of Inverell. The wind farm area is located within Glen Innes Severn Shire and Inverell Shire local government areas, NSW.

From Grahams Valley Road, the northern end of the wind farm Project site is approximately 16 km to the southern end. WRWF is planned to comprise a maximum of 118 wind turbines, with 70 approved WTG under construction for Stage 1.

The wind farm site is situated in an area comprised mainly of farming properties on gently rolling terrain.

The proposed Stage 2 (MOD 6) wind farm layout for Stage 1 (approved) and Stage 2 (proposed), issued on 12 May 2017 by Goldwind.

Figure 7 shows WRWF Stage 1 and Stage 2 (numbered) and local government boundaries (Source: Goldwind, WRWF Stage 1 and Stage 2 WTG locations, NSW LGAs and Google Earth).

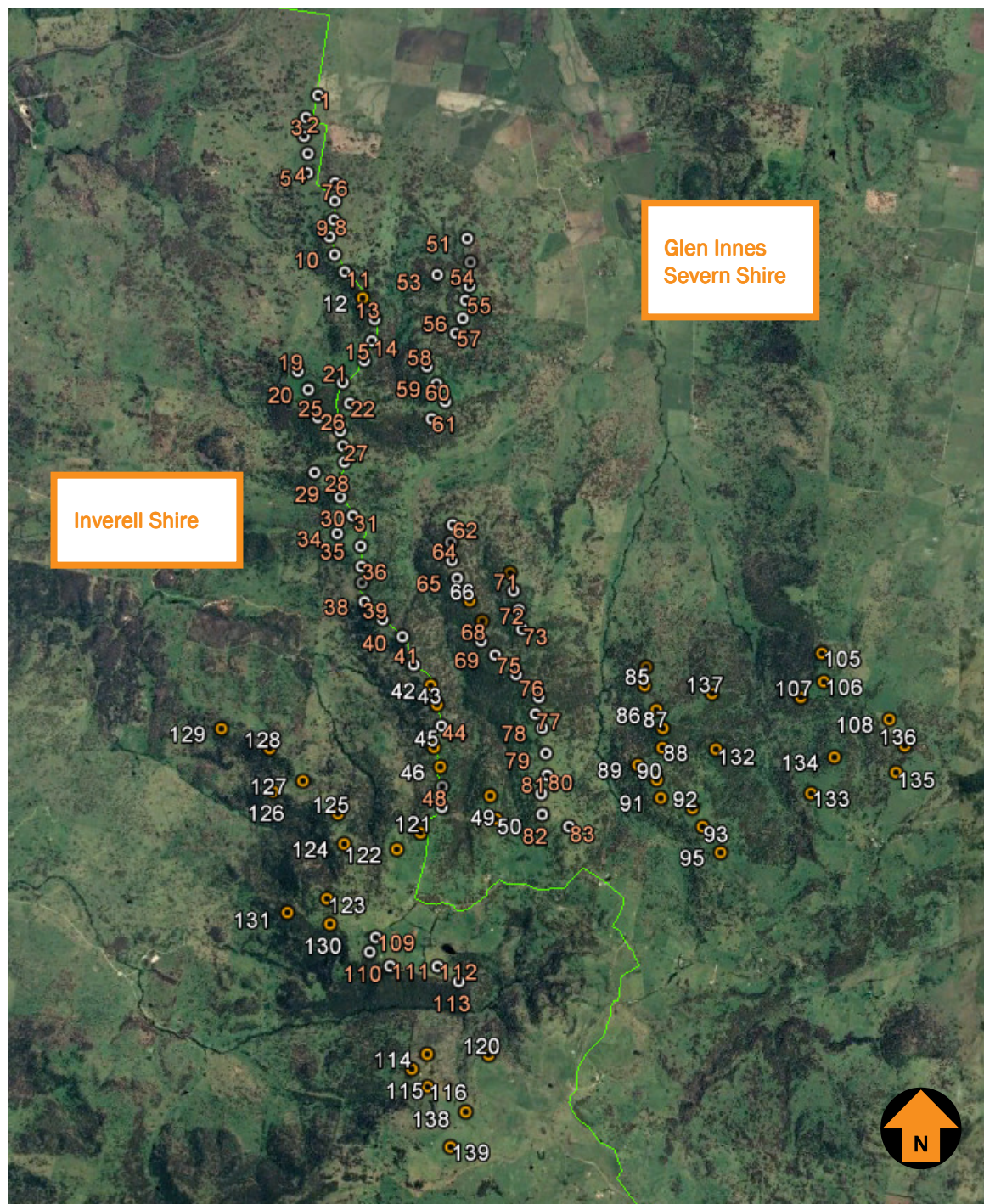


Figure 7 White Rock Wind Farm Stage 1 and Stage 2 (numbered) and local government boundaries

4.2. Wind turbine description

The proposed wind turbines for Stage 2 (MOD 6) will have a height of up to 200 m AGL (656.2 ft). The maximum ground elevation for the proposed GW140 wind turbine is WTG91 with a ground elevation of at 1396 m AHD (4580 ft), equating to a maximum overall height of 1596 m AHD (5236 ft AMSL). The coordinates and ground elevations of the Project wind turbines are listed at **Annexure 1**.

4.3. Wind monitoring tower description

There are currently two permanent wind monitoring towers (WMTs) on site for WRWF Stage 1, each with heights of approximately 90 m (295.3ft) AGL. The permanent WMTs have been reported to RAAF AIS (Airservices Australia).

The Stage 1 permanent WMTs have a total of six guy wires supporting the mast and there are three 300 mm orange marker balls installed on the top level guy wires and the WMTs are powdered in alternating colours.

The details of the permanent WMTs are provided in Table 2.

Table 2 Permanent Stage 1 wind monitoring tower description

<i>WMT reference</i>	<i>Coordinates (UTM)</i>		<i>Site elevation m (AHD)</i>	<i>Overall height m (AHD)</i>	<i>Construction date</i>	<i>Duration</i>
MM_2025_WEST	359271	6701066	1272.6	1362.6	December 2015	25 Years
MM_5960_EAST	361633	6701292	1269.6	1359.6	December 2015	25 Years

GWA proposes five additional WMTs to 100 m height, three temporary and two permanent WMTs. Details of the temporary WMTs are listed in Table 3. Figure 8 shows the location of the Stage 1 (permanent WMTs) and Stage 2 WMTs (three temporary WMTs and two permanent WMTs) as white triangles.

Table 3 Temporary and Permanent Stage 2 WMTs

<i>Detail</i>	<i>WMT1 (Temporary)</i>	<i>WMT2 (Temporary)</i>	<i>WMT3 (Temporary)</i>	<i>WMT4 (Permanent)</i>	<i>WMT5 (Permanent)</i>
Location Zone 56 J E/S	362373 6690279	368404 6695866	364706 6695356	368579 6695563	362023 6690279
Ground elevation at site	TBA	TBA	TBA	TBA	TBA
Height of tower AGL	100 m (328 ft)	100 m (328 ft)	100 m (328 ft)	100 m (328 ft)	100 m (328 ft)
Height of tower AHD	TBA	TBA	TBA	TBA	TBA

Micrositing of turbines and wind monitoring towers (WMTs) means an alteration to the siting of a turbine or WMTs 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 WMTs have been taken into account in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the nominal turbine position. The micrositing of the turbines and WMTs is likely to not result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this aviation impact assessment would remain the same.

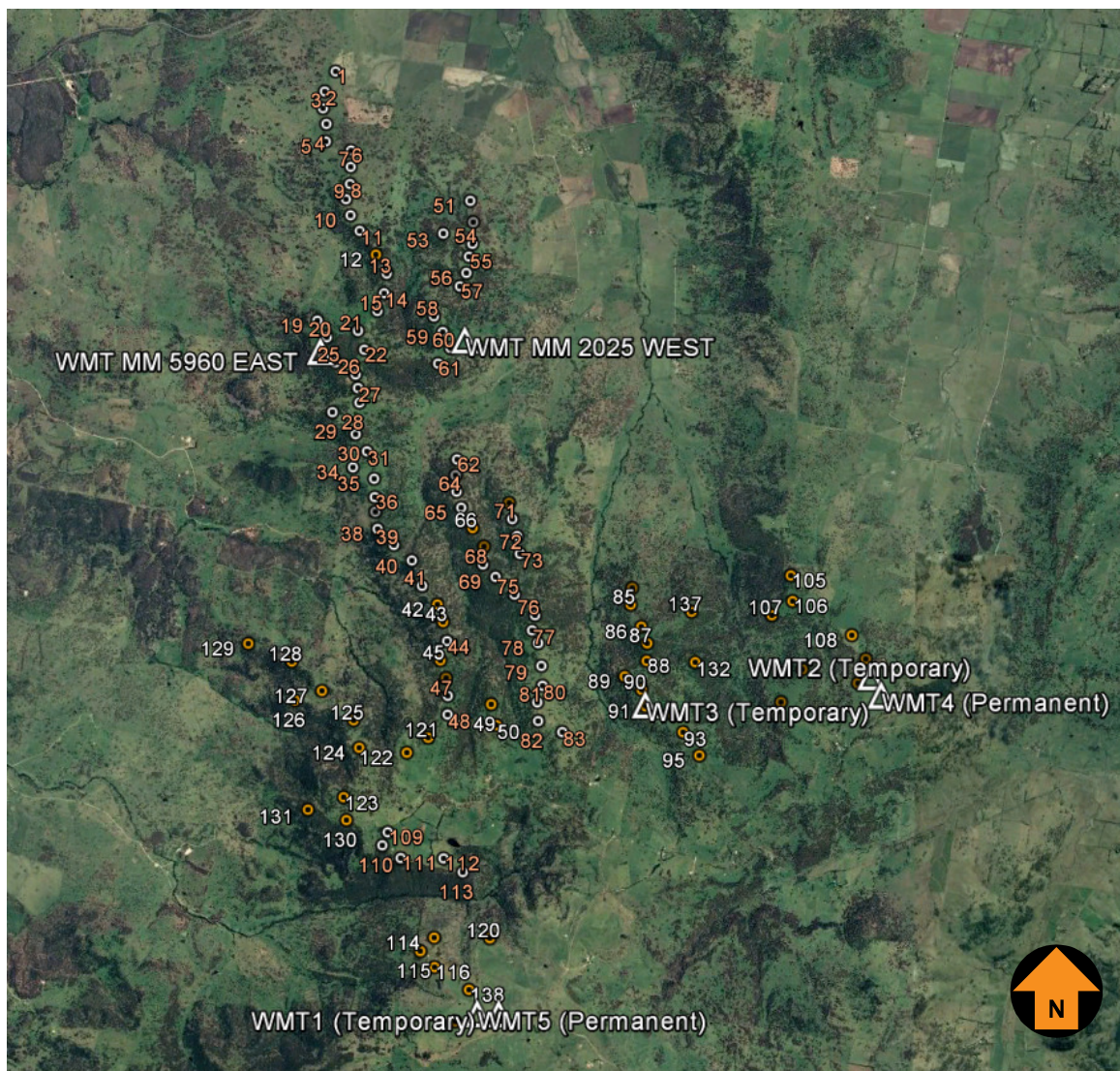


Figure 8 Permanent and temporary wind monitoring tower locations

5. CONSULTATION

Aviation Projects carried out extensive consultation occurred during Stage 1 Obstacle Lighting Risk Assessment, dated February 2015.

5.1. Airservices Australia previous advice

GWA consulted with Airservices Australia with regard to the aviation impact of WRWF Stage 1. In a reply email dated 1 December 2014 by Carly Fiumara (Airport Development Assistant), Airservices has stated the following:

I confirmed with our Airspace section that the Procedures at Glen Innes Aerodrome were recently changed so the issue of the Arrival Procedure is no longer an issue.

I refer to your request for Airservices assessment of the White Rock Wind Farm at Glen Innes.

With respect to procedures designed by Airservices in accordance with ICAO PANS OPS and Document 9905, at a maximum height of 1556m (5105ft) AHD, the proposed wind farm development will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Glen Innes Airport nor will it adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, HF/VHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

Note: procedures not designed by Airservices at Glen Innes Airport were not considered in this assessment.

In addition, Jessica Neidert (Airport Development Assistant) stated the following in a reply email dated 11 December 2014:

I can confirm that all procedures at Glen Innes Airport are produced and owned by Airservices and that no other CASR Part 173 designs are published for Glen Innes Airport. As we have amended our procedures to accommodate the wind farm, there is no impact on our procedures at Inverell or Glen Innes Airport.

For Stage 2 (MOD 6) application, the following stakeholders were consulted in July to September 2017.

- Airservices Australia;
- Civil Aviation Safety Authority;
- Department of Defence; and
- The Airport Group.

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

Table 4 Stakeholder consultation details

<i>Agency/Contact</i>	<i>Activity/Date</i>	<i>Response/Date</i>	<i>Issues Raised During Consultation</i>	<i>Action Proposed</i>
Airservices Australia Airport Developments	26 July 2017 Email to Airport Developments	4 September 2017 Email from Airport Developments	Due to upcoming flight validation activity by Airservices, steps are being taken to amend procedures at Glenn Innes Airport that will result in the White Rock Wind Farm not impacting Glenn Innes Airport. These changes will become effective in the Departure and Approach Procedures (DAP) issued on 24 May 2018. After this date the proposed White Rock Wind Farm will have no impact on instrument flight procedures at Glenn Innes Airport. Note that Airservices has co-ordinated this change process with <i>The Airport Group</i> and their procedures at Glenn Innes Airport. Therefore, based on the above amendments proceeding for 24 May 2018, below is our assessment advice: AIRSPACE PROCEDURES With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at 1577m (5174ft), 1596m (5237ft) and 1591m (5220ft) AHD, WTG90, WTG91 and WTG95 respectively will <u>currently</u> affect the following instrument procedures at Glen Innes Airport: • 10 NM Minimum Sector Altitude (MSA) • 25 NM south-eastern MSA (between B-185° and B-065°) With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at 1596m (5237ft) and 1591m	Note timings

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
			(5220ft) AHD, WTG91 and WTG95 respectively will <u>currently</u> affect the following instrument procedures at Inverell Airport: 25 NM eastern MSA (between B-190° and B-035°) - GNSS Arrival Procedures - Sector A and B arrivals If approval is granted to construct WTG91 to a height of 1596m (5237ft) AHD now, the following permanent increases to procedure altitudes will be required: - Glen Innes south-eastern 25NM MSA sector: increase by 100ft to 6300ft. - Glen Innes 10NM MSA: increase by 200ft to 6300ft. - Inverell eastern 25NM MSA sector: increase by 100ft to 6300ft. - Sector A initial approach segment: increase by 100ft to 6300ft. - Sector B initial approach segment: increase by 100ft to 6300ft. The maximum height of WTG90, WTG91 and WTG95 without affecting any procedures at Glen Innes Airport or Inverell Airport is 1559.35m (5116ft) AHD. However please note: Procedures are currently being amended which will result in the White Rock Wind Farm causing no impact to airspace procedures designed by Airservices. These changes are expected to become effective on 24 May 2018. Note that procedures not designed by Airservices at Glen Innes or Inverell Airports were not considered in this assessment	

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
			COMMUNICATIONS/NAVIGATION/SURVEILLANCE (CNS) FACILITIES The proposal at the provided location the White Rock Wind Farm will not adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links	
Civil Aviation Safety Authority	26 July 2017 Email to Air Navigation, Airspace & Aerodromes Branch, CASA\Aviation Group, Matthew Windebank, Aerodrome Engineer	14 August 2017 Letter from Air Navigation, Airspace & Aerodromes Branch, CASA\Aviation Group, Matthew Windebank, Aerodrome Engineer	Thank you for your email dated 26 July 2017 requesting CASA comment with regard to the White Rock Wind Farm (MOD 6) development near Glen Innes, NSW. The proposal seeks to increase the overall height to a select number of previously assessed wind turbine sites from 150 m to 200 m and proposes to increase in the number of turbines from 70 to 118 with some of these being new locations previously unassessed. CASA considers the proposed 200 m high turbines to be a hazard to aviation safety, but the risks to aircraft safety would be mitigated by the provision of approved lighting. There remains no requirement for the turbines as previously assessed at 150 m AGL to be lit. CASA recommends that the 200 m high wind turbines be lit with steady red medium intensity lighting at night as per NASF Guideline D – Managing Wind Turbine Risk to Aircraft.	Recommend 200 m high wind turbines be lit with steady red medium intensity lighting at night. Refer to obstacle marking and lighting section.
Department of Defence Estate Planning QVe	26 July 2017 Email to DSRGIDEP.ExecutiveSupport@defence.gov.au	24 August 2017 Letter from Land Planning and Regulation, Estate	Thank you for your correspondence of 27 July 2017 referring to 100308-01 Aviation Hazard Assessment – Amendment to Approval for White Rock Wind Farm to the Department of Defence (Defence) for comment. Defence understands that the proposal is to amend the existing approval	CASA recommends turbines be lit with steady red

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
		Planning Branch, Sonya Dare, Director	for a wind farm site approximately 20 km west of Glen Innes. The proposal includes an increase in the height of the wind turbines from 150 m AGL up to 200 m AGL. Defence has conducted an assessment of the proposed changes to the approval for White Rock Wind Farm for potential impacts on the safety of military flying operations as well as possible interference to Defence communications and radar. The proposed 200 m AGL 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 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 m AGL, that are within 30 km of an aerodrome; and b. 45 m AGL elsewhere. The proposed structure 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 notes that the NASF Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers	medium intensity lighting at night. Refer to obstacle marking and lighting section. Notify ASA once the design is finalised (prior to construction) and provide “as constructed” details.

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
			recommends that where a wind turbine 150 m or taller in height is proposed away from aerodromes, the proponent should conduct an aeronautical risk assessment. It also recommends that the risk assessment be submitted to CASA to determine whether the proposal is a hazard to aircraft safety and requires approved lighting or marking. Defence supports this requirement and believes that in this instance, it would be prudent for the risk assessment for this proposal to be sent to CASA for consideration. If CASA determines that obstruction 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 lights emitted should be within the range of wavelengths 665 to 930 nanometers. The proposal has also been assessed as having no adverse impact on existing Defence communications and radar in the region.	
The Airport Group	26 July 2017 Email to TAG173, The Airport Group, Ray Romany, Chief Designer – Instrument Flight Procedures, Airspace Specialist	11 August 2017 Report from TAG173, The Airport Group, Ray Romano, Airspace Specialist, Chief Designer of Instrument Flight Procedures	Stage 2 of the WRWF increases the number of proposed wind turbine, and extends the wind farm operational area. The new WTG sites cover land which has higher elevation than Stage 1. Combined with the relatively tall WTG, the maximum heights will affect published aircraft flight paths. In order to safeguard those flight paths, it is necessary to consider the current Instrument Flight Procedures at Glen Innes and Inverell and also several routes overflying the wind farm. The scope of the changes is the 25 nm Minimum Sector Altitudes, start altitudes and descent points for the Instrument Flight Procedures and Route Lowest Safe Altitudes.	Note timings nominated by Airservices Australia

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
			At the locations provided and using wind turbine data supplied, the following are changes required to aircraft operations at the 2 aerodromes: • Aircraft manoeuvring heights in the southern sector within 25 nm of Glen Innes rise to 6300 ft; • Aircraft manoeuvring heights within 10 nm of Glen Innes rise to 6300 ft; • Holding procedures for all RNAV GNSS procedures increase to 6300 ft; • Commencement altitudes for all RNAV GNESS procedures to increase to 6300 ft; • Descent points for all RNAV GNESS procedures commence slightly earlier. • The commencement altitude for GNSS Arrival Sector B increases to 6300ft for the segment to 12 nm; • For consistency, the GNSS Arrival Sectors A and C should also commence at 6300 ft; • GNSS Arrivals decent points should be adjusted accordingly; and • There is no requirement for change to enroute Lowest Safe Altitude tracking via Glen Innes or Inverell.	

6. AVIATION IMPACT STATEMENT

6.1. Previous studies

Aviation Projects prepared an aeronautical study titled *Obstacle Lighting Risk Assessment White Rock Wind Farm* for Goldwind Australia Pty Ltd, revision 1.1 dated 03 November 2015, in support of the application for the Planning Approval of Modification Application MP 10_160 MOD 3.

The report provided the following conclusions:

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

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

The wind farm will be clear of the obstacle limitation surfaces at Glen Innes Airport and Inverell Airport.

The risk of an aircraft collision with a wind turbine, without obstacle lighting on the turbines, of White Rock Wind Farm is considered acceptable. However, GWA may consider other factors in its decision as to whether obstacle lighting should be installed.

The risk of an aircraft collision with a wind turbine, without obstacle lighting on the turbines, of White Rock Wind Farm is considered acceptable. However, GWA may consider other factors in its decision as to whether obstacle lighting should be installed.

The risk of harsh aircraft manoeuvring to avoid collision with a wind turbine leading to controlled flight into terrain, without obstacle lighting on the turbines of WRWF, is considered acceptable.

The risk of White Rock Wind Farm imposing operational limitations on aircraft operating crew, without obstacle lighting on the turbines, is considered acceptable. However, GWA may consider other factors in its decision as to whether obstacle lighting should be installed.

Visual impact from obstacle lights can be negated if they are not installed, but if obstacle lights are to be installed, they must meet Project Approval Condition C29, and can be designed so that there is an acceptable risk of visual impact to neighbours.

The following risk treatments may provide an additional margin of safety:

- *Details of the wind farm, including wind monitoring towers should be communicated to local and regional aircraft operators and arrangements to publish details in ERSAs for surrounding aerodromes prior to, during and following construction to heighten their awareness of its location and so that they can plan their operations accordingly.*
- *Although there is no obligation to do so, consideration could be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings; specifically:*
 - *8.10.2.6 Masts, poles and towers must be marked in contrasting bands with the darker colour at the top, as shown in Figure 8.10-3. The bands must be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less.*

- 8.10.2.8 Wires or cable obstacles must be marked using three-dimensional coloured objects such as spheres and pyramids, etc; of a size equivalent to a cube with 600 mm sides, spaced 30m apart.

6.2. Glen Innes Airport

Instrument procedures in use at Glen Innes Airport include RNAV (GNSS) RWY 14 and RNAV-Z (GNSS) RWY 32.

The minimum safe altitude (MSA) for Glen Innes Airport within 10 nm (18.52 km) is 1859.3 m (6100 ft) AMSL, within 25 nm (46.3 km) between 245° magnetic and 005° magnetic from the aerodrome is 1676.4 m (5500 ft) AMSL and elsewhere within 25 nm is 1889.8 m (6200 ft) AMSL. For circling procedures, circling south west of runway 10 and runway 28 is prohibited (Source: Departure/Arrival Procedures (DAP) Chart, 2 March 2017). The WRWF is located south west from Glen Innes Airport. Refer to Figure 9.

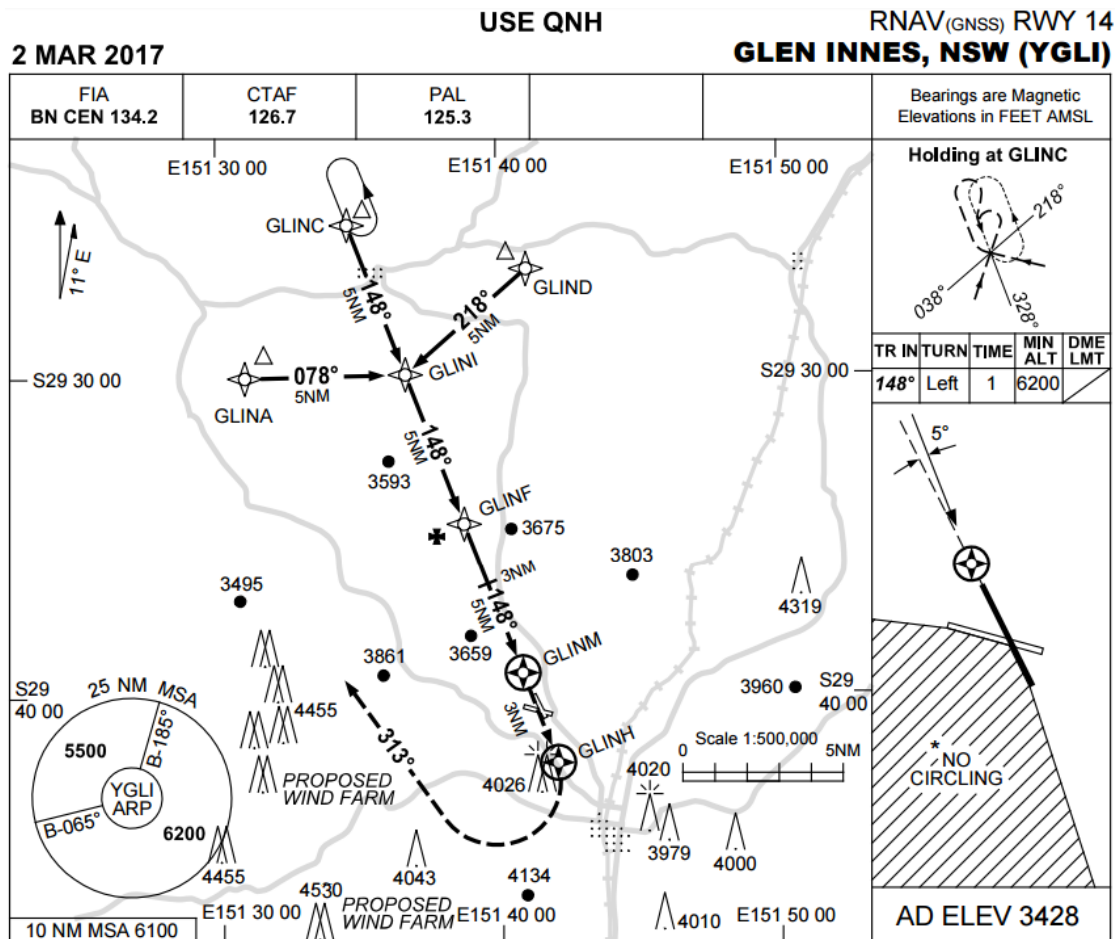


Figure 9 Glen Innes RNAV (GNSS) RWY 14 procedures

Runway 14 is an instrument, non-precision code 3 runway. According to MOS 139 Chapter 7, the critical obstacle limitation surfaces are as follows:

- Inner horizontal surface 4000 m radius – no impact from WRWF; and
- Approach and take-off surface total length – 15 000 m – no impact from WRWF.

6.3. Obstacles

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

The wind turbine with the maximum height is turbine WTG91, which is in the southern section of Stage 2 and has a ground elevation of 1396 m AHD (4580 ft AMSL).

The maximum overall blade tip height will be 1596 m AHD (5236 ft AMSL) for 200 m AGL turbines.

A map of the Project layout and showing the tallest turbine WTG91 is provided in Figure 10 (source: Goldwind and Google Earth).

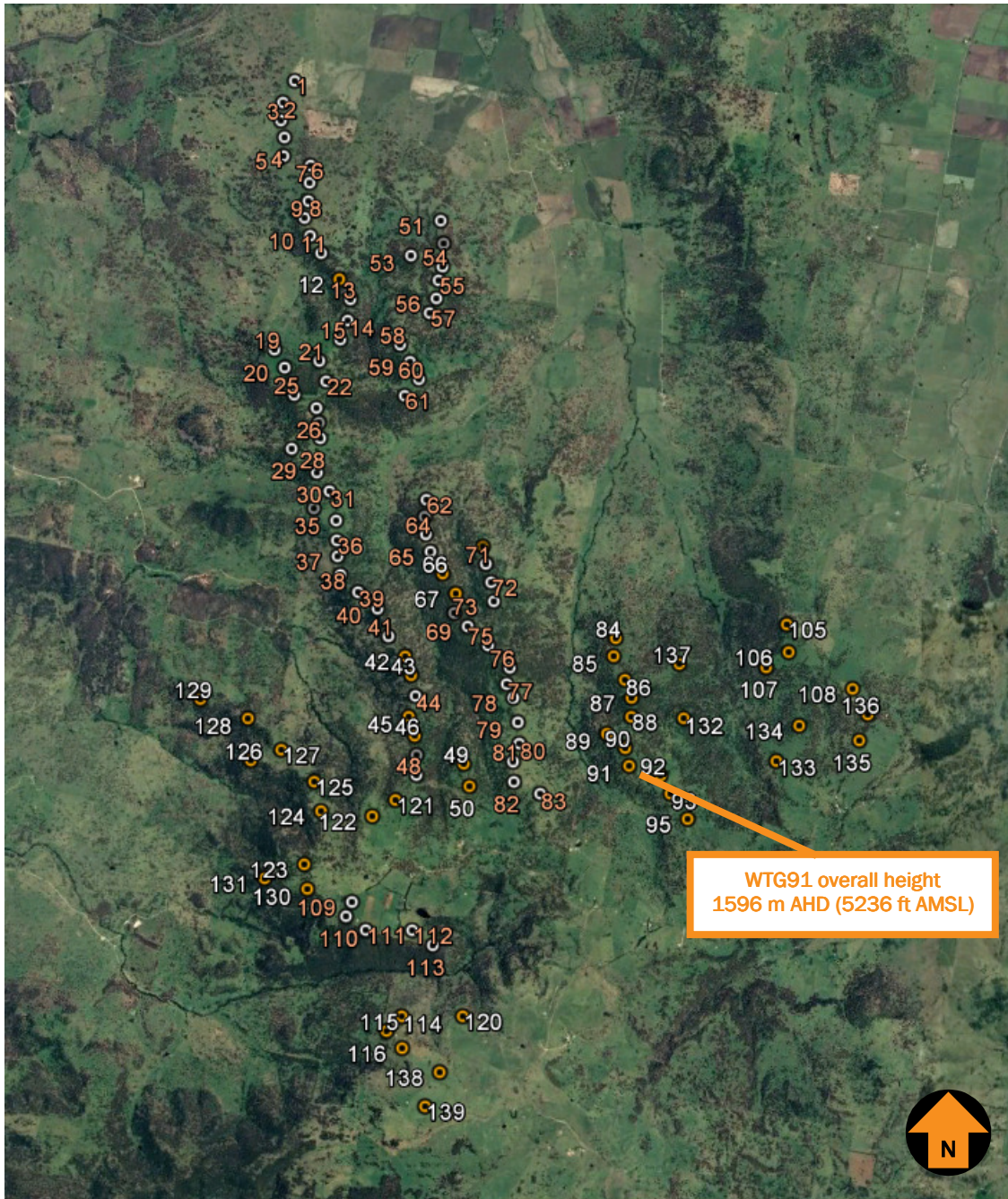


Figure 10 Highest wind turbine WTG91

6.4. Aerodromes

The location of the total 118 (Stage 1 and Stage 2) wind turbines overlaid on a 1:250 000 scale topographical base, extracted from OzRunways, dated 2 March 2017 is illustrated in Figure 11. This figure also shows the 30 nm radius from the WRWF, that shows Glen Innes Airport and Inverell Airport are within this area.

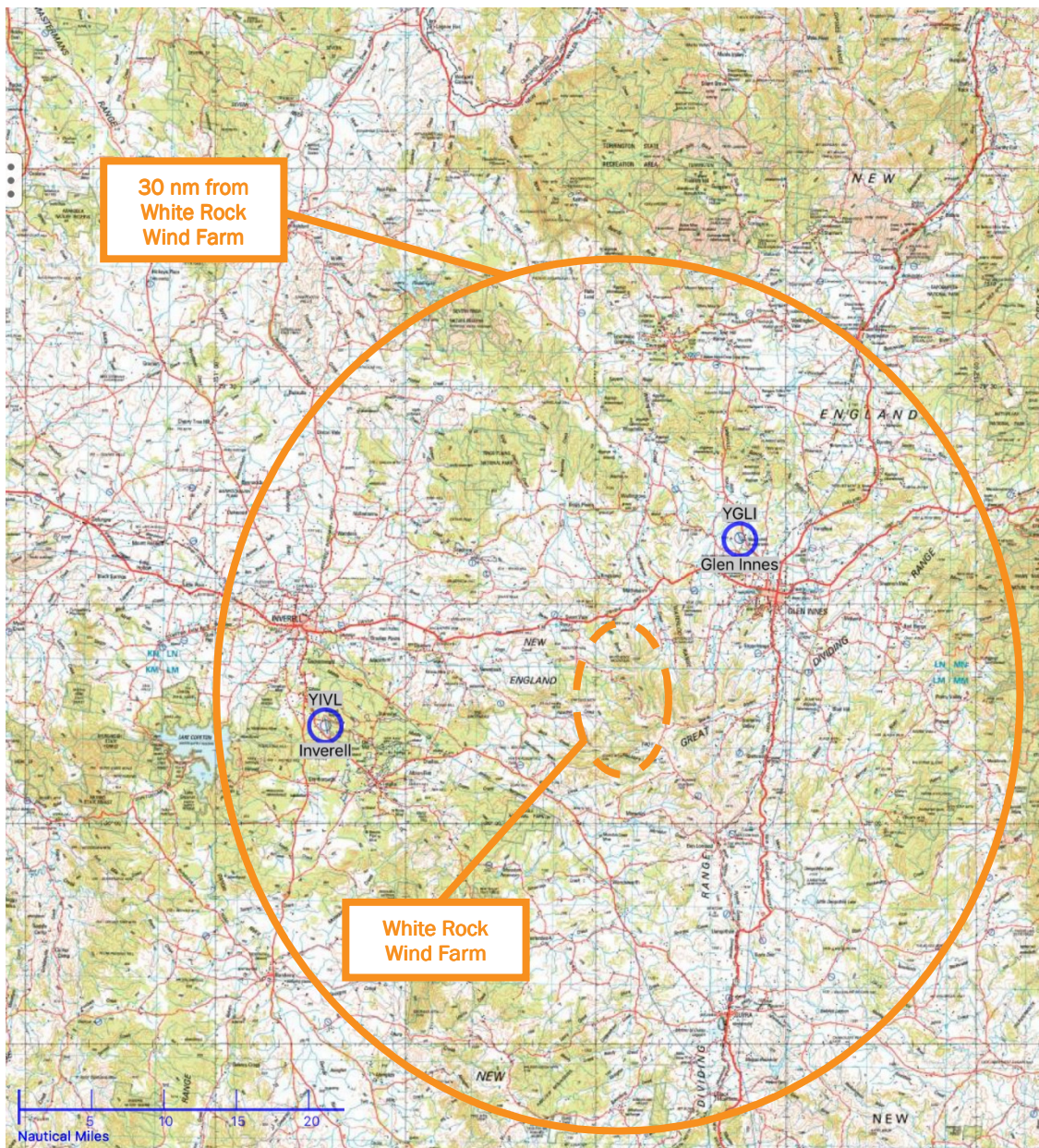


Figure 11 Topographical base 1:250 000 showing 30 nm buffer around White Rock Wind Farm

The aerodromes within 30 nm of the approved wind turbines are listed in Table 5. This table also provides the analysis of impacts on the aerodromes obstacle limitation surfaces (OLS) and procedures for air navigation services – air operations (PANS-OPS) surfaces, in the right-most column. The analysis is based on the standards provided in CASA’s documents titled *Manual of Standards (MOS) Part 139—Aerodromes* and *MOS Part 173—Standards Applicable to Instrument Flight Procedure Design*.

For the GW140 wind turbine model, WTG91 is the tallest proposed turbine at 1596 m AHD (5236 ft AMSL).

The controlling surfaces associated with nearby registered or certified aerodromes are the 25 nm MSA protective surfaces, which extend to 30 nm. 1000 ft obstacle clearance is required to be maintained below these protective surfaces. For the wind turbine model GW140, WTG91, the published MSA for both Glen Innes and Inverell Airports, the published overlaying MSA is 6200 ft AMSL. There are infringements of both MSAs, which will require further action to ensure no obstacle surface is penetrated. Refer to Table 5.

Table 5 Nearby aerodromes MOD 6 (Stage 2)

<i>Aerodrome</i>	<i>Type</i>	<i>DAPs</i>	<i>Reference</i>	<i>Stage 2 WTG Location from airport</i>	<i>OLS / PANSOPS</i>
Glen Innes YGLI Operator: Glen Innes Regional Airport Pty Ltd.	Registered Code 3 Instrument non- precision	RNAV-Z (GNSS) RWY 14 RNAV-Z (GNSS) RWY 32	WGS84 29 40 30" 151 41 22" UTM zone 56 E 371571.545 N 13283510.11	Closest turbine is proposed WTG 105 187° Magnetic 198° True 20.31 km 10.96 nm	Overlaying surfaces are the 25 nm MSA published at 5500 ft AMSL to the North and North West and the MSA of 6200 ft to the east and south. Minimum obstacle clearance of 1000 ft is not maintained as proposed WTG 91 penetrates the 6200 ft MOC by 36ft. The missed approach surface from RWY 14 overlays the farm with a 2.5% climbing surface to 6200 ft. No impact.
Inverell YINV Operator: Inverell Shire Council	Registered Code 3 Instrument non- precision	GNSS ARRIVAL NDB RWY 16 RNAV (GNSS) RWY 34	WGS84 29°53'18" 151°08'39" UTM zone 56 E 320793.227 N 13307858.45	Closest turbine is proposed WTG 129 84.5° Magnetic 73.5° True 37.48 km 20.24 nm	Overlaying surface is the 25 nm MSA published at 6200 ft AMSL. Minimum obstacle clearance of 1000 ft is not maintained as proposed WTG 91 penetrates the 6200 ft MOC by 36ft.

The minimum obstacle clearance (MOC) of 1000 ft for Inverell Airport 25 nm MSA is will be infringed by the turbines listed in Table 6.

Table 6 Turbines penetrating MOC - Inverell Airport

WTG	Overall height (m) AHD	Overall height (Feet) AMSL	MOC (feet)	Penetrates MOC (feet)
WTG91	1596	5236	5200	36
WTG95	1591	5219	5200	20

6.5. Airspace and air routes

The air routes within the vicinity of WRWF, taken from En Route Chart Low 2 (ERC L2), dated 2 March 2017 are shown in Figure 12.

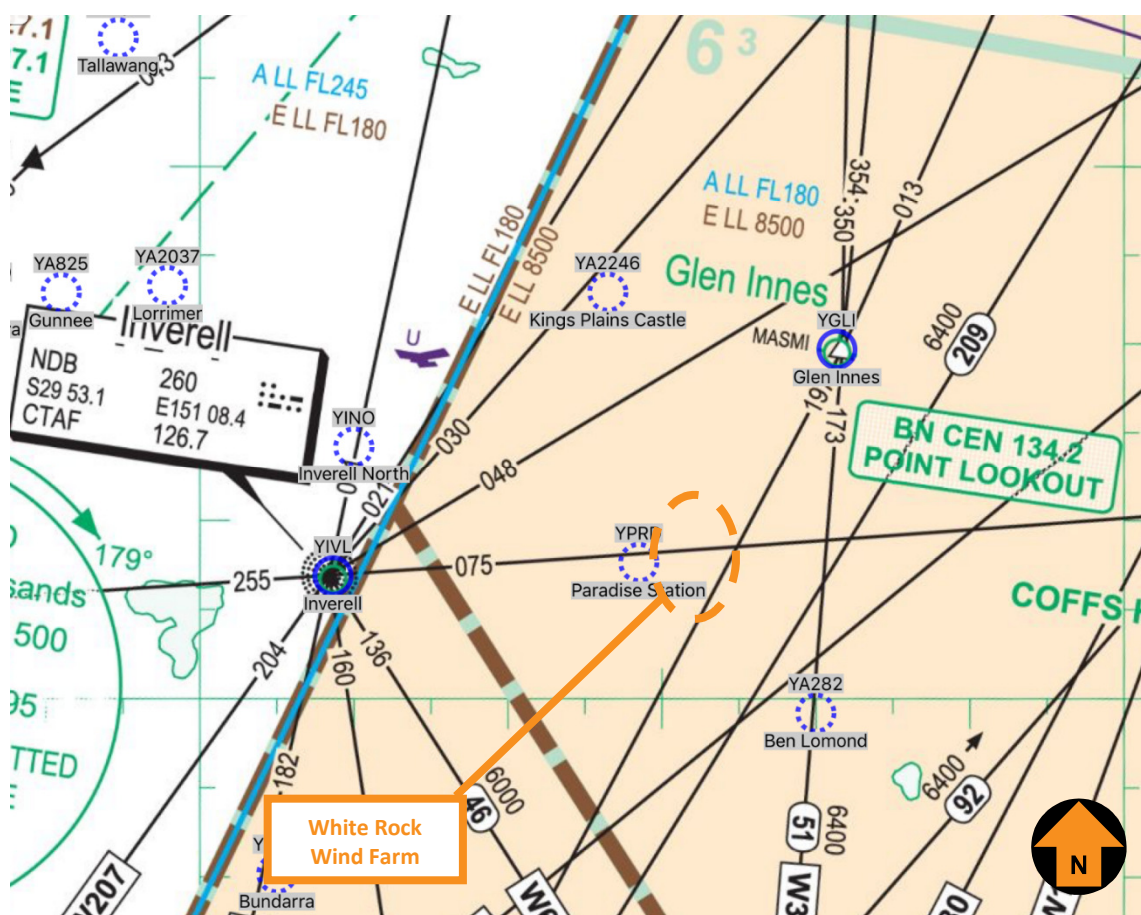


Figure 12 Air routes within the vicinity of White Rock Wind Farm

Table 7 shows the minimum Lowest Safe Altitudes (LSALTs) for air routes adjacent to the site.

Table 7 Route Numbers, Waypoints and Published LSALT

<i>Route Number</i>	<i>Waypoint Names on Route</i>	<i>Published Route Lowest Safe Altitude</i>
W598	Casino - Inverell	6400 (1950.7 m)
W326	Glen Innes – Tamworth	6300 (1920.2 m)
W347	Glen Innes – Armidale	6400 (1950.7 m)
W623	Grafton – Inverell	6400 (1950.7 m)
W760	ALDAR – Gunnedah	6400 (1950.7 m)

6.6. Air routes and grid LSALT

The proposed WTG91 will be the tallest turbine at 1596 m AHD (5236 ft AMSL).

Lowest Safe Altitudes (LSALTs) published in AIP must be clear of obstacles by 1000 ft. The project is entirely located within a grid LSALT of 6300 ft AMSL. There will be no impact on this air route LSALT.

The Project is also located beneath airway W326. This air route between Glen Innes and Tamworth has a published LSALT of 6300 ft (1920.2 m). There will be no impact on this air route LSALT.

6.7. Airspace

The Project will be situated entirely within uncontrolled, G class airspace.

The Project is not located inside designated (danger, restricted or prohibited) airspace. The project lies in Class G airspace on top of which is E class which starts at 8500 ft.

6.8. Radar

The closest Airservices Australia radar facility is Mt Somerville PSR (SSR), located approximately 5nm south west of Gold Coast Airport. This facility is approximately 363 km from WRWF and there is no impact due to intervening terrain.

6.9. Airservices Australia feedback

Consultation with Airservices Australia regarding aviation safety has been undertaken during preparation of the impact assessment. Airservices Australia response is as follows:

Due to upcoming flight validation activity by Airservices, steps are being taken to amend procedures at Glenn Innes Airport that will result in the White Rock Wind Farm not impacting Glenn Innes Airport. These changes will become effective in the Departure and Approach Procedures (DAP) issued on 24 May 2018. After this date the proposed White Rock Wind Farm will have no impact on instrument flight procedures at Glenn Innes Airport. Note that Airservices has co-ordinated this

change process with The Airport Group and their procedures at Glenn Innes Airport. Therefore, based on the above amendments proceeding for 24 May 2018, below is our assessment advice:

AIRSPACE PROCEDURES

With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at 1577m (5174ft), 1596m (5237ft) and 1591m (5220ft) AHD, WTG90, WTG91 and WTG95 respectively will currently affect the following instrument procedures at Glen Innes Airport:

- 10 NM Minimum Sector Altitude (MSA)
- 25 NM south-eastern MSA (between B-185° and B-065°)

With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at 1596m (5237ft) and 1591m (5220ft) AHD, WTG91 and WTG95 respectively will currently affect the following instrument procedures at Inverell Airport:

- 25 NM eastern MSA (between B-190° and B-035°)
- GNSS Arrival Procedures - Sector A and B arrivals

If approval is granted to construct WTG91 to a height of 1596m (5237ft) AHD now, the following permanent increases to procedure altitudes will be required:

- Glen Innes south-eastern 25NM MSA sector: increase by 100ft to 6300ft.
- Glen Innes 10NM MSA: increase by 200ft to 6300ft.
- Inverell eastern 25NM MSA sector: increase by 100ft to 6300ft.
- Sector A initial approach segment: increase by 100ft to 6300ft.
- Sector B initial approach segment: increase by 100ft to 6300ft.

The maximum height of WTG90, WTG91 and WTG95 without affecting any procedures at Glen Innes Airport or Inverell Airport is 1559.35m (5116ft) AHD.

However please note: Procedures are currently being amended which will result in the White Rock Wind Farm causing no impact to airspace procedures designed by Airservices. These changes are expected to become effective on 24 May 2018.

Note that procedures not designed by Airservices at Glen Innes or Inverell Airports were not considered in this assessment

COMMUNICATIONS/NAVIGATION/SURVEILLANCE (CNS) FACILITIES

The proposal at the provided location the White Rock Wind Farm will not adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

The Airport Group advised airspace procedures designed by TAG173 of the Airport Group will be amended which will result in the WRWF causing no impact to airspace procedures.

7. AIRCRAFT OPERATOR CHARACTERISTICS

7.1. Passenger transport operations

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

7.2. 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.

7.3. Aerial application

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

7.3.1. Aerial Agriculture Association of Australia

In previous consultation with the Aerial Agriculture Association of Australia (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, AAAAA realises that some wind farm proposals may be approved in areas where aerial application takes place. In those circumstances, AAAAA 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 also the operational stage, for pilots/aircraft operators during aircraft operations and discusses economic compensation. NASF Guideline D is included as Appendix 1, and AAAAA Aerial Application Pilots Manual – excerpts on planning are provided as Appendix II.

7.3.2. Local aerial application operators

Local aerial application operators consulted in previous studies 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 agricultural operations including such activities as fertiliser, pest and crop spraying are generally conducted under day VFR below 500 ft AGL; usually between 60 ft (18.3 m) and 100 ft (30.5 m) AGL. Local ALA owners that were consulted with have stated that, to the best of their knowledge, the aerial application operators have only operated during day light hours and that the operators have previously delayed or cancelled flying operations due to unsuitable meteorological conditions.

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

According to Enid McLeod (owner of McLeod ALA), half of her property is fertilised in one year and the other half of her property is fertilised in the following year. Each application takes approximately one day. Enid also notes that there is no other aircraft operation conducted at the ALA.

Jodie Burey (owner of Burey ALA) has stated that there are approximately seven aircraft operations per year, which include Super Air and Rural Air, which are for the purposes of fertilising. Jodie also noted that no night operations are conducted at her ALA.

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

The Aerial Agricultural Association of Australia (AAAA) has a formal risk management program which is recommended for use by its members.

Consultation with local aerial application operators has been undertaken during preparation of the impact assessment. These operators generally align their positions with the AAAAA policies.

Based on previous studies, and subject to the results of consultation with AAAAA 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 Project site and neighbouring the Project site, subject to final turbine locations, and subject to a case-by-case assessment and by following recommendations provided in this report.

To facilitate the flight planning of aerial application operators, details of the Project, including location and height information of wind turbines, wind monitoring towers and overhead powerlines should be provided to land owners so that, when asked for hazard information on their property, the land owner may provide the aerial application pilot with all relevant information.

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

7.4. Aerial fire fighting

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

Most aerial fire fighting 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.

7.5. Emergency services/air ambulance/RFDS

Air ambulance 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.

8. HAZARD LIGHTING AND MARKING

8.1. Civil Aviation Safety Authority

In considering the need for aviation hazard lighting, the applicable regulatory context was determined and direct consultation with the Civil Aviation Safety Authority was undertaken.

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.

8.1.1. Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

In areas remote from an aerodrome, CASR 139.365 requires the owner of a structure (or proponents of a structure) that will be 110 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.

8.1.2. Manual of Standards Part 139—Aerodromes

Chapter 7 of MOS 139 sets out the standards applicable to Obstacle Restriction and Limitation. Section 7.1.5 deals with Objects Outside the OLS:

7.1.5.1 Under CASR Part 139 any object which extends to a height of 110 m or more above local ground level must be notified to CASA.

Note: For instrument runways, obstacle monitoring includes the PANS-OPS surface which extends beyond the OLS of the aerodrome. See MOS 139 paragraph 7.1.1.

7.1.5.2 Any object that extends to a height of 150 m or more above local ground level must be regarded as an obstacle unless it is assessed by CASA to be otherwise.

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

Section 9.4.1 provides some general guidance on obstacle lighting:

9.4.1.2 In general, an object in the following situations would require to be provided with obstacle lighting unless CASA, in an aeronautical study, assesses it as being shielded by another lit object or that it is of no operational significance:

(b) outside the obstacle limitation surfaces of an aerodrome, if the object is or will be more than 110 m above ground level.

Section 9.4.2 provides guidance on Types of Obstacle Lighting and Their Use:

9.4.2.1 Three types of lights are used for lighting obstacles. These are low intensity, medium intensity and high intensity lights, or a combination of such lights.

9.4.2.2 Low intensity obstacle lights are steady red lights and are to be used on non-extensive objects whose height above the surrounding ground is less than 45 m.

Note: A group of trees or buildings is regarded as an extensive object.

9.4.2.3 Medium intensity obstacle lights are to be used either alone or in combination with low intensity lights, where:

- (a) the object is an extensive one;*
- (b) the top of the object is 45 m or more above the surrounding ground; or*
- (c) CASA determines that early warning to pilots of the presence of the object is desirable.*

9.4.2.4 There are three types of medium intensity obstacle lights:

- (a) Flashing white light. Likely to be unsuitable for use in environmentally sensitive locations, and near built-up areas. May be used in lieu of obstacle markings during the day to indicate temporary obstacles in the vicinity of an aerodrome, for example construction cranes, etc. and are not to be used in other applications without specific CASA agreement.*
- (b) Flashing red light, also known as a hazard beacon. Is suitable for all applications, and is extensively used to mark terrain obstacles such as high ground.*
- (c) Steady red light. May be used where there is opposition to the use of a flashing red light, for example in environmentally sensitive locations.*

9.4.2.5 High intensity obstacle lights are flashing white lights used on obstacles that are in excess of 150 m in height...

Section 9.4.3.4A provides guidance on obstacle lighting specific to wind farms:

9.4.3.4A In the case of a wind farm whose wind turbines must have obstacle lighting, medium intensity lights are to be installed as follows:

- (a) if any part of the wind turbine, including the rotating blades, penetrates the obstacle limitation surface (OLS) of an aerodrome, top lights must mark the highest point reached by the rotating blades;*

Note: Because it is not practicable to install obstacle lights at the tip of the blades, these lights may be located on a separate structure, adjacent to the wind turbine, at a height that corresponds to the highest point of the rotating blade of the turbine.

- (b) if the rotating blades do not penetrate the OLS, the top lights must be placed on top of the generator housing;*
- (c) obstacle lights must be provided on a sufficient number of individual wind turbines to indicate the general definition and extent of the wind farm, with intervals between lit turbines not exceeding 900 m;*
- (d) all of the obstacle lights on a wind farm must be synchronised to flash simultaneously;*
- (e) the downward component of obstacle lighting may be shielded to the extent mentioned in either or both of the following sub-subparagraphs:*
 - (i) so that no more than 5% of the nominal light intensity is emitted at or below 5° below horizontal;*

(ii) so that no light is emitted at or below 10° below horizontal;

(f) to prevent obstacle light shielding by the rotating blades, 2 lights must be provided on top of the generator housing in a way that allows at least 1 of the lights to be seen from every angle in azimuth.

Consultation with CASA regarding aviation hazard lighting has been undertaken during preparation of the impact assessment. CASA recommended that the 200 m high wind turbines be lit with steady red medium intensity lighting at night as per *NASF Guideline D – Managing Wind Turbine Risk to Aircraft*.

8.1.3. Advisory Circular 139-08(0)—Reporting of Tall Structures

In Advisory Circular (AC) 139-08(0)—*Reporting of Tall Structures*, CASA provides guidance to those authorities and persons involved in the planning, approval, erection, extension or dismantling of tall structures so that they may understand the vital nature of the information they provide.

The RAAF Aeronautical Information Service (AIS) (recently changed to 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 RAAF AIS (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.

As the proposed turbines will not be located within 30 km of an aerodrome (registered or certified) and will be higher than 45 m AGL, they must be reported to RAAF AIS (Airservices Australia). This action should occur once the final layout after micro-siting is confirmed and prior to construction.

8.2. International Civil Aviation Organisation

Australia, as a contracting State to the International Civil Aviation Organization (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 obstacle limitation surfaces states the following:

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

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

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

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

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

8.3. Turbine lighting layout

In the event that obstacle lighting is required, a lighting design should be prepared on the basis of the requirements set out in ICAO Annex 14 Vol 1 Chapter 6, MOS 139 Chapter 9.

Turbines to be lit are, wherever possible, located on the perimeter of the wind farm at appropriate spacing and/or are significantly higher than surrounding turbines.

In addition, the lighting layout should be based on:

- the specific configuration of the wind farm and its location in relation to surrounding facilities and features (including terrain);
- the relative elevation and proximity of each turbine in relation to others; and
- the position of turbines in relation to falling and rising terrain.

The obstacle lighting (if required) should be operated as per industry standards applicable to aviation obstacle lighting. Obstacle lighting providers may meet the applicable obstacle lighting requirements in various ways using various technology with respect to lighting characteristics and methods of mitigating visual impact. A common method in the industry is to use photoelectric cells in switching mechanisms to switch obstacle

lighting on and off based on the level of natural sun light. Additionally, synchronising the flashing of flashing obstacle lighting is commonly achieved with the use of Global Positioning System (GPS) technology.

8.4. 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.

A summary of generally accepted design characteristics (which reflects the provisions in the regulatory framework) is provided below:

- For the GW140 wind turbine model (i.e. exceeding 150 m AGL but not exceeding 315 m AGL):
 - 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
 - in addition, an intermediate level at half the nacelle height of at least three low-intensity Type E lights (i.e. red flashing) should be provided. If an aeronautical study shows that low-intensity Type E lights are not suitable, low-intensity Type A or B (i.e. red fixed) lights may be used;
- in any case, the light fixtures should be mounted sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction; and
- 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 section 9.4.6 outlines Characteristics of Low Intensity Obstacle Lights.

9.4.6.1 Low intensity obstacle lights, for general applications, are to have the following characteristics:

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

Notes:

1. *The intensity level is higher than ICAO standards because in Australia only obstacles assessed as significant to aircraft operations are required to be provided with obstacle lighting.*
2. *Currently the intensity requirement is normally met by a double-bodied light fitting which also provides a degree of redundancy.*
3. *Double-bodied light fittings should be orientated so that they show the maximum illuminated surface towards the predominant, or more critical, direction of aircraft approach.*
4. *For objects that do not infringe the obstacle limitation surfaces, and where CASA has not determined that obstacle lights are required, if the object owner wishes, of their own volition, to provide obstacle lights, it is sufficient for these low intensity obstacle lights to have the following intensity distribution: peak intensity 32 cd minimum, vertical beam spread of 10°, and 32 cd minimum at +6° and +10° elevation.*

9.4.6.2 Low intensity obstacle lights, used to indicate taxiway obstacles or unserviceable areas of the movement area, are to have a peak intensity of 10 cd minimum.

- MOS 139 section 9.4.7 outlines Characteristics of Medium Intensity Obstacle Lights.

9.4.7.1 Medium intensity obstacle lights are to be flashing or steady red lights or flashing white lights, visible in all directions in azimuth.

9.4.7.2 The frequency of flashes is to be between 20 and 60 flashes per minute.

9.4.7.3 The peak effective intensity is to be $2,000 \pm 25\%$ cd with a vertical distribution as follows:

- (a) vertical beam spread is to be 3° minimum (beam spread is defined as the angle between two directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity);
- (b) at -1° elevation, the intensity is to be 50% minimum and 75% maximum of lower tolerance value of the peak intensity; and
- (c) at 0° elevation, the intensity is to be 100% minimum of the lower tolerance value of the peak intensity.

9.4.7.4 Where the flashing white light is used in lieu of obstacle marking during the day to indicate temporary obstacles in the vicinity of an aerodrome, in accordance with Paragraph 9.4.2.4(a), the peak effective intensity is to be increased to $20,000 \pm 25\%$ cd when the background luminance is 50 cd/m² or greater.

- MOS 139 Section 9.4.10 sets out the requirements for ongoing availability of obstacle lights:

9.4.10.4 For obstacles located outside the obstacle limitation surface area of an aerodrome, the owners of the lights need to establish a program to monitor the lights and report light failures. The reporting point for obstacle light failure is normally the nearest CASA office. When an obstacle light is unserviceable, the matter needs to be reported immediately to the relevant CASA office so that a NOTAM warning pilots of the light outage can be initiated.

To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program would need to be established in accordance with this guidance.

- MOS 139 section 9.4.3.4A provides a standard, and NASF Guideline D provides guidance for obstacle lighting on a wind turbine of a wind farm, if lighting is required, to be fitted with medium intensity obstacle lighting.
- 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.

Consultation with CASA regarding aviation hazard lighting has been undertaken during preparation of the impact assessment. CASA recommended that the 200 m high wind turbines be lit with steady red medium intensity lighting at night as per *NASF Guideline D – Managing Wind Turbine Risk to Aircraft*.

If CASA determines that obstruction lighting is to be provided, consultation with Department of Defence has been undertaken during preparation of the impact assessment. Department of Defence requires lighting 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 655 to 930 nanometres.

Any subsequent correspondence received following preparation of this report will be considered by Aviation Projects and incorporated as applicable.

8.5. Visual impact of night lighting

Annex 14 Section 6.2.4 and MOS 139 9.4.3.4A 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;
- Where two lights are mounted on a nacelle, dynamic shielding or light extinction of one light at a time, for the period that a blade is passing in front of the light, is permissible, providing that at all times at least one light can be seen, without interruption, from every angle of azimuth;
- If flashing obstacle lighting is required, all obstacle lights on a wind farm should be synchronised so that they flash simultaneously; 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 conspicuity of the overall turbine.

8.6. 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 white, unless otherwise indicated by an aeronautical study.

It is generally accepted that 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.

8.7. Wind monitoring towers

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

Consideration could be given to marking any wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings; specifically:

8.10.2.1 A structure must be marked when more than 150 m higher than the surrounding terrain. Surrounding terrain means the area within 400 m of the structure. Structures above 90 m may need to be marked, and inconspicuous structures 75 m above ground level should also be marked. Fixed objects on the aerodrome movement area, such as ILS buildings, must be marked as obstacles.

8.10.2.6 Masts, poles and towers must be marked in contrasting bands with the darker colour at the top, as shown in Figure 8.10-3. The bands must be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less.

8.10.2.8 Wires or cable obstacles must be marked using three-dimensional coloured objects such as spheres and pyramids, etc; of a size equivalent to a cube with 600 mm sides, spaced 30 m apart.

NASF Guideline D suggests consideration of the following measures specific to the marking and lighting of wind monitoring towers:

- *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.*

8.8. Overhead power lines

Details of power line connections from the proposed WRWF will be provided by Goldwind prior to finalising of this report.

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

According to the AAAA Powerlines Policy dated March 2011:

Most agricultural land in Australia is crisscrossed with powerlines and aerial application companies and pilots put enormous effort into managing these hazards safely, generally using a risk identification, assessment and management process in line with Australian Standard AS4360/ISO 31000.

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

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

Once the overhead power line route is determined, it is prudent to consider potential adverse impacts on aerial application operations. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Section 8.10 Obstacle Markings; specifically:

8.10.2.8 Wires or cable obstacles must be marked using three-dimensional coloured objects such as spheres and pyramids, etc; of a size equivalent to a cube with 600 mm sides, spaced 30 m apart.

9. ACCIDENT STATISTICS

9.1. General aviation operations

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

- Aerial work. This includes flying for the purposes of agriculture (spraying and spreading), mustering, search and rescue, fire control, or survey and photography;
- Flying training; and
- Private, business and sports aviation. Sports aviation includes gliding, parachute operations, ballooning, warbird operations, and acrobatics.

9.2. 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.

9.3. National aviation occurrence statistics 2006-2015

The Australian Transport Safety Bureau recently published a summary of aviation occurrence statistics for the period 2006 to 2015 (AR-2016-122) Final, 11 January 2017.

According to the report, there were no fatalities in high capacity RPT operations, two in low capacity RPT operations and 17 in charter operations during the period 2006-2015.

Of the 360 fatalities recorded in the 10-year period, almost two thirds (231 or 64.17%) occurred in the general aviation segment. On average, there were 1.5 fatalities per aircraft associated with a fatality in this segment. Other than aerial survey and photography (2:1) and private/business (1.725:1), the fatalities to aircraft ratio ranges from 1:1 to 1.5:1. 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 8 (source: ATSB).

Table 8 Number of fatalities by GA sub-category 2006 to 2016

<i>Sub-category</i>	<i>Aircraft assoc. with fatality</i>	<i>Fatalities</i>	<i>Fatalities to aircraft ratio</i>
Agriculture	16	16	1:1
Mustering	13	14	1.08:1
Search and rescue	2	2	1:1
Fire control	3	3	1:1
Survey and photography	8	16	2:1
Other aerial work	6	9	1.5:1
Flying training	8	11	1.375:1
Private/business	80	138	1.725:1
Sport aviation (excluding gliding)	5	5	1:1
Gliding	12	16	1.33:1
Totals	153	230	1.5:1

According to the ATSB report, the number of fatal accidents per million departures for GA aircraft over the 10-year reporting period ranged between 11.3 in 2012 and 5.9 in 2014. Refer to Figure 13 (source: ATSB).

Figure 15: General aviation accident and fatal accident rate (per million departures, VH-registered aircraft only), 2006 to 2014

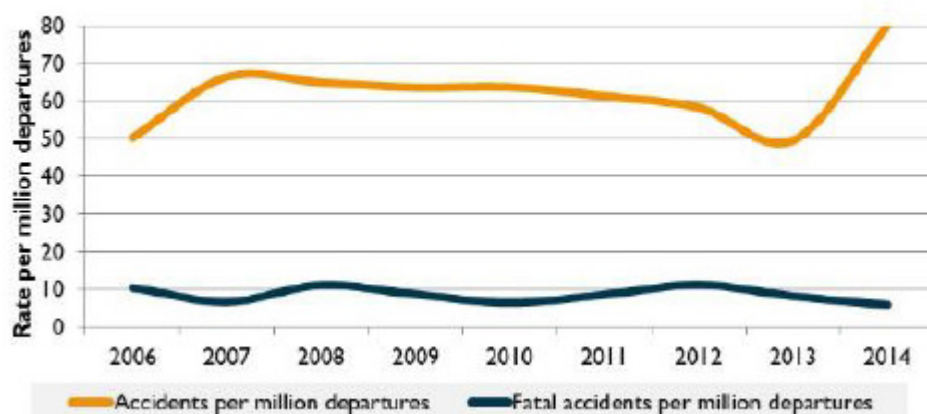


Figure 13 GA accident and fatal accident rate per million departures

In 2014, there were 11 fatal accidents and 19 fatalities involving GA aircraft, resulting in a rate of 5.9 fatal accidents per million departures and 9.3 fatal accidents per million hours flown.

In 2015, there were 1,849,000 departures, and 1,295,000 hours flown by VH-registered general aviation aircraft in Australia, with 13 fatal accidents and 15 fatalities. Based on these results, in 2015 there were 7.0 fatal accidents per million departures and 10.0 fatal accidents per million hours flown. A summary of fatal accidents in 2015 by GA sub-category is provided in Table 9 (source: ATSB).

Table 9 Fatal accidents by GA sub-category - 2015

<i>Sub-category</i>	<i>Fatal accidents</i>	<i>Fatalities</i>
Aerial work	3	3
Aerial agriculture	1	1
Aerial mustering	2	2
Search and rescue	0	0
Fire control	0	0
Survey and photography	0	0
Flying training	1	1
Private/business	5	7
Sports	1	1
Foreign registered	0	0
Totals	13	15

Over the 10-year period, there were 16,689,000 general aviation departures in Australia, during which time no aircraft collided with a wind turbine or a wind monitoring tower.

Of the 3,761 incidents and accidents in GA operations in the 10-year period, 994 (26.4%) were terrain collisions.

There is an underlying fatality rate for GA operations that is considered tolerable within Australia's regulatory and social context.

9.4. 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.

Global Wind Energy Council reports on its website there were 314,000 wind turbines operating around the world at the end of 2015.

Australia's Clean Energy Council reports on its website there were 2062 wind turbines in Australia at the end of 2015.

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, is difficult to conclude that obstacle lighting would have prevented the accident.

The other fatal accident occurred at night in 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 10.

Table 10 Summary of accidents involving collision with a wind turbine

<i>ID</i>	<i>Description</i>	<i>Date</i>	<i>Location</i>	<i>Fatalities</i>	<i>Flight rules</i>	<i>Turbine height</i>	<i>Obstacle lighting</i>	<i>Cause of accident</i>	<i>Relevant to obstacle lighting Day VFR?</i>
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	It is difficult to conclude that obstacle lighting would have prevented the accident.
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 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	Not specified	No

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting Day VFR?
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.	It is difficult to conclude that obstacle lighting would have prevented the accident.

<i>ID</i>	<i>Description</i>	<i>Date</i>	<i>Location</i>	<i>Fatalities</i>	<i>Flight rules</i>	<i>Turbine height</i>	<i>Obstacle lighting</i>	<i>Cause of accident</i>	<i>Relevant to obstacle lighting Day VFR?</i>
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	No

10. 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 has been developed in consideration of AS/NZS ISO 31000:2009 *Risk management—Principles and guidelines* and the guidance provided by CASA in its 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 Standards and Recommended Practices (SARPs), and is therefore adopted as the primary reference for aviation safety risk management in the context of the subject assessment.

Section 2.1 *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.”

10.1. Likelihood

Likelihood is defined in AS/NZS ISO 3100:2009 as the chance of something happening. Likelihood descriptors used in this report are as indicated in Table 11.

Table 11 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)

10.2. Consequence

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

Consequence descriptors used in this report are as indicated in Table 12.

Table 12 Consequence Descriptors

<i>No</i>	<i>Descriptor</i>	<i>People Safety</i>	<i>Property/Equipment</i>	<i>Effect on Crew</i>	<i>Environment</i>
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.

10.3. Risk matrix

The risk matrix, which correlates likelihood and consequence to determine a level of risk, used in this report is shown in Table 13.

Table 13 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

10.4. Actions required

Actions required according to the derived level of risk are shown in Table 14.

Table 14 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.

10.5. Risk Identification

The primary risk being assessed is that of aviation safety. Based on an extensive review of occurrence data and input from stakeholders, the significant risks that are manifested by the Project have been identified for further assessment:

- there is potential for an aircraft to collide with a wind turbine (CFIT);
- there is potential for an aircraft to collide with a wind monitoring tower (CFIT);
- there is potential for a pilot to initiate manoeuvring in order to avoid colliding with a wind turbine or monitoring tower resulting in collision with terrain; and
- there is potential for the hazards associated with the Project to invoke operational limitations or procedures on operating crew.

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.

The secondary risk being assessed is the visual impact that obstacle lights (if fitted) will have on the surrounding residents.

10.6. 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.

Each of the five risk events are considered in separate tables in the following pages.

Risk ID:	1. Aircraft collision with wind turbine
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. 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 don't individually fly a significant number of hours in total, let alone in the area in question; - There is a very small chance that a pilot, suffering the stress of weather, will continue into poor weather conditions (contrary to the rules of flight) rather than divert away from it, is not aware of the wind farm, will not consider it or will not be able to accurately navigate around it; and - If the aircraft was flown through the wind farm, there is still a very small chance that it would hit a wind turbine. Refer to the discussion of worldwide accidents at Section 9.4. There are no known aerial agriculture operations conducted at night in the vicinity of the Project. Any object that extends to a height of 150 m or more above local ground level must be regarded as an obstacle unless it is assessed by CASA to be otherwise.	
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 Project is clear of the obstacle limitation surfaces of any aerodrome. - Aircraft are restricted to a minimum height of 500 ft (152.4 m) AGL above the highest point of the terrain and any object on it within a radius of 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 200 m	

(656.2 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 47.6 m (156 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 AGL (500 ft) AGL (day) (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 RAAF AIS (Airservices Australia) so that the location and height of wind farms can be noted on aeronautical maps and charts. • Because the turbines are above 110 m AGL, there is a statutory requirement to report the towers to CASA.	
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.	
Current Level of Risk	8 - Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Proposed Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Details of the Project should be communicated to local and regional aircraft operators prior to, during and following construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically: ○ Engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the wind turbine rotor blades prior to the commencement of the subject aircraft operations within the Project area ○ Arrangements should be made to publish details of the wind farm in ERSAs 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 the Project.

However, the Proponent may consider other factors in its decision as to whether obstacle lighting should be installed.

<i>Residual Risk</i>	7 - Tolerable
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Risk ID:	2. Aircraft collision with a wind monitoring tower	
Discussion		
An aircraft collision with a wind monitoring tower (WMT) would result in harm to people and damage to property. GWA advises there are currently two wind monitoring towers in WRWF Stage 1 with heights of 90 m (295.3 ft) AGL. The current towers have orange marker balls installed on the top level guy wires. Their location and other applicable details have been advised to Airservices Australia. GWA advises WRWF Stage 2 will have an additional five WMTs (three temporary WMTs and two permanent WMTs) with heights up to 100 m (328 ft) AGL. There are a few instances of aircraft colliding with a wind monitoring tower, but they were all during the day with good visibility, and none 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 110 m AGL or more and outside the OLS of an aerodrome, CASA must be notified. Obstacle lighting may be required unless CASA, in an aeronautical study, assesses it as being shielded by another lit object or that it is of no obstacle significance. Any object that extends to a height of 150 m or more above local ground level must be regarded as an obstacle unless it is assessed by CASA to be otherwise.		
Consequence		
If an aircraft collided with a wind monitoring tower, 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 wind monitoring tower, but all were during the day with good visibility when obstacle lighting would arguably be of no effect, and none was in Australia. It is assessed that collision with a 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 (without lighting)		
- The wind monitoring towers at WRWF Stage 1 are 90 m (295.3 ft) high and WRWF Stage 2 are 100 m (328 ft) high, and do not require lighting. The location of Stage 1 WMTs and other applicable details have been advised to 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 wind monitoring towers will likely be at a maximum height of 100 m (328 ft) AGL, so there will be at least 52.4 m (172 ft) vertical separation from 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.	
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.	
Current Level of Risk	8 - Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Proposed Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: - Details of any wind monitoring towers when they are constructed should be advised to Airservices Australia. - Although there is no obligation to do so, consideration could be given to marking any wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D); specifically: 8.10.2.6 <i>Masts, poles and towers must be marked in contrasting bands with the darker colour at the top, as shown in Figure 8.10-3. The bands must be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less.</i> 8.10.2.8 <i>Wires or cable obstacles must be marked using three-dimensional coloured objects such as spheres and pyramids, etc; of a size equivalent to a cube with 600 mm sides, spaced 30 m apart.</i> - Ensure details of any additional wind monitoring towers on the Project site have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction. - It should also be noted that, when the wind turbines are constructed, the existing wind monitoring tower and any proposed tower(s) will be surrounded by wind turbines or within close proximity or wind turbines which are significantly more visible, and pilots should therefore be deterred from flying near the wind monitoring tower which will further reduce the likelihood of a collision.	

Residual Risk

With the additional recommended treatments, the likelihood of an aircraft collision with a wind monitoring tower 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, other than if the 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 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 the wind monitoring towers, without obstacle lighting on the turbines of the Project.

Residual Risk	7 - Tolerable
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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.		
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 Project is clear of the obstacle limitation surfaces of any aerodrome. • Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. • GW140 turbines will be a maximum of 200 m (656.2 ft) at the top of the blade tip, so the rotor blade at its maximum height will be approximately 47.6 m (156 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of 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 110 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
Proposed Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction. • Although there is no requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures, 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 Project area.	
Residual Risk With the additional recommended treatments, the likelihood of ground collision resulting from manoeuvring to avoid a wind turbine resulting in multiple fatalities and damage beyond repair will be Unlikely, and the consequence remains Catastrophic, resulting in an overall risk level of 7 – Tolerable. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. In the circumstances, the level of risk under the proposed treatment plan is considered as low as reasonably practicable (ALARP). It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a wind turbine, without obstacle lighting on the turbines of the Project.	
Residual Risk	7 - Tolerable

Risk ID:	4. Effect of the Project on operating crew	
Discussion		
Introduction or imposition of additional operating procedures or limitations can affect an aircraft’s operating crew.		
There are no known aerial agriculture operations conducted at night in the vicinity of the Project.		
Consequence		
The worst credible effect a wind farm could have on flight crew would be the imposition of operational limitations, and in some cases, the potential for use of emergency procedures. This would be a Minor consequence.		
Consequence		Minor
Untreated Likelihood		
The imposition of operational limitations is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.		
Untreated Likelihood		Possible
Current Treatments (without lighting)		
The Project is clear of the obstacle limitation surfaces of any aerodrome.		
Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas.		
GW140 turbines will be a maximum of 200 m (656.2 ft) at the top of the blade tip, so the rotor blade at its maximum height will be 47.6 m (156 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.		
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 110 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 Project, there is likely to be little additional safety benefit to be gained by installing obstacle lighting, other than if a WMT exceeds 150 m AGL in height and is not in relatively close proximity to a wind turbine. However, the following treatments, which can be implemented at little cost, will provide an additional margin of safety: • Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction. • Although there is no requirement to do so, the Proponent 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 Project area.	
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 Moderate. In the circumstances, the risk level of 5 is considered as low as reasonably practicable (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 turbines of the Project.	
Residual Risk	5 - Tolerable

Risk ID:	5. Effect of obstacle lighting on neighbours	
Discussion		
This scenario discusses the consequential impact of a decision to install obstacle lighting on the wind farm. Installation and operation of obstacle lighting on wind turbines or WMT can have an effect on neighbours' visual amenity and enjoyment, specifically at night and in good visibility conditions. If the wind turbines or WMT will be higher than 150 m AGL (492 ft), the wind turbines must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 110 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 WMT will be higher than 150 m AGL (492 ft), they must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 110 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. 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.		
Level of Risk		
The level of risk associated with a Likely likelihood of a Moderate consequence is 8.		

<i>Current Level of Risk</i>		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.		
<i>Risk Decision</i>		Unacceptable
Proposed Treatments Not installing obstacle lighting would completely remove the source of the impact. If lighting is required, there are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours. These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to those on the ground.		
Residual Risk Not installing obstacle lights would clearly be an acceptable outcome to those affected by visual impact. Consideration of visual impact in the lighting design should enable installation of lighting that produces an acceptable impact to neighbours, which reduces the likelihood of a Moderate consequence to Possible – the event might occur at some time in the future, resulting in a risk level of 7 – Tolerable. It is our assessment that visual impact from obstacle lights can be negated if they are not installed, but if obstacle lights are to be installed, they can be designed so that there is an acceptable risk of visual impact to neighbours.		
<i>Residual Risk</i>		7 - Tolerable

10.7. Summary of risks

A summary of the level of risk associated with the proposed WRWF Project, under the proposed treatment regime, is provided in Figure 14.

Figure 14 Summary of Risks

<i>Risk Element</i>	<i>Consequence</i>	<i>Likelihood</i>	<i>Risk</i>	<i>Actions Required</i>
Aircraft collision with wind turbine	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with monitoring tower	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings, specifically 8.10.2.6 and 8.10.2.8. Any wind monitoring towers that exceed a height of 150 m AGL should be lit with a high intensity white flashing obstacle light during the day and a low intensity steady red light at night, until such time as a wind turbine is constructed within close proximity to the WMT (nominally 900 m). Communicate details of wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes following construction.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Effect on crew	Minor	Possible	5	Acceptable without obstacle lighting (ALARP) Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights	Moderate	Likely	7	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact.

11. CONCLUSIONS

The results of this study are summarised as follows:

11.1. Project description

- There are currently permanent two wind monitoring towers in WRWF with heights of 90 m (295.3 ft) AGL. The current towers are marked with orange marker balls. Their location and other applicable details have been advised to RAAF AIS.

11.2. Regulatory requirements

- With respect to MIS 139 7.1.5.1, the proposed wind turbine and wind monitoring towers must be reported to CASA if they will be higher than 110 m AGL.
- With respect to MOS 139 7.1.5.2, the wind turbines must be regarded as an obstacle if they are higher than 150 m AGL, unless CASA assesses otherwise. Obstacle monitoring includes the PANS-OPS surface which extends beyond the OLS of the aerodrome.
- With respect to MOS 139 9.4.1.2 (b), the wind turbines will need to be lit if they will be outside the OLS and above 110 m AGL, unless an aeronautical study assesses they are of no operational significance.

11.3. Consultation

- An appropriate and justified level of consultation is being undertaken with relevant parties.

11.4. Aviation Impact Statement

- Stage 2 (MOD 6) proposes a revised wind farm layout and overall turbine height of up to 200 m AGL, the highest WTG, which is WTG91, will not exceed 1596 m AHD (5236ft AMSL) and:
 - will not penetrate any OLS surfaces;
 - WTG 91 infringes the 25 nm MSA 6200 ft minimum obstacle clearance (MOC) of 1000 ft by 36 ft and WTG95 by 20 ft (Glen Innes and Inverell Airports), which could be mitigated by reducing WTG maximum height or raising the MSA;
 - WTG 91 does not infringe the grid LSALT 6300 ft AMSL protective surface;
 - no other PANS-OPS surfaces are impacted;
 - is wholly contained within Class G airspace;
 - is not inside designated (danger, restricted or prohibited) airspace; and
 - is not inside clearance zones associated with aviation navigation aids and communication facilities.

- Airservices Australia advised procedures are currently being amended which will result in the WRWF causing no impact to airspace procedures designed by Airservices. These changes are expected to become effective on 24 May 2018.
- The Airport Group advised airspace procedures designed by LAT173 of the Airport Group will be amended which will result in the WRWF causing no impact to airspace procedures.

11.5. Aircraft operator characteristics

- There is a relatively low rate of aircraft activity in the vicinity of the wind farm site.
- There are no known aerial agriculture operations conducted at night in the vicinity of the wind farm site.
- The wind farm will be clear of the obstacle limitation surfaces at Glen Innes Airport and Inverell Airport.
- Aircraft will be required to navigate around the Project site in low cloud conditions where aircraft need to fly at 500 ft AGL.
- Although there is no requirement to do so, the Proponent 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 Project area.
- Wind turbines 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.

11.6. Hazard lighting and marking

- With respect to MOS 139 7.1.5.1, the proposed wind turbines must be reported to CASA if they will be higher than 110 m AGL. With respect to MOS 139 7.1.5.2, the GW140 model wind turbines must be regarded as obstacles since they are higher than 150 m AGL, unless CASA assesses otherwise.
- There are currently two permanent WMTs in WRWF (Stage 1) with heights of approximately 90 m (295.3 ft) AGL. The current towers are marked with orange marker balls. WRWF (Stage 2) will have up to five additional WMTs; three temporary and two permanent, with heights of 100 m AGL.
- With respect to MOS 139 9.4.1.2 (b), the wind turbines will need to be lit if they are higher than 110 m AGL, unless an aeronautical study assesses they are of no operational significance.
- **Aviation Projects assesses that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of the Project.**
- Consultation with CASA regarding aviation hazard lighting has been undertaken during preparation of the impact assessment. CASA recommended that the 200 m high wind turbines be lit with steady red medium intensity lighting at night as per *NASF Guideline D – Managing Wind Turbine Risk to Aircraft*.

- MOS 139 section 9.4.3.4A provides a standard, and NASF Guideline D provides guidance for obstacle lighting on a wind turbine of a wind farm, if lighting is required, to be fitted with medium intensity obstacle lighting.
- 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.
- If CASA determines that obstruction lighting is to be provided, Department of Defence requires lighting 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 655 to 930 nanometres.
- Although there is no obligation to do so, consideration should be given to marking any wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D). This was done for the two permanent WMT installed as part of WRWF Stage 1.
- In respect of the overhead power line route, it is prudent to consider potential adverse impacts on aerial application operations. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Section 8.10 Obstacle Markings; specifically:

8.10.2.8 Wires or cable obstacles must be marked using three-dimensional coloured objects such as spheres and pyramids, etc; of a size equivalent to a cube with 600 mm sides, spaced 30 m apart.

11.7. Risk assessment

- A summary of the level of risk associated with the proposed Modification Application (MOD 6) for WRWF Stage 2, under the proposed treatment regime is provided in Table 15.

Table 15 Risk assessment summary

<i>Risk Element</i>	<i>Consequence</i>	<i>Likelihood</i>	<i>Risk</i>	<i>Actions Required</i>
Aircraft collision with wind turbine	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with monitoring tower	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings, specifically 8.10.2.6 and 8.10.2.8. Any wind monitoring towers that exceed a height of 150 m AGL should be lit with a high intensity white flashing obstacle light during the day and a low intensity steady red light at night, until such time as a wind turbine is constructed within close proximity to the WMT (nominally 900 m). Communicate details of wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes following construction.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Effect on crew	Minor	Possible	5	Acceptable without obstacle lighting (ALARP) Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights	Moderate	Likely	7	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact.

12. RECOMMENDATIONS

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

Notification and reporting

1. 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to Airservices Australia, at vod@airservicesaustralia.com

Condition C12 of the Project Approval (MOD 4) requires:

C12 Prior to the commencement of construction and operation, the Proponent shall provide the following information to the Civil Aviation Safety Authority, Airservices Australia, Royal Australian Air Force - Aeronautical Information Services, as well as all known users of privately owned local airfields:

- (a) "as constructed" coordinates in latitude and longitude of each wind turbine generator;*
 - (b) final height of each wind turbine generator in Australian Height Datum; and*
 - (c) ground level at the base of each wind turbine generator in Australian Height Datum.*
2. Defence should be consulted if there is any subsequent modification in the wind turbine locations, height or scale of development.
3. Any obstacles above 110 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
 - a. The planned operational timeframe and maximum height of the crane; and
 - b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

Operation

4. Although not a mandatory requirement, the Proponent should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project. The Proponent may consider developing procedures such as, for example, stopping the rotation of the wind turbine rotor blades prior to the commencement of the subject aircraft operations within the Project area.

Marking of turbines

5. The rotor blades, nacelle and the supporting mast of the wind turbines should be painted white.

Lighting of turbines

6. Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.
7. The Proponent may consider other factors in its decision as to whether obstacle lights should be installed.

Marking of wind monitoring towers

8. Consideration should be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D).

Marking of overhead transmission lines and poles

9. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Section 8.10.2.8. Note that the new transmission lines that are proposed will not adversely affect aircraft operations.

Micrositing

10. Alteration to the siting of a turbine or WMTs will not be more than 100 m and micrositing will address any consequential changes to access tracks and internal power cable routes. The potential micrositing of the turbines and WMTs have been taken into account in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the nominal turbine position. The micrositing of the turbines and WMTs is likely to not result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this aviation impact assessment would remain the same.

Triggers for review

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

13. ANNEXURES

1. Turbine coordinates and heights

ANNEXURE 1 – TURBINE COORDINATES AND HEIGHTS

Source: Goldwind – 170512_WTG_Elevations – Stage 2, revised, received 3 July 2017.

<i>WTG ID</i>	<i>Easting</i>	<i>Northing</i>	<i>Longitude</i>	<i>Latitude</i>	<i>Base Elevation Metres (AHD)</i>	<i>Tip Height (m) for Wind Turbine (AGL)</i>	<i>Hub Height (m) for (200 m) Wind Turbine (AGL)</i>	<i>Rotor Clearance (m) for 200 m Wind Turbine (AHD)</i>
WTG12	360138	6702698	151.553	-29.798	1113	200	130	1313
WTG42	361251	6696961	151.564	-29.850	1200	200	130	1400
WTG43	361347	6696676	151.565	-29.853	1214	200	130	1414
WTG45	361320	6696046	151.564	-29.858	1223	200	130	1423
WTG46	361422	6695759	151.565	-29.861	1232	200	130	1432
WTG49	362185	6695344	151.573	-29.865	1314	200	130	1514
WTG50	362280	6695007	151.574	-29.868	1316	200	130	1516
WTG66	361818	6698224	151.570	-29.839	1239	200	130	1439
WTG67	362015	6697923	151.572	-29.842	1228	200	130	1428
WTG70	362413	6698645	151.576	-29.835	1202	200	130	1402
WTG84	364459	6697276	151.597	-29.848	1220	200	130	1420
WTG85	364442	6697003	151.597	-29.850	1258	200	130	1458
WTG86	364626	6696645	151.599	-29.853	1338	200	130	1538

<i>WTG ID</i>	<i>Easting</i>	<i>Northing</i>	<i>Longitude</i>	<i>Latitude</i>	<i>Base Elevation Metres (AHD)</i>	<i>Tip Height (m) for Wind Turbine (AGL)</i>	<i>Hub Height (m) for (200 m) Wind Turbine (AGL)</i>	<i>Rotor Clearance (m) for 200 m Wind Turbine (AHD)</i>
WTG87	364730	6696374	151.600	-29.856	1307	200	130	1507
WTG88	364727	6696088	151.600	-29.858	1302	200	130	1502
WTG89	364365	6695828	151.596	-29.861	1340	200	130	1540
WTG90	364655	6695615	151.599	-29.863	1377	200	130	1577
WTG91	364716	6695348	151.599	-29.865	1396	200	130	1596
WTG92	365190	6695204	151.604	-29.866	1372	200	130	1572
WTG93	365344	6694933	151.606	-29.869	1336	200	130	1536
WTG95	365618	6694558	151.609	-29.872	1391	200	130	1591
WTG105	367074	6697516	151.624	-29.846	1274	200	130	1474
WTG106	367109	6697097	151.624	-29.850	1282	200	130	1482
WTG107	366767	6696860	151.621	-29.852	1277	~~200~~	~~130~~	1477
WTG108	368091	6696553	151.634	-29.855	1288	~~200~~	~~130~~	1488
WTG114	361291	6691510	151.563	-29.899	1308	200	130	1508
WTG115	361070	6691289	151.561	-29.901	1341	200	130	1541
WTG116	361311	6691034	151.564	-29.904	1332	200	130	1532

<i>WTG ID</i>	<i>Easting</i>	<i>Northing</i>	<i>Longitude</i>	<i>Latitude</i>	<i>Base Elevation Metres (AHD)</i>	<i>Tip Height (m) for Wind Turbine (AGL)</i>	<i>Hub Height (m) for (200 m) Wind Turbine (AGL)</i>	<i>Rotor Clearance (m) for 200 m Wind Turbine (AHD)</i>
WTG120	362214	6691519	151.573	-29.899	1308	200	130	1508
WTG121	361160	6694785	151.562	-29.870	1307	200	130	1507
WTG122	360813	6694536	151.559	-29.872	1321	200	130	1521
WTG123	359796	6693798	151.548	-29.879	1338	200	130	1538
WTG124	360018	6694601	151.551	-29.871	1273	200	130	1473
WTG125	359906	6695045	151.550	-29.867	1291	200	130	1491
WTG126	358893	6695350	151.539	-29.864	1192	200	130	1392
WTG127	359366	6695518	151.544	-29.863	1192	200	130	1392
WTG128	358828	6695986	151.538	-29.859	1180	200	130	1380
WTG129	358087	6696270	151.531	-29.856	1129	200	130	1329
WTG130	359846	6693425	151.549	-29.882	1336	200	130	1536
WTG131	359180	6693573	151.542	-29.880	1314	200	130	1514
WTG132	365521	6696075	151.608	-29.859	1260	200	130	1460
WTG133	366943	6695444	151.622	-29.864	1296	200	130	1496
WTG134	367284	6695985	151.626	-29.860	1289	200	130	1489

<i>WTG ID</i>	<i>Easting</i>	<i>Northing</i>	<i>Longitude</i>	<i>Latitude</i>	<i>Base Elevation Metres (AHD)</i>	<i>Tip Height (m) for Wind Turbine (AGL)</i>	<i>Hub Height (m) for (200 m) Wind Turbine (AGL)</i>	<i>Rotor Clearance (m) for 200 m Wind Turbine (AHD)</i>
WTG135	368202	6695772	151.635	-29.862	1301	200	130	1501
WTG136	368327	6696168	151.637	-29.858	1280	200	130	1480
WTG137	365440	6696898	151.607	-29.851	1253	200	130	1453
WTG138	361893	6690681	151.569	-29.907	1346	200	130	1546
WTG139	361677	6690162	151.567	-29.911	1336	200	130	1536



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