Appendix I

Aviation Impact Assessment (Aviation Projects)

JULY 2018

AVIATION IMPACT ASSESSMENT – MOD 4

FLYERS CREEK WIND FARM

Prepared for Flyers Creek Wind Farm Pty Ltd

AVIATION PROJECTS

DOCUMENT CONTROL

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ACRONYMS

AAAA	Aerial Agricultural Association of Australia
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
FCWFPL	Flyers Creek Wind Farm Pty Ltd
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions
MOC	minimum obstacle clearance
MOS	Manual of Standards
MSA	minimum sector altitude
OLS	obstacle limitation surface
FCWF	Flyers Creek Wind Farm
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

Flyers Creek Wind Farm Pty Ltd (FCWFPL) is preparing a modification application (Mod 4) which includes a proposal to increase the tip height at Flyers Creek Wind Farm (FCWF) by 10 m from 150 m to 160 m (525 ft) above ground level (AGL). This also includes changes in rotor diameter and hub height.

Initial project approval for the development application No. MP 08_0252 from the Minister of Planning and Infrastructure NSW was granted on 14 March 2014 and has been subject of three modifications:

- Mod 1 – 13 March 2015;
- Mod 2 – 14 September 2015; and
- Mod 3 – 30 November 2017.

The existing project approval is for up to 38 wind turbine generators (WTGs) at 150 m height and all associated infrastructure (including wind monitoring towers (WMT)) to be developed over the project area. There are two WMTs currently installed on site and existing approval for 3 WMTs.

The FCWF project area is situated within the locality of Forest Reefs, approximately 24 km (13 nm) south of the town of Orange, 15 km (8 nm) south of Orange Airport, 53 km (28.5 nm) south west of Bathurst Airport and 46 km (25 nm) north east of Cowra Airport in the Central Tablelands region of New South Wales.

Flyers Creek Wind Farm Pty Ltd engaged Aviation Projects to prepare an Aviation Impact Assessment for the modification 4 application.

The Aviation Impact Assessment will review potential impacts of proposed Modification 4 to the FCWF 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 proposed FCWF will comprise of the following:
    - up to 38 WTGs, which will be higher than 150 m above ground level (AGL);
    - maximum overall height (tip height) of the WTG is 160 m (525 ft) AGL with the final height built for each turbine being comprised of the hub height and blade length where the:
        - maximum hub height of the WTG is 92 m AGL; and
        - maximum WTG rotor blade length is 70 m.
    - highest WTG is WTG20 with ground elevation of 954 m Australian Height Datum (AHD) and overall height of 1114 m AHD (3655 ft) ft above mean sea level (AMSL).

Conclusions

- The proposed increase in the maximum turbine envelope proposed as part of Modification 4 does not increase the potential impact to aviation from that previously assessed for the Project.

Regulatory requirements

- There is no regulatory requirement for lighting of obstacles lower than 150 m AGL (492 ft AMSL) and that are not within the vicinity of an aerodrome.
- With respect to MOS 139 7.1.5.1, the proposed WTGs and WMTs must be reported to CASA if they will be higher than 110 m AGL.
- With respect to MOS 139 7.1.5.2, the WTGs or WMTs 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 WTGs or WMTs 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.
- **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**. Section 10– Risk Assessment of the aeronautical impact assessment concluded no lights were not required for wind turbines or wind monitoring towers.

Consultation

- The following parties were consulted about the proposed planning modification:
    - Aerial Agricultural Association of Australia;
    - Airservices Australia;
    - Department of Defence;
    - Fred Fahey Aerial Services; and
    - Orange City Council.

Aviation Impact Statement

- Based on the proposed FCWF layout and overall WTG overall blade tip height limit of 160 m AGL, the blade tip elevation of the highest WTG, which is WTG20, will not exceed 1114 m AHD (3655 ft) and:
    - will not penetrate any OLS surfaces;
    - will not penetrate PANS-OPS surfaces;
    - will not impact on nearby designated air routes;
    - will not have an impact on prescribed airspace;
    - is contained within Class G airspace; and

- is outside the clearance zones associated with aviation navigation aids and communication facilities.

- With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1114m (3655ft) AHD the wind farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Orange, Cowra or Bathurst Airport, any air route lowest safe altitude (LSALT) and will not adversely impact the performance of Precision/Non-Precision Nav Aids, HF/VHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

Aircraft operator characteristics

- Aircraft will be required to navigate around the proposed FCWF 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 for their safe operation within the Project area.

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

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

- Aerial fire fighting: There are no known aerial agriculture operations conducted at night in the vicinity of the wind farm site. Any fire-fighting activities in the vicinity of the proposed wind farm by either fixed or rotary wing aircraft would need to be conducted in consideration of the location of the wind turbines and monitoring masts. To this end it is important that the location of the wind turbines and monitoring masts are made available to fire-fighting agencies and aerial agriculture operators.

  Notwithstanding that aerial fire-fighting operations will potentially be restricted in the vicinity of the proposed wind farm, there is still a valid (ground-based) means of fighting bushfires on and near the properties on which the wind farm is proposed to be located.

  The Country Fire Authority Emergency Management Guidelines for Wind Energy Facilities includes a section on planning, design and development of wind energy facilities and section 2(2.3) stated:

  > *Wind turbines should be located approximately 300 metres apart. This provides adequate distance for aircraft to operate around a Wind Energy Facility given the appropriate weather and terrain conditions. Fire suppression aircraft operate under "Visual Flight Rules". As such, fire suppression aircraft only operate in areas where there is no smoke and during daylight hours. Wind turbines, similar to high voltage transmission lines, are part of the landscape and would be considered in the incident action plan.*

- Aerial agricultural operators: The proposed wind farm will most likely prevent fixed wing aerial agricultural operations on the wind farm site, whilst the viability of conducting these operations on properties adjacent to the wind farm would have to be assessed on an individual basis.

  It is reasonable to conclude that safe aerial application operations would be possible on properties neighbouring the proposed wind farm with some operational or cost impacts, subject to final microsited turbine locations, and subject to a case by case assessment.

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.

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 110 m AGL. With respect to MOS 139 7.1.5.2, the proposed 160 m wind turbine overall blade tip height must be regarded as obstacles since they are higher than 150 m AGL.
- There are two existing WMTs at a height of 82 m (269 ft), which have been reported to Airservices Australia.
- With respect to MOS 139 9.4.1.2 (b), the wind turbines and WMTs will need to be lit if they are higher than 110 m AGL, unless an aeronautical study assesses they are of no operational significance.
- CASA has advised that it will only review assessments referred to it by a planning authority or agency.
- **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.**
- If obstacle lighting is required by the assessment manager, installed lights should be designed according to criteria set out in the applicable regulatory material.
- 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 Department of Defence regarding lighting has been undertaken during the preparation of the aviation impact assessment. Department of Defence has reviewed the requirement for lighting and has determined that lighting will not be required. If LED lighting is proposed, Department of Defence requests that the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometers, so that the WTGs are visible to pilots using night vision goggles.

  If wind monitoring towers are constructed as part of the proposal, Defence notes that the National Airports Safeguarding Framework Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers - Paragraph 39 recommends the top 1/3 of wind monitoring towers are painted in alternating contrasting bands of colour in accordance with the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998.
- 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).
- With respect to power line route determination (refer to Section 4.3), 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.

- The transmission line and switching station proposed as part of Modification 4 will not adversely affect aircraft operations.

Conditions of approval

- Conditions of approval D11, D12, D13, D22 and D25 were identified as being relevant to the assessment contained herein.
- In relation to Condition D11 (a), correspondence sent from Orange City Council to FCWFPL advised that there would be no impact on current or future obstacle limitation surfaces of Orange Airport.
- In relation to Condition D11 (b), redesign of the NDB approach at Orange Airport is not required, since the NDB has been decommissioned, and Airservices Australia has advised that there will be no impacts on instrument approach procedures at aerodromes, navigational aids, communications and surveillance facilities.
- In relation to Condition D12, during recent consultation, RAAF AIS advised that all future correspondence should be directed through Airservices Australia. Accordingly, the requirement to notify Royal Australian Air Force – Aeronautical Information Services should be removed from this condition..
- The remainder of Conditions D11, D12, D13, D22 and D25 remain appropriate to managing potential aviation impacts.

Risk Assessment

- A summary of the level of risk associated with the proposed FCWF, under the proposed treatment regime, is provided in Table E1.

Table E1 Risk assessment summary

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
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 En Route Supplement Australia (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 any new 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. 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

If the recommendations set out below are implemented, the Project will not adversely affect the safety, operational integrity and efficiency of air services.

Notification and reporting

1. 'As constructed' details of wind turbine coordinates and elevations should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
2. 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.
3. Details of the wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations. Specifically, details should be provided to the NSW/ACT Regional Airspace and Procedures Advisory Committee for consideration by its members in relation to VFR transit routes in the vicinity of the wind farm.

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.

Marking of turbines

5. The rotor blades, nacelle and the supporting mast of the wind turbines should be painted white, typical of most wind turbines operational in Australia.

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. If obstacle lighting was required by the assessment manager, the lighting should have the following characteristics:
    a. Obstacle lighting should be designed in accordance with the characteristics specified in ICAO Annex 14 Vol 1 Chapter 6 (note that Section 6.2.4 addresses obstacle marking and lighting of wind turbines) and MOS 139 Chapter 9 (note that Section 9.4.3.4A addresses obstacle lighting for a wind farm), while minimising visual impact;
    b. Department of Defence determined that lighting will not be required. If LED lighting is proposed, the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometers, for night vision devices compatibility; and

c. To ensure the ongoing operation and availability of obstacle lights (if required) at night and during times of reduced visibility, a monitoring, reporting and maintenance program should be established in accordance with the guidance in MOS 139 Section 9.4.10.

8. Any decision to require or to not require lighting remains with the planning authority to determine.

Marking of wind monitoring towers

9. Consideration should be given to marking any new WMTs according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D). Refer to Section 8.6 and 0 for the detailed description of the marking requirements.

Marking of overhead transmission lines and poles

10. 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.

Micrositing

11. Alteration to the siting of a turbine 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 has 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 is not likely to result in a change in the maximum overall AGL 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.

1. INTRODUCTION

1.1. Situation

Flyers Creek Wind Farm Pty Ltd (FCWFPL) is preparing a modification application (Mod 4) which includes a proposal to increase the tip height at Flyers Creek Wind Farm (FCWF) by 10 m from 150 m to 160 m (525 ft) above ground level (AGL). This also includes changes in rotor diameter and hub height.

Initial project approval for the development application No. MP 08_0252 from the Minister of Planning and Infrastructure NSW was granted on 14 March 2014 and has been subject of three modifications:

- Mod 1 – 13 March 2015;
- Mod 2 – 14 September 2015; and
- Mod 3 – 30 November 2017.

The existing project approval is for up to 38 wind turbine generators (WTGs) at 150 m height and all associated infrastructure (including wind monitoring towers (WMT)) to be developed over the project area. There are two existing WMTs on site.

Conditions of approval relevant to this assessment are copied below:

> *Aviation Obstacles and Hazards*
>
> *D11.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, inclusive of the redesign of the Non-Directional Beacon Approach (if required);*
> >
> > *(c) Aerial Agriculture Association Australia, to determine potential hazards to aerial application and related operations; and*
> >
> > *(d) Rural Fire Service, to determine potential hazards to the aerial fighting of fires. Feasible and reasonable mitigation measures for each of the potential impacts and hazards identified, shall be determined in consultation with the respective groups identified in this condition, prior to the commencement of construction.*
>
> *D12.Prior to the commencement of construction, the Proponent shall provide the following information to the Civil Aviation Safety Authority, Airservices Australia, Royal Australian Air Force - Aeronautical Information Services, the Aerial Agricultural Association of Australia, Rural Fire Service as well as all known users of privately owned local airfields:*
>
> > *(a) 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.*

D13.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.

Visual Appearance

D22. The Proponent must:

(a) minimise the off-site visual impacts of the development;

(b) ensure the wind turbines are:

- *painted off white/grey, unless otherwise agreed by the Secretary; and*
- *finished with a surface treatment that minimises the potential for glare and reflection;*

(c) ensure the visual appearance of all ancillary infrastructure (including paint colours) blends in as far as possible with the surrounding landscape; and

(d) not mount any advertising signs or logos on wind turbines or ancillary infrastructure.

Night Lighting

D25.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 Proponent 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 receivers as far as feasible and reasonable.

The FCWF project area is situated within the locality of Forest Reefs, approximately 24 km (13 nm) south of the town of Orange, 15 km (8 nm) south of Orange Airport, 53 km (28.5 nm) south west of Bathurst Airport and 46 km (25 nm) north east of Cowra Airport in the Central Tablelands region of New South Wales.

The FCWF project area is approximately 14 km (7.5 nm) from the northern extent to the southern extent, and approximately 10 km (5.5 nm) from the eastern extent to the western extent.

Flyers Creek Wind Farm Pty Ltd engaged Aviation Projects to prepare an Aviation Impact Assessment for the modification 4 application.

The Aviation Impact Assessment will review potential impacts of proposed Modification 4 to the FCWF on aviation safety in respect of relevant requirements of air safety regulations and procedures and in respect of consultation with relevant regulators.

1.2. Purpose and Scope

This Aviation Impact Assessment has been prepared to assess the impacts of Proposed Modification 4 to support a modification application proposed to be made under section 4.55 of the Environmental Planning & Assessment Act 1979.

1.3. Methodology

In undertaking this task, Aviation Projects:

1. confirmed the scope and deliverables with Flyers Creek Wind Farm Pty Ltd;
2. reviewed client material;
3. reviewed relevant regulatory requirements and information sources;
4. conducted a site visit to properly investigate aviation safety aspects and identifying existing tall structures within or adjacent to the proposed FCWF project area;
5. prepared a First Draft Aviation Impact Assessment (including Aviation Impact Statement, qualitative risk assessment to determine the need of obstacle lighting and specifications (if obstacle lighting is required)) for client review and consideration by applicable stakeholders;
6. completed the risk assessment following the guidelines in Risk management—Guidelines AS/NZS ISO 31000:2018;
7. consulted with relevant stakeholders, including Airservices Australia, Department of Defence, state and local government authorities, aerodrome operators, aircraft operators, Aerial Agriculture Association of Australia and land owners/leaseholders. Included preparation of correspondence, telephone consultation as applicable and consolidation of responses;
8. finalised the assessment report for client acceptance when responses from relevant stakeholders were received; and
9. finalised the assessment for submission.

1.4. Aviation Impact Statement

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

Aerodromes:

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

Air Routes:

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

Airspace:

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

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

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;
- Accident statistics;
- Risk assessment;
- Conclusions; and
- Recommendations.

1.6. Stakeholders

The following parties were consulted about the proposed planning modification:

- Aerial Agricultural Association of Australia;
- Airservices Australia;
- Department of Defence;
- Fred Fahey Aerial Services; and
- Orange City Council.

Aviation Projects also considered the needs of the following parties:

- aircraft operators;
- Civil Aviation Safety Authority;
- operators of non-regulated aerodromes within the vicinity of the Project; and
- other stakeholders where noted.

1.7. Material reviewed

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

- FCWF consolidated project approval (30 November 2017), including project layout and turbine locations;
- Original Environmental Assessment Safety Chapter, May 2011 (including aviation assessment); and
- Consultation correspondence with:
    - AAAA;
    - Airservices Australia;
    - CASA;
    - Orange Airport; and
    - Royal Australian Air Force.

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 1 March 2018;
- Airservices Australia, *Designated Airspace Handbook*, effective 9 November 2017;
- Aircraft Owners and Pilots Association of Australia (AOPA), *National Airfield Directory 2012*, 15th ed;
- AS/NZS ISO 31000:2018 Risk management—Guidelines, Standards Australia;
- Bureau of Meteorology, NSW/ACT Radar Sites Table and information, http://www.bom.gov.au/australia/radar/nsw_radar_sites_table.shtml
- 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), as amended;
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 92-1(1): Guidelines for aeroplane landing areas, dated July 1992;
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 166-1 v4.1 Operations in the vicinity of non-controlled aerodromes, dated April 2017;

- Civil Aviation Safety Authority, *Manual of Standards Part 139 – Aerodromes*, version 1.14: dated January 2017;
- Civil Aviation Safety Authority, Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design, version 1.5, dated March 2016;
- Civil Aviation Safety Authority, Advisory Circular (AC) 139-8 (v2.0): Reporting of Tall Structures, dated March 2018;
- Department of Planning and Environment, NSW Government, *NSW Wind Farm Guideline for State significant wind energy development*, December 2016;
- Department of Planning and Environment, NSW State Government, Wind Energy: Visual Assessment Bulletin – For State significant wind energy development, December 2016;
- Department of Infrastructure and Regional Development, Australian Government, *National Airport Safeguarding Framework, Guideline D Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*, dated June 2013;
- EUROCONTROL, European Organisation for the safety of air navigation, *EUROCONTROL Guidelines, How to assess the potential impact of wind turbines surveillance sensors*, edition 1.2, ISBN: 978-2-87497-043-6, Reference number: EUROCONTROL-GUID-130, September 2014;
- International Civil Aviation Organization (ICAO), Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS);
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes;
- NSW Government, NSW Legislation, Blayney Shire Council Local Environment Plan 2012, May 2018;
- NSW Government, NSW Legislation, Cowra Council Local Environment Plan 2012, No. 22, January 2013;
- NSW Government, NSW Legislation, Orange Local Environmental Plan 2011, April 2018;
- OzRunways, aeronautical navigation charts (WAC and ERC) extracts, dated 26 April 2018; and
- other references as noted.

1.9. Triggers for review

Triggers for review of this risk assessment are noted below:

- following any significant changes to the context in which the assessment was prepared, including the regulatory framework; and
- following any near miss, incident or accident associated with operations considered in this risk assessment.

2. BACKGROUND

2.1. Background

An overview of the FCWF layout and site area, along Beneree Flyers Creek and Burnt Yards Errowanbang Roads, and between Carcoar Errowanbang Road and Gap Road within the local government area of Blayney Shire Council, NSW, is shown in Figure 1 (Source: FCWFPL, Google Earth, 2018).

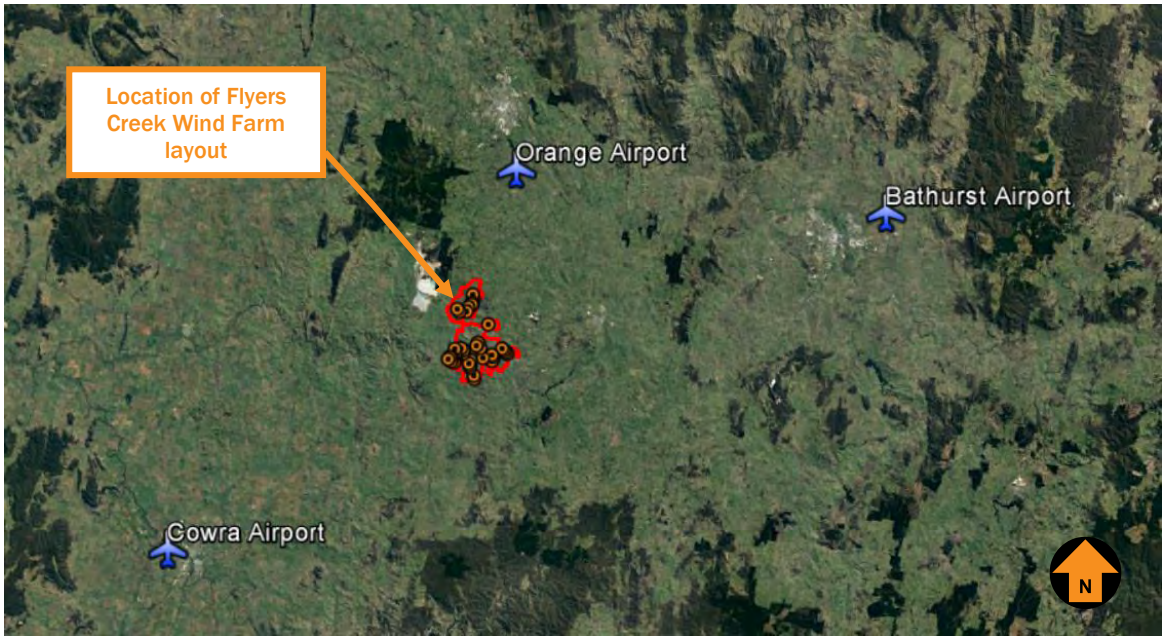

Figure 1 Flyers Creek Wind Farm layout

3. EXTERNAL CONTEXT

3.1. 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 Airservices Australia's database*
- *consultation with local agricultural pilots and nearby unlicensed airstrip owners*
- *consultation with CASA and Airservices*
- *consultation with the Department of Defence.*

3.2. Aircraft operations at non-controlled aerodromes

Civil Aviation Advisory Publications (CAAP) provide guidance, interpretation and explanation on complying with the Civil Aviation Regulations 1988 (CAR) or Civil Aviation Orders (CAO). CAAP 166-1(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) paragraph 3.4 states the following:

> *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).*

The standard circuit consists of a series of flight paths known as *legs* when departing, arrival or when conducting circuit practice. Illustrations of the standard aerodrome traffic circuit procedures are provided in Figure 2 and Figure 3.

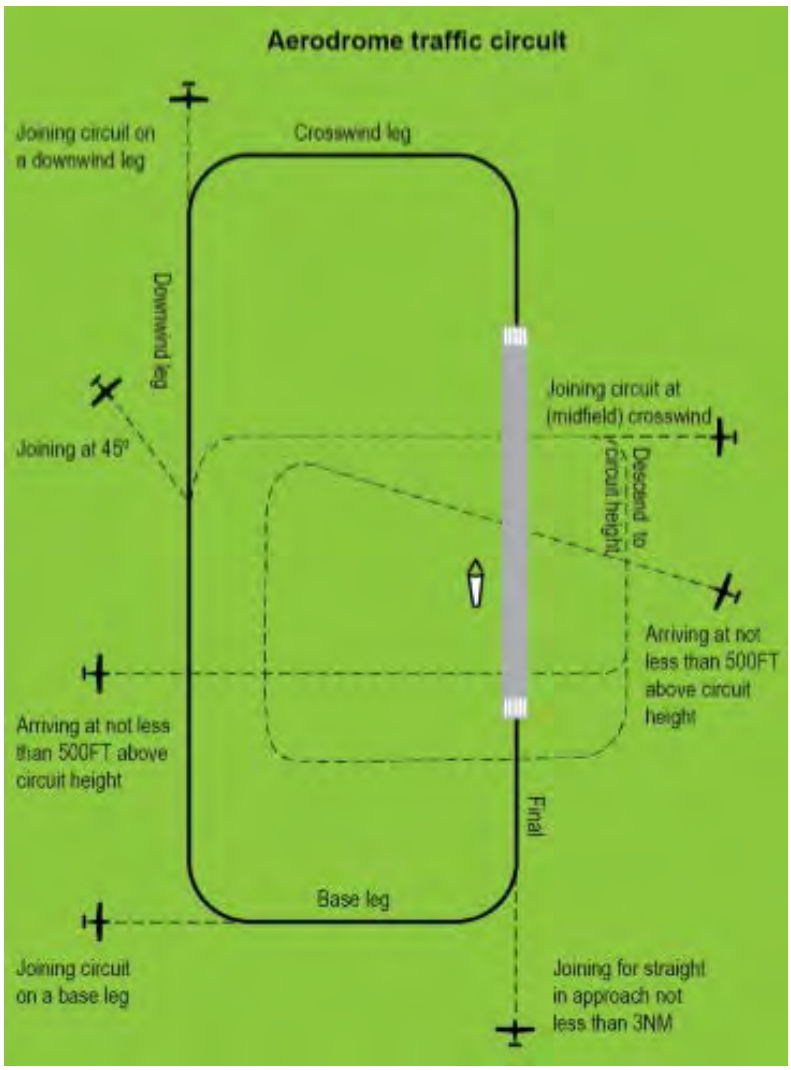

Figure 2 Aerodrome standard traffic circuit, showing arrival and joining procedures

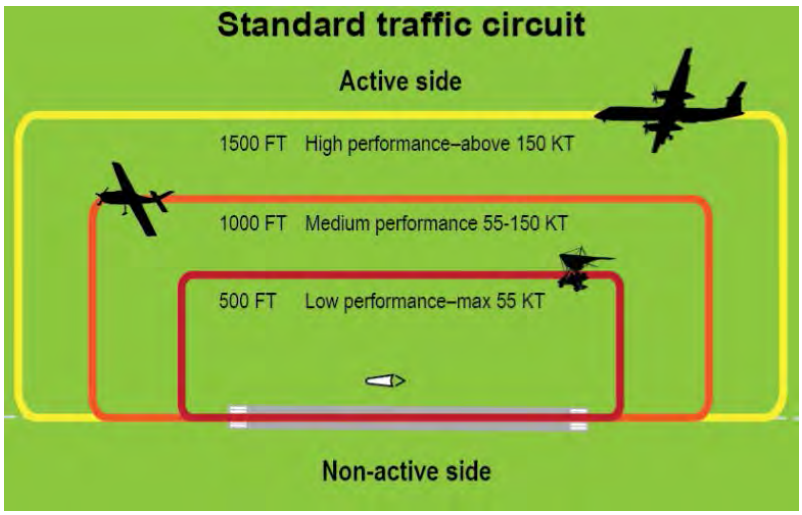

Figure 3 Lateral and vertical separation in the standard aerodrome traffic circuit

CAAP 166-1(3) paragraph 6.4.1 makes reference to a distance that is "normally" well outside the circuit area and where no traffic conflict exists, which is at least 3 nm (5556 m). The paragraph is copied below:

> *6.4 Departing the circuit area*
>
> *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.*

3.3. Rules of flight

3.3.1. 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.

3.3.2. 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.*

3.3.3. 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.

3.4. Aircraft operator characteristics

3.4.1. Passenger transport operations

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

3.4.2. 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.

3.4.3. 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.

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

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.

3.4.4. 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.

3.4.5. Emergency services/RFDS

Aeromedical 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.

4. INTERNAL CONTEXT

4.1. Wind turbine description

The maximum blade tip height of the wind turbines proposed in Modification 4 will be up to 160 m above ground level (AGL). The maximum ground elevation for the proposed WTG20 wind turbine is 954 m AHD, equating to a maximum overall height of 1114 m AHD (3655ft AMSL).

Figure 4 provides the approved FCWF turbine locations and highlights WTG 20 having the greatest elevation (source: Google Earth, 2018).

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

The approved coordinates and approximate ground elevations of the Project wind turbines are listed at **Annexure 1.**

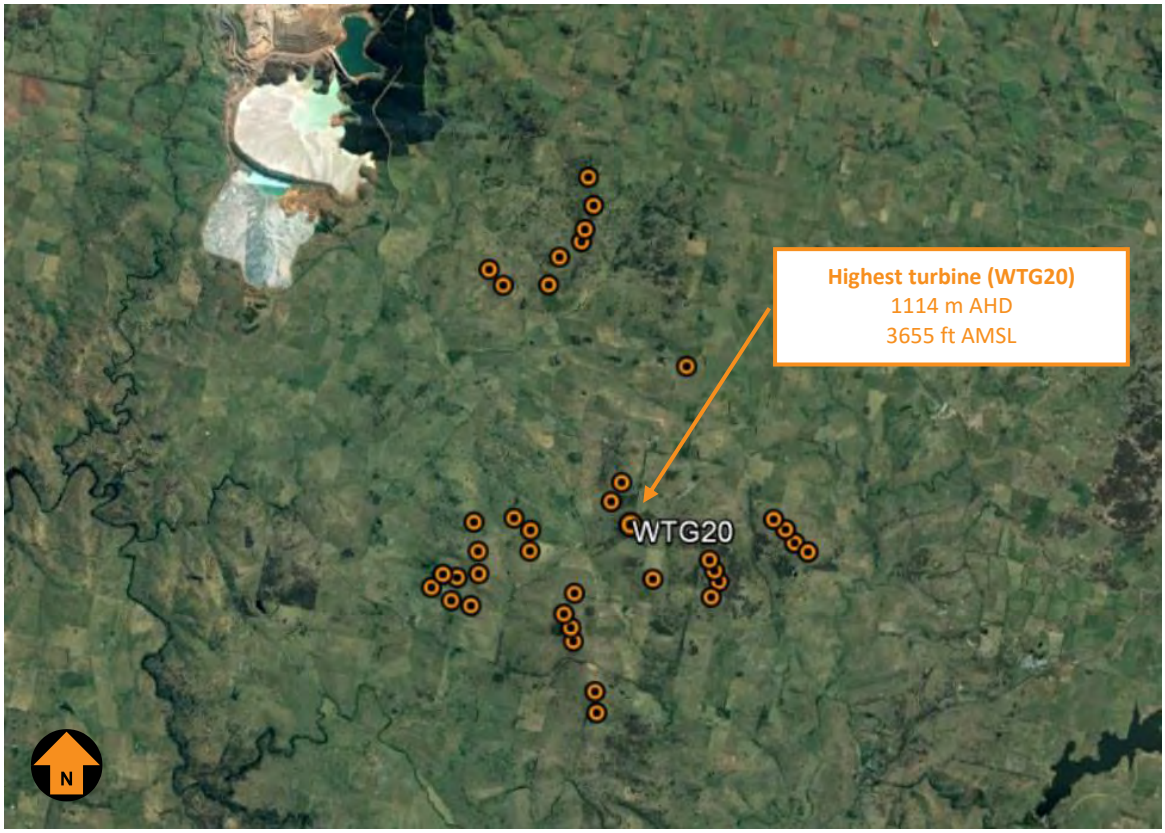

Figure 4 Approved wind turbines layout and highest wind turbine

The wind farm is situated in an area comprised mainly of farming properties on high terrain. Figure 5 shows a view looking east from Burnt Yards Errowanbang Road towards the proposed FCWF site.

Figure 5 Burnt Yards Errowanbang Road looking east at the proposed Flyers Creek Wind Farm site

Figure 6 is taken from Carcoar Errowanbang Road looking north-west to the proposed FCWF site area approximately 3 km north of Mid Western Highway.

Figure 6 A view from Carcoar Errowanbang Road

4.2. Wind monitoring tower description

There are two existing wind monitoring towers (WMTs) installed at the site and existing approval for three WMT's. WMT 1 is located east of WTG 3 and WMT 2 is located between WTG 34 and WTG 35.

FCWFPL is planning to retain the WMTs until construction commences at which point they would either remain or be relocated on the site and may remain throughout the operational phase of the wind farm. The height of WMTs is currently 82 m (269 ft) AGL, however any new met masts which are installed would be up to 92m to correspond to the hub height of the turbines proposed in modification 4.

All future proposed WMTs are subject to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D).

4.3. Power routes grid connections

Planning modification 4 includes a 132 kV grid connection electrical line which will connect the on-site wind farm substation to the wider grid network. The 132 kV line will travel along the Panuara Road and Cadia Road reserves and adjoining land where available. It will be an overhead grid connection line with poles being approximately 24 m in height

5. CONSULTATION

Details and results of the consultation activities are provided in Table 1. The following stakeholders were consulted:

- Aerial Agricultural Association of Australia;
- Airservices Australia;
- aerodrome operators or non-regulated aerodromes within the vicinity of the Project;
- Civil Aviation Safety Authority;
- Department of Defence;
- Orange City Council; and
- other stakeholders where noted.

Table 1 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Aerial Agricultural Association Australia (AAAA)	12 April 2018 Email to Phil Hurst, CEO-AAAA	12 April 2018 Email from Phil Hurst, CEO-AAAA	Information on the proposed planning modification 4 and request for information or comments.	Recommendation has been given to follow National Windfarm Operating Guidelines for Aerial Application for the FCWF Project
Aerial Agricultural Service (Fahey Fred Aerial Services)	14 June 2018 Phone/Email to Fred Fahey	14 June 2018 - Phone; 20 June 2018 – Email, Fred Fahey	Discussed aircraft landing areas in the proximity to the project site to identify which airfields are still used in the area. Mr Fahey requested to send him email with a map showing identified ALAs during the preparation of this AIA. Mr. Fahey marked aircraft landing areas (ALA) in the proximity to the proposed FCWF location. A comparison analysis of provided and previously identified location of ALAs showed that there are no new airstrips in the area of the proposed project.	No further action required at this stage.
Airservices Australia **Airport Developments**	12 April 2018 Email to Airport Developments	12 April 2018 Email from William Zhao, Advisor Airport Development, Operational Standards & Assurance, Airservices Australia	Information on the proposed planning modification 4 and request for information or comments.	Airservices Australia requested an updated aviation impact assessment report which was duly provided.

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
	10 May 2018 Email to Airport Developments	06 June 2018 Email from William Zhao, Advisor Airport Development, Operational Standards & Assurance, Airservices Australia	**Airspace Procedures** With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1114m (3655ft) AHD, the wind farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Orange, Cowra or Bathurst Airport. The wind farm will not affect any air route LSALT. Note that procedures not designed by Airservices at Orange, Cowra or Bathurst Airport were not considered in this assessment. **Communications/Navigation/Surveillance (CNS) Facilities** This wind farm to a maximum height of 1114m (3655ft) AHD will not adversely impact the performance of Precision/Non-Precision Nav Aids, HF/VHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.	No further action required at this stage.
Civil Aviation Safety Authority	12 April 2018 Email to Matthew Windebank, Aerodrome Engineer, Air Navigation, Airspace & Aerodromes Branch, CASA/Aviation Group	13 April 2018 Email from CASA/Aviation Group	CASA has advised that it will only review assessments referred to it by a planning authority or agency.	Submit aviation impact assessment to NSW Department of Planning and Environment

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Commonwealth Department of Defence **Estate Planning QVT**	12 April 2018 Email to Estate Planning Land Planning and Regulation Infrastructure Division and DSRGIDEP.ExecutiveSupport@defence.gov.au	12 April 2018 Email from Debbie Fisher, Distribution Coordinator, Aeronautical Information Service – Air Force	Information on the proposed planning modification 4 and request for information or comments.	Report vertical obstruction information to Airservices Australia.
	10 May 2018 Email to Department of Defence, E&IG Infrastructure EP Exec Support	26 June 2018 Email from Michael Ellis, Land Planning and Regulation, Estate Planning – Infrastructure Division, Department of Defence	Defence has conducted an assessment of the proposed wind farm for potential impacts on the safety of military flying operations as well as possible interference to Defence communications and radar. The proposed 160 metre 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 metres AGL, that are within 30 kilometres of an aerodrome; and b. 45 metres AGL elsewhere.	Notify Airservices Australia of 'as-constructed' details. Submit an aeronautical risk assessment to CASA. Refer to CASA and the *National Airports Safeguarding Framework Guideline D* requirements to marking and lighting of wind turbines.

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			The proposed structures will meet the above definition of a tall structure. Defence therefore requests that the applicant provide ASA with "as constructed" details. The details can be emailed to ASA at vod@airservicesaustralia.com. Defence notes that the *National Airports Safeguarding Framework Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* recommends that where a wind turbine 150 metres 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 the Civil Aviation Safety Authority (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 of this proposal to be sent to CASA for consideration. If CASA determines that obstacle lighting is to be provided, it should be compatible with persons using night vision devices. If LED lighting is proposed, the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometres. If wind monitoring towers are constructed as part of the proposal, Defence notes that the *National Airports Safeguarding Framework Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* - Paragraph 39 recommends the top 1/3 of wind monitoring towers are painted in alternating contrasting bands of colour in accordance with the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998.	

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
			Defence has no objection to the proposed wind farm.	
Orange City Council	12 April 2018 Phone and Email to Tim Mooney, Plant and Depot Manager Orange City Council	12 April 2018 Email from Paul Fitzgerald.	The Orange Airport OLS protection / flight procedures. No impact on OLS.	Confirm that there is no impact on the Orange Airport flight procedures from Airservices Australia – Complete.

6. AVIATION IMPACT STATEMENT

6.1. Nearby registered/certified aerodromes

Bathurst Airport, Cowra Airport and Orange Airport are the certified aerodromes that are located within 30 nm of the FCWF Project site.

Bathurst Airport is located approximately 53 km (28.5 nm) north east of the FCWF site. Cowra Airport is located approximately 46 km (25 nm) south west of the wind farm site, and Orange Airport is located approximately 15 km (8 nm) north of the Project.

The location of the aerodromes relative to the project site are shown in Figure 7 (source: OzRunways, World Aeronautical Chart (WAC), dated 3 May 2018).

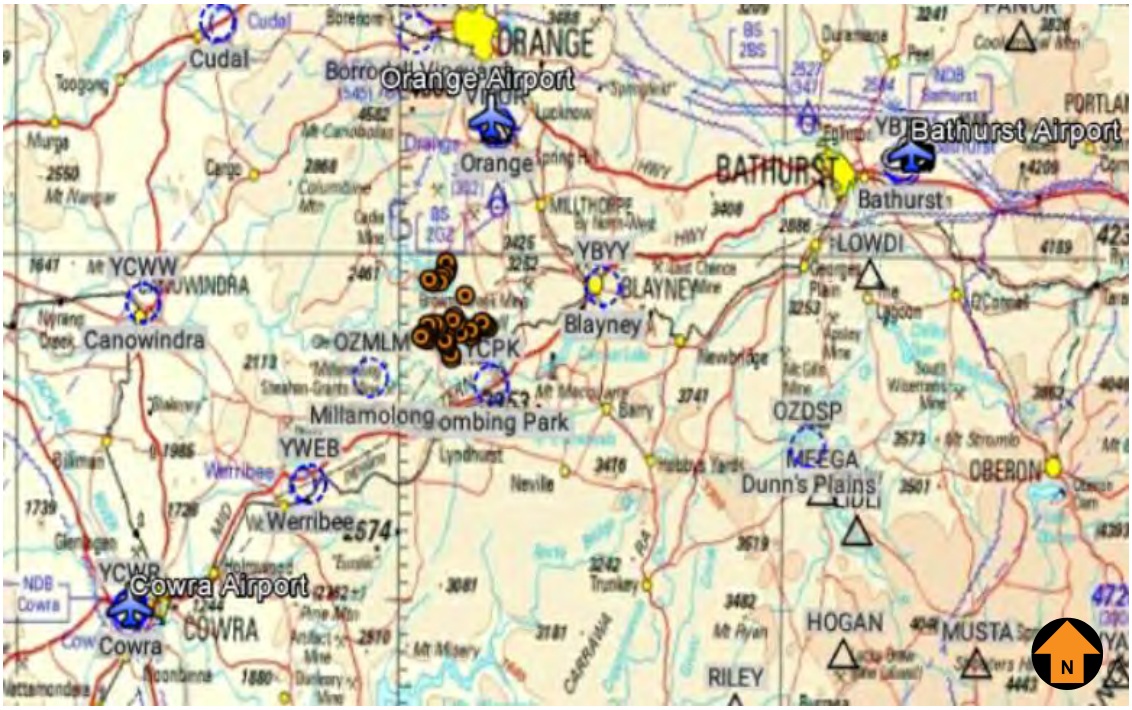

Figure 7 Flyers Creek Wind Farm in relation to registered/certified aerodromes

6.2. Bathurst Airport

Bathurst Airport is an aerodrome identified in this assessment as being a certified airport within 30 nm of the proposed FCWF. This airport is owned and operated by Bathurst Regional Council and is located approximately 7 km (3.8 nm) east from Bathurst city.

Bathurst Airport is a Code 3 certified aerodrome with non-precision approach procedures.

A check of Airservices Australia's Aeronautical Information Package (AIP), dated 1 March 2018, shows that Bathurst Airport (YBTH) has one sealed runway 17/35 and one brown gravel runway 08/26, details as follows:

- 17/35 is 1705 m long and 30 m wide sealed runway with a runway strip of 150 m; and
- 08/26 is 1315 m long and 30 m wide brown gravel runway with a runway strip of 90 m.

Bathurst Airport's aerodrome elevation is 2435 ft (AMSL) (742.2 m AHD).

Bathurst Airport Aerodrome Reference Point (ARP) and Non-Directional Beacon (NDB) published in Airservices Australia's Designated Airspace Handbook (DAH) as follows:

- ARP coordinates are Latitude 33°24'34"S and Longitude 149°39'07"E; and
- NDB coordinates are Latitude 33°24'08"S and Longitude 149°39'4"E.

6.3. Cowra Airport

Cowra Airport is an aerodrome identified in this assessment as being a certified airport within 30 nm of the proposed FCWF. This airport is owned and operated by Cowra Regional Council and is located approximately 4 km (2.2 nm) west from Cowra town.

Cowra Airport is a Code 3 certified aerodrome with non-precision approach procedures.

A check of Airservices Australia's Aeronautical Information Package (AIP), dated 1 March 2018, shows that Cowra Airport (YCWR) has one sealed runway 15/33 and one grass runway 03/21, details as follows:

- 15/33 is 1630 m long and 30 m wide sealed runway with a runway strip of 90 m; and
- 03/21 is 1166 m long and 30 m wide grass runway with a runway strip of 80 m.

Cowra Airport's aerodrome elevation is 973 ft (AMSL) (297 m AHD).

Cowra Airport Aerodrome Reference Point (ARP) and Non-Directional Beacon (NDB) published in Airservices Australia's Designated Airspace Handbook (DAH) as follows:

- ARP coordinates are Latitude 33°50'41"S and Longitude 148°38'56"E; and
- NDB coordinates are Latitude 33°50'7"S and Longitude 148°39'2"E.

6.4. Orange Airport

Orange Airport is an aerodrome identified in this assessment as being a certified airport within 30 nm of the proposed FCWF. This airport is owned and operated by Orange City Council and is located approximately 10.5 km (5.7 nm) south from Orange City.

Orange Airport is a Code 4 certified aerodrome with non-precision approach procedures.

A check of Airservices Australia's Aeronautical Information Package (AIP), dated 1 March 2018, shows that Orange Airport (YORG) has one sealed runway 11/29 and one grass runway 04/22, details as follows:

- 11/29 is 2213 m long and 30 m wide sealed runway with a runway strip of 150 m; and
- 04/22 is 723 m long and 30 m wide grass red clay runway with a runway strip of 90 m.

Orange Airport's aerodrome elevation is 3112 ft (AMSL) (949 m AHD).

Orange Airport Aerodrome Reference Point (ARP) published in Airservices Australia's Designated Airspace Handbook (DAH) as follows:

- ARP coordinates are Latitude 33°22'41"S and Longitude 149°07'32"E.

6.5. Obstacles limitation surfaces

The *NSW Guideline for State significant wind energy development* requires assessment to determine if the project height infringes on the Obstacle Limitation Surfaces (OLS) of an aerodrome.

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

The proposed FCWF site is located approximately:

- 53 km (28.5 nm) west of Bathurst Airport;
- 46 km (25 nm) north east of Cowra Airport; and
- 14.8 km (8 nm) south of Orange Airport.

Refer to Figure 8 that shows the maximum possible extent of obstacle limitation surfaces of Bathurst, Cowra and Orange Airports.

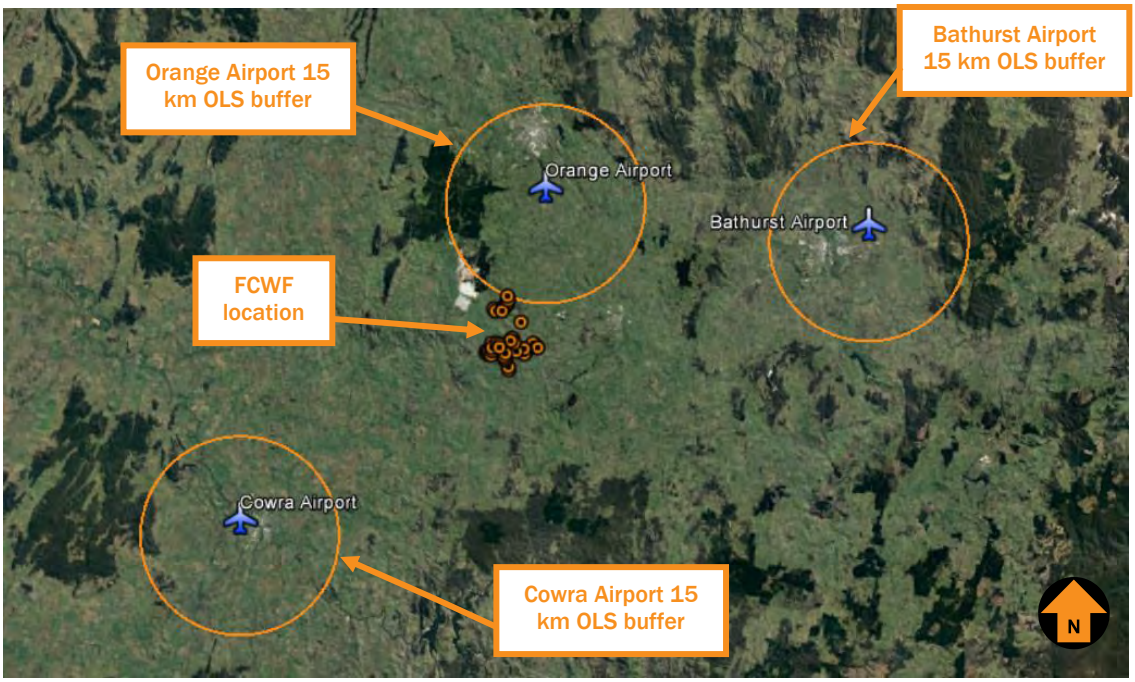

Figure 8 Indicative maximum possible extent of OLS of Bathurst, Cowra and Orange Airports

The OLS of Bathurst and Cowra airports will not be impacted by the proposed development of the FCWF Project.

For the purpose of this report a graphical representation of the OLS of Orange Airport was used from Figure 16.1 *'Orange Aerodrome Obstacle Limitation Surface and approaches relative to wind turbine sites'* to demonstrate an indicative location of the FCWF site, in particular, WTG3 relative to the maximum possible extent of the OLS of Orange Airport.

Correspondence sent from Orange City Council to FCWFPL noted that a future outer horizontal surface, applicable to precision instrument approaches which are not currently in place, would have a height of 1095.5 m AHD. WTG 3, which is the only turbine within 15 km of the aerodrome reference point, will have an overall height of 1056 m AHD and will not penetrate the outer horizontal surface if it ever becomes operationally applicable. Refer to Figure 9 (FCWFPL, 2011).

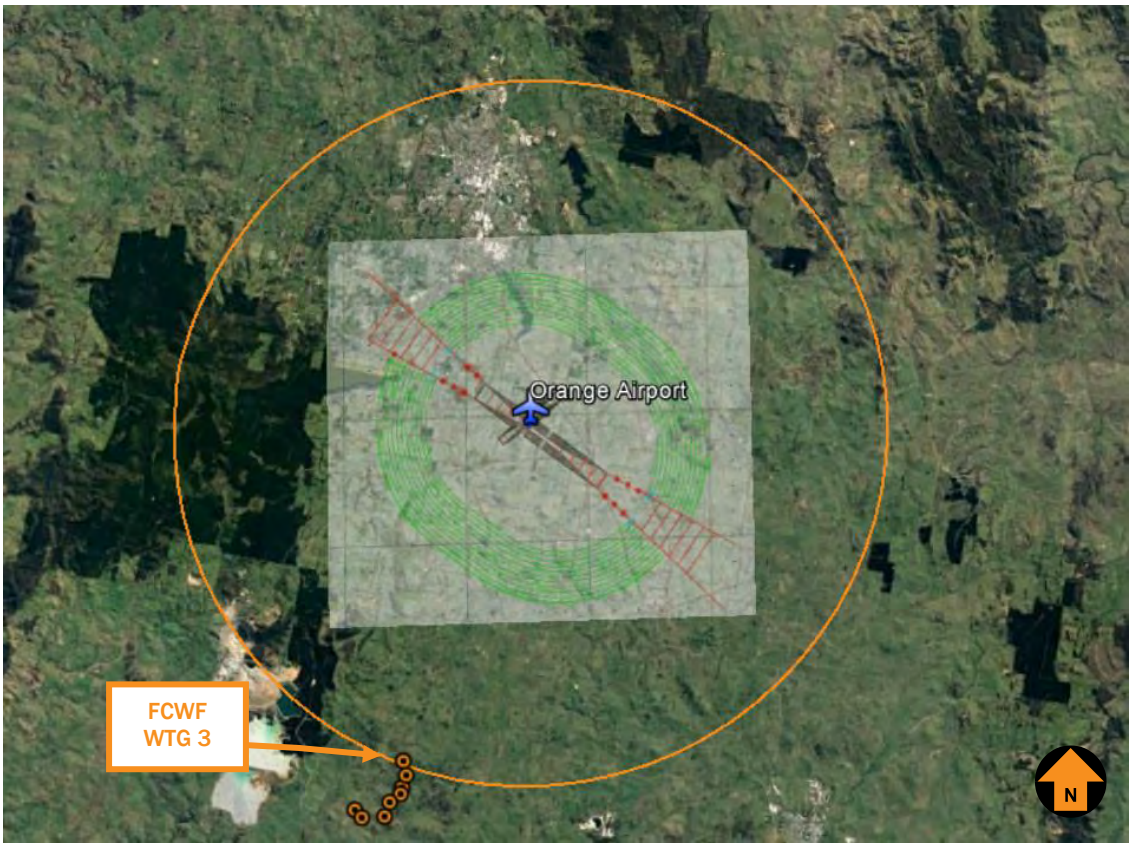

Figure 9 OLS of Orange Airport relative to the WTG 3 of the FCWF Project

6.6. Instrument procedures

A check of the AIP via the Airservices Australia website showed that Bathurst Airport, Cowra Airport and Orange Airport are served by non-precision terminal instrument flight procedures as per Table 2 (source: Airservices Australia, 2018).

Table 2 Bathurst Airport, Cowra Airport and Orange Airport aerodrome and procedure charts

Chart name (Procedure Designer)	*Effective date*
Bathurst Airport (YBTH)	
AERODROME CHART (AsA)	25 May 2018 (BTHAD01-151)
RNAV ARRIVAL PAGE 1 (AsA)	25 May 2018 (BTHDG01-151)
RNAV ARRIVAL PAGE 1 (AsA)	25 May 2018 (BTHDG02-151)
NDB RWY 17 (AsA)	25 May 2018 (BTHNB01-151)
RNAV (GNSS) RWY 17 (AsA)	25 May 2018 (BTHGN01-151)
RNAV (GNSS) RWY 35 (AsA)	25 May 2018 (BTHGN02-151)
Cowra Airport (YCWR)	
AERODROME CHART (AsA)	25 May 2017 (CWRAD01-151)
GNSS ARRIVAL (AsA)	25 May 2017 (CWRDG01-151)
NDB RWY 15 (AsA)	25 May 2017 (CWRNB01-151)
RNAV-Z (GNSS) RWY 15 (AsA)	25 May 2017 (CWRGN01-151)
RNAV-Z (GNSS) RWY 33 (AsA)	25 May 2017 (CWRGN02-151)
Orange Airport (YORG)	
AERODROME CHART (AsA)	25 May 2017 (ORGAD01-151)
RNAV-Z (GNSS) RWY 11 (AsA)	25 May 2017 (ORGGN01-151)
RNAV-Z (GNSS) RWY 29 (AsA)	25 May 2017 (ORGGN02-151)

It is noteworthy that the non-directional beacon (NDB) facility that was at Orange Airport has been decommissioned, and hence the issue raised in the Project Approval regarding assessment of the impact on the associated procedures is no longer relevant.

The minimum safe altitude (MSA) is applicable for each instrument approach procedure at Bathurst, Cowra and Orange airports. An image of the MSA published for each airport is shown in Figure 10.

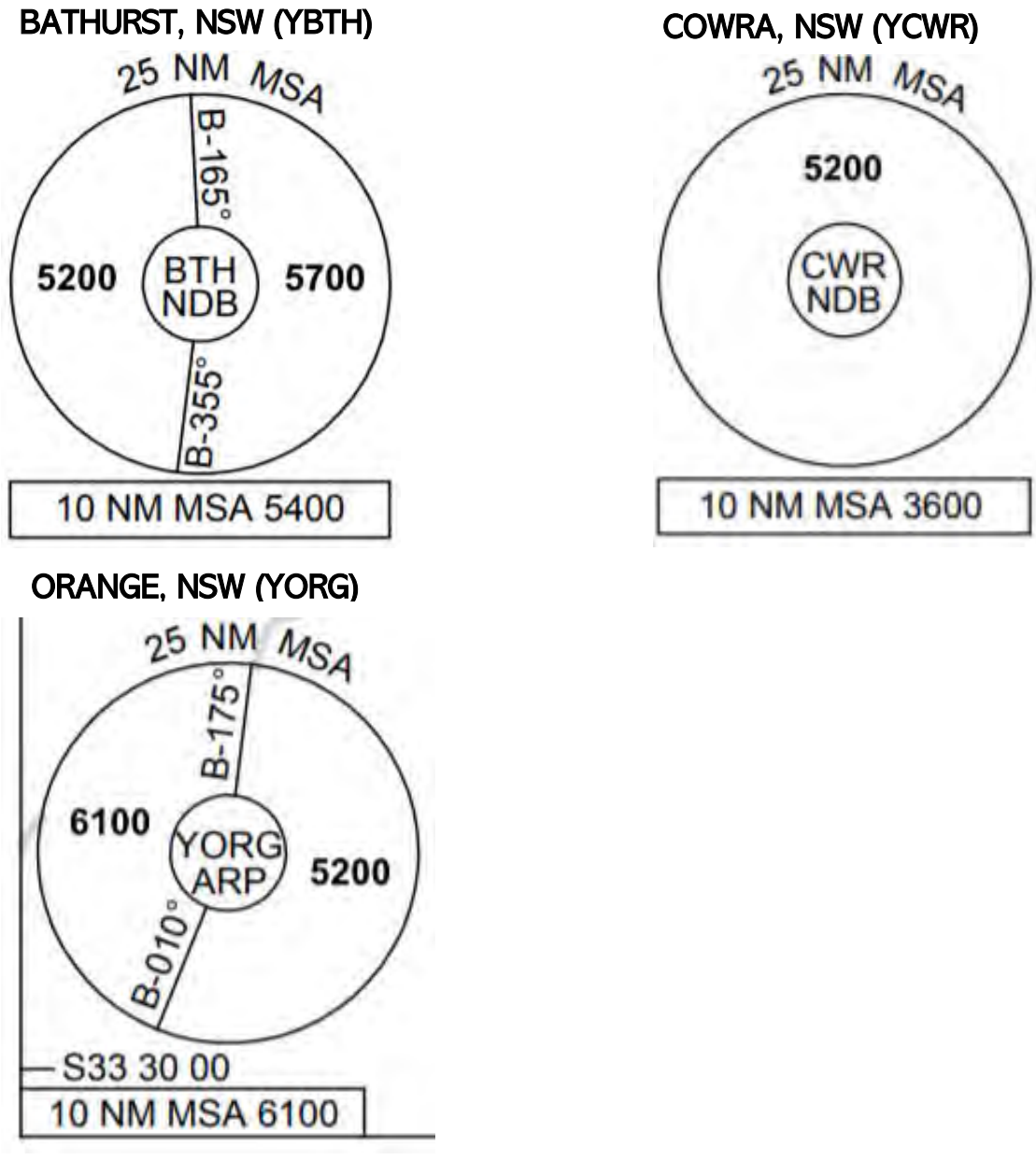

Figure 10 MSA at Bathurst Airport, Cowra Airport and Orange Airport

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

Aircraft are subject to a minimum altitude of 5200 ft AMSL within 30 nm (25 nm MSA + 5 nm buffer) of Bathurst Airport, Cowra Airport and Orange Airport.

At a maximum overall height of approximately 1114 m AHD (3655 ft AMSL) for a wind turbine at 160 m AGL, none of the proposed FCWF turbines and wind monitoring towers are above the Bathurst, Cowra and Orange airports 25 nm MSA MOC.

Within 15 nm (10 nm MSA + 5 nm buffer) of Airport Aerodrome Reference Points (ARP), aircraft are subject to the following minimum safe altitudes:

- 5400 ft AMSL within 15 nm MSA of Bathurst Airport;
- 3600 ft AMSL within 15 nm of Cowra Airport; and
- 6100 ft AMSL within 15 nm MSA of Orange Airport.

Bathurst Airport's and Cowra Airport's 15 nm buffers do not overlay the proposed FCWF Project. Therefore, the MSAs of Bathurst and Cowra airports will not be impacted by the Project. Refer to Figure 11.

Within 10 nm of Orange Airport ARP, aircraft are subject to a minimum safe altitude 6100 ft AMSL. At a maximum overall height of approximately 1114 m AHD (3655 ft AMSL) for a wind turbine at 160 m AGL, none of the proposed FCWF turbines are above the Orange Airport 10 nm MSA MOC and will have no impact on the airport MSA.

Wind turbines of the project will not affect any circling area heights for any of the three airports.

Figure 11 Bathurst, Cowra and Orange Airports 15 nm and 30 nm MSA rings

6.7. Nearby aircraft landing areas (ALAs)

There is only one ALA in close proximity to the proposed FCWF: ALA 1 (un-named) located 5.2 km (2.8 nm) south east from WTG 37.

A Google Earth search also revealed the following ALAs near the FCWF development:

- ALA 2 (un-named) is located approximately 21 km (11.3 nm) south west from the WTG 29;
- ALA 3 (un-named) is located approximately 65.5 km (35.4 nm) south west from the WTG 3; and
- Cudal ALA is located approximately 38 km (21 nm) north west from WTG 3.

Refer to Figure 12 for ALAs location relative to the proposed development of the FCWF Project (source: Google Earth, 2018).

A further search on OzRunways, which sources its data from Airservices Australia (AIP) and AOPA National Airfield Directory datasets, returned no further nearby non-regulated aerodromes. The aeronautical data provided by OzRunways is approved by CASA under Civil Aviation Regulation 233(1)(h).

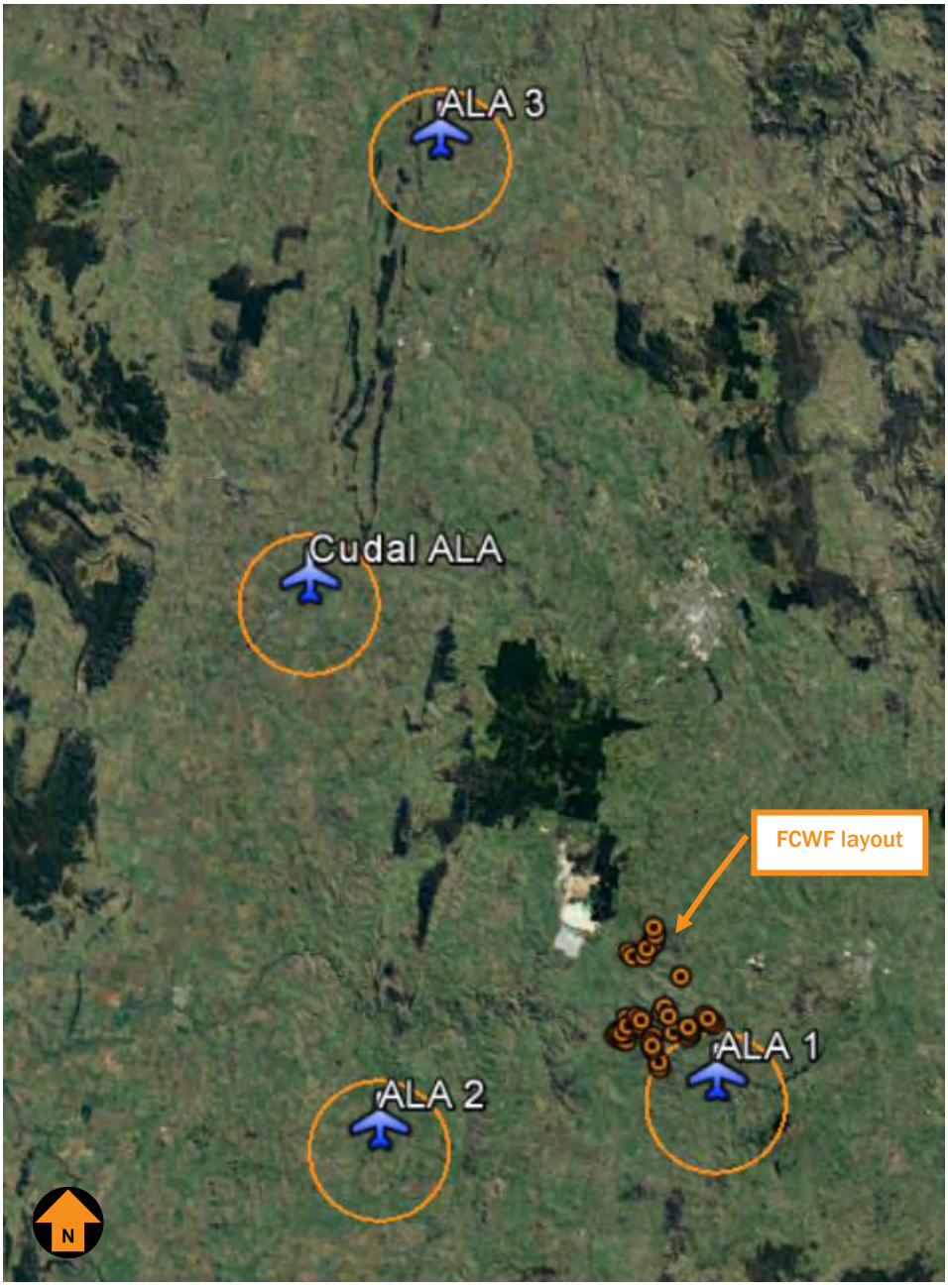

Figure 12 Flyers Creek Wind Farm in relation to aircraft landing areas

ALA 1 (un-named) is located 5.2 km (2.8 nm) and 5.5 km (2.98 nm) south east from wind turbine WTG 37 and WTG 39 respectively. Refer to Figure 13 (source: Google Earth, 2018).

ALA 1 is located south of Mid Western Highway. ALA 1 runway is east-west oriented relative to the FCWF site, which is parallel to wind turbines. Therefore, the proposed development of the FCWF Project will not impact ALA 1 approach and take-off areas.

To maintain acceptable aviation safety for pilots operating at night in ALA 1, including the RFDS, the local traffic procedures at the ALA should be changed to ensure circuits are flown only to the southern side of the runway, particularly at night. This measure addresses the risk of collision and encountering noticeable wake turbulence.

The Project should have no impact on an un-named ALA 1 3 nm OLS in the view of aircraft landing area layout and its flight paths and circuit areas relative to the proposed location of WTG 37 and WTG 39.

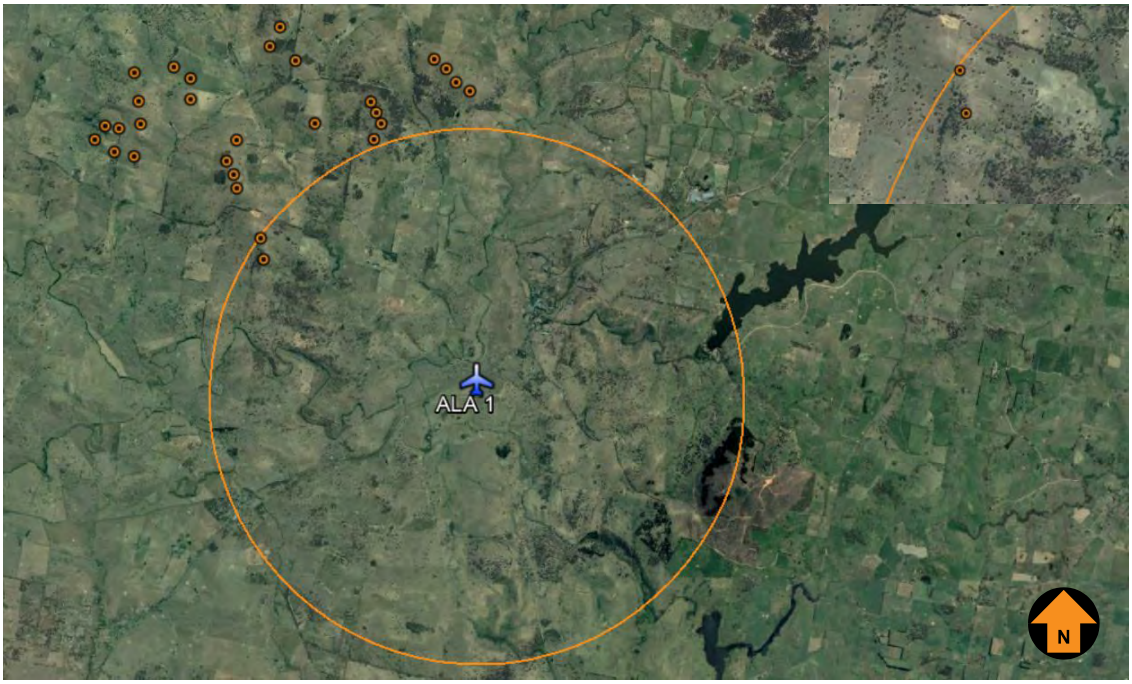

Figure 13 Flyers Creek Wind Farm in relation to aircraft landing area ALA 1 (un-named)

6.8. Air routes and LSALT

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

The En Route Chart Low National shows the grid LSALT and the air routes in the vicinity of the Project (source: OzRunways, 2018). Figure 14 provides the En-Route Chart Low National and air routes within the vicinity of FCWF (source: En Route Chart Low National, dated 3 May 2018).

Figure 14 En-Route Chart Low National and air routes within the vicinity of Flyers Creek Wind Farm

An impact analysis of the surrounding air routes is provided at Table 3.

Table 3 Air-route impact analysis

Air route	*Waypoint pair*	*Route LSALT*	*MOC*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
W440	Parkes and HOGAN	6100 ft AMSL	5100 ft AMSL	Nil	N/A	Nil
W419	Werribee and Bathurst	5400 ft AMSL	4400 ft AMSL	Nil	N/A	Nil
W654	Cowra and VIRUR	5500 ft AMSL	4500 ft AMSL	Nil	N/A	Nil

Note: Minimum obstacle clearance (MOC) is the height above which obstacles would impact on LSALTS or air routes.

The applicable grid LSALT is 5900 ft AMSL, with an MOC of 4900 ft AMSL.

The Project will not impact on route or grid LSALTs.

6.9. Airspace

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

6.10. Aviation facilities

The proposed FCWF is not likely to infringe any protection areas associated with aviation facilities.

6.11. Radar

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

With respect to aviation radar facilities, the closest radar is located at Mt Boyce (approximately 106 km (43 nm) to the north east). This radar facility will not be affected by the proposed wind farm.

6.12. Airservices Australia

With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1114m (3655ft) AHD the wind farm:

- will not affect any sector or circling altitude, nor any instrument approach or departure procedure at at Orange, Cowra or Bathurst Airport;
- will not impact any air route lowest safe altitude (LSALT); and
- will not adversely impact the performance of Precision/Non-Precision Nav Aids, HF/VHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

Redesign of the NDB approach at Orange Airport mentioned in Condition of Approval D11 (b) is not required, since the NDB has been decommissioned.

6.13. Summary

The proposed increase in the maximum turbine envelope proposed as part of Modification 4 does not increase the potential impact to aviation from that previously assessed for the Project. A list of wind turbines and their coordinates and elevation data that are applicable to this Aviation Impact Statement (AIS) are provided in Annexure 1.

6.14. Summary

Based on the proposed wind farm layout and overall turbine overall blade tip height limit of 160 m AGL, the blade tip elevation of the highest WTG, which is WTG20, will not exceed 1114 m AHD (3655 ft AMSL) and:

- will not penetrate any OLS surfaces;
- will not penetrate PANS-OPS surfaces;
- will not have an impact on nearby designated air routes;
- will not have an impact on prescribed airspace;
- is contained within Class G airspace; and
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

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

7. AIRCRAFT OPERATOR CHARACTERISTICS

7.1. Passenger transport operations

Regular public transport (RPT) operations are only conducted at registered and certified aerodromes. Thangool Airport is the only certified aerodrome within 30 nm of the Project.

RPT and passenger carrying charter operations are generally operated under the Instrument Flight Rules (IFR). The Aviation Impact Statement provided in Section 6 addresses the matters associated with IFR aircraft operations.

The Project is unlikely to impact on RPT operations.

7.2. Flying training, private, recreational and gliding operations

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

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

IFR and Night VFR (which are required to conform to IFR applicable altitude requirements) aircraft operations are addressed in Section 3.

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

The protocols list considerations for developers during the design/build stage and also the operational stage, for pilots/aircraft operators during aircraft operations and discusses economic compensation. NASF Guideline D is included as Appendix 1, and AAAA 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.

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

Based on previous studies, and subject to the results of consultation with AAAA and any further consultation with local aerial application operators, it is reasonable to conclude that safe aerial application operations would be possible on properties within the Project site and neighbouring the Project site, subject to final WTG 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 WTGs, WMTs 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

The Australasian Fire and Emergency Services Council (AFAC) developed a national position on wind turbines: *Wind Farms and Bush Fires Operations*, version 2.0, dated 30 October 2014.

Of specific interest in this document is the paragraph copied below:

> *Aerial fire fighting operations will treat turbine towers similar to other tall obstacles. Pilots and Air Operations Managers will assess these risks as part of routine procedures. Risks due to wake turbulence and the moving blades should also be considered. Wind turbines are not expected to pose unacceptable risks.*

7.5. Emergency services/RFDS

Royal Flying Doctor Services 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.

7.6. Summary

The proposed increase in the maximum turbine envelope proposed as part of Modification 4 does not increase the potential impact to aviation from that previously assessed for the Project.

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.

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.

CASA recommends that the wind farm is lit with steady red medium intensity lighting at night and recommends a lighting plan consistent with the provisions of Guideline D of the National Airports Safeguarding Framework (NASF).

8.1.3. Advisory Circular 139-08 v2—Reporting of Tall Structures

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

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

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

b) 45 metres or more above ground level elsewhere.

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

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

8.2. International Civil Aviation Organization

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.*

Refer to **Section 10** for a detailed assessment of the requirement for obstacle lighting.

8.3. Turbine lighting design

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

In addition, the lighting proposal 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 lighting design should seek to minimise visual impacts by minimising the number of lit wind turbines while achieving the recommendations provided in MOS 139 chapter 9 and ICAO Annex 14 volume 1.

The lighting design should be subject to confirmation of the final turbine layout as any changes proposed could potentially affect which turbines should be lit in accordance with the 900 m interval consideration.

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 wind turbines 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 9.4.6outlines 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 ± 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 ± 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 will need to be established in accordance with this guidance.

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 WTG.

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, typical of most wind turbines operational in Australia, 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 4.2 of this report.

Consideration could be given to marking any WMTs 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 WMTs:

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

8.8. Overhead power lines

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

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

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

With respect to power line route determination (refer to Section 4.3), 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: FCWFPL has advised to provide details on the overhead transmission lines prior to finalising this report.

> *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 4 (source: ATSB).

Table 4 Number of fatalities by GA sub-category - 2006 to 2015

Sub-category	*Aircraft assoc. with fatality*	*Fatalities*	*Fatalities to aircraft ratio*
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. Figure 15 refers (source: ATSB).

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

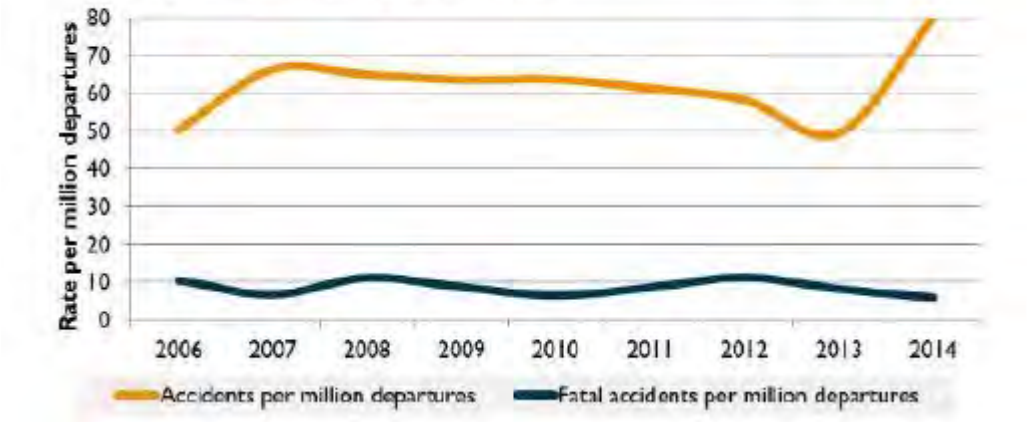

Figure 15 GA accident and fatal accident rate per million departures

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 5 (source: ATSB).

Table 5 Fatal accidents by GA sub-category - 2015

Sub-category	*Fatal accidents*	*Fatalities*
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.

Note that there are no recorded accidents involving an aircraft colliding with a wind turbine in Australia.

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 (in 2008 and 2017), and one at night (in 2014).

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.

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.

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 6.

Table 6 Summary of accidents involving collision with a wind turbine

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

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

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

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

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 31000:2018 *Risk management— 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 3100:2018 as the chance of something happening. Likelihood descriptors used in this report are as indicated in Table 7.

Table 7 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 8.

Table 8 Consequence Descriptors

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

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 9.

Table 9 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 10.

Table 10 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 160 m

(523 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 7 m (23 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) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The wind turbines are typically coloured white, typical of most wind turbines operational in Australia, so they should be visible during the day.
- The as constructed details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- 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 an unacceptable 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:
- Provide the details to the NSW/ACT Regional Airspace and Procedures Advisory Committee for consideration by its members in relation to VFR transit routes in the vicinity of the wind farm.
- Engage with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the Project area.
- Arrangements should be made to publish details of the wind farm in ERSA (En Route Supplement Australia) 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.	
Residual Risk	7 - Tolerable

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.

FCWFPL advises there are two existing WMTs at 82 m (269 ft) AGL. WMT locations shall be advised to Airservices Australia.

The proposed WMTs shall have high visibility aviation marker balls up on the top level guy wires. The location of the proposed WMTs location and other applicable details shall be advised to Airservices Australia.

The towers shall be steel lattice masts (at or below the wind turbine hub height) and shall be installed at different locations the site.

There are a few instances of aircraft colliding with a WMT, 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 WMT, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.

Consequence	Catastrophic

Untreated Likelihood

There are a few occurrences of an aircraft colliding with a WMT, but all were during the day with good visibility when obstacle lighting would arguably be of no effect, and none was in Australia. It is assessed that collision with a WMT without obstacle lighting that would be effective in alerting the pilot to its presence may only occur in exceptional circumstances, which is classified as Rare.

Untreated Likelihood	Rare

Current Treatments (without lighting)

- The existing wind monitoring towers at FCWF are 82 m (269 ft) high, and do not require lighting. Their location and other applicable details shall be 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 highest WMT is at a maximum height of 82 m (269 ft) AGL, leading to no intrusion above the minimum height of 500 ft AGL for an aircraft flying at this height.

- In the event that descending cloud forces an aircraft lower than 152.4 m AGL (500 ft), the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of the tower.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The towers are constructed from grey steel.
- Since the existing towers are not higher than 110 m AGL, there is no a statutory requirement to report them to CASA.

Level of Risk

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

Current Level of Risk	8 - Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Proposed Treatments

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

- Details of any WMTs when they are constructed should be advised to Airservices Australia.
- Although there is no obligation to do so, consideration could be given to marking any WMTs 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 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.
- Ensure details of any additional WMTs on the Project site have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction.

Residual Risk With the additional recommended treatments, the likelihood of an aircraft collision with a WMT resulting in multiple fatalities and damage beyond repair will be Unlikely, and the consequence remains Catastrophic, resulting in an overall risk level of 7 – Tolerable. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified, 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 WMTs, without obstacle lighting on the turbines of the Project.	
Residual Risk	7 - Tolerable

Risk ID:	3. Harsh manoeuvring leads to controlled flight into terrain (CFIT)

Discussion

An aircraft colliding with terrain as a result of manoeuvring to avoid colliding with a 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.
- Wind turbines will be a maximum of 160 m (523 ft) at the top of the blade tip, so the rotor blade at its maximum height will be approximately 7 m (23 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, typical of most wind turbines operational in Australia, so they should be visible during the day.
- The ‘as constructed’ details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- Since the turbines will be higher than 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; and • Although there is no requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the Project area.	
Residual Risk With the additional recommended treatments, 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.
- Wind turbines will be a maximum of 160 m (523 ft) at the top of the blade tip, so the rotor blade at its maximum height will be approximately 7 m (23 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 WMTs are not higher than 110 m AGL, there is no 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 for such aircraft operations in the vicinity of the Project

Residual Risk

Notwithstanding the current level of risk is considered tolerable, the additional recommended treatments 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.

Level of Risk

The level of risk associated with a Likely likelihood of a Moderate consequence is 8.

Current Level of Risk	8 - Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Proposed Treatments

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

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

- reducing the number of 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.

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

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

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

Residual Risk

Not installing obstacle lights would clearly be an acceptable outcome to those 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 Likely – The event is likely to occur sometimes (has occurred infrequently), 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.

Residual Risk	7 - Tolerable

10.7. Summary of risks

The proposed 10 m increase in the maximum turbine tip height proposed as part of Modification 4 does not increase the potential impact to aviation from that previously assessed for the Project.

A summary of the level of risk associated with the proposed FCWF Project, under the proposed treatment regime, is provided in Table 11.

Table 11 Summary of Risks

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in En Route Supplement Australia (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 any new 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. 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.