Australian Government

Civil Aviation Safety Authority

AIRSPACE AND AERODROME REGULATION

File Ref: EF11/1146-22

19 February 2016

Mr Michael Juttner
Senior Planner
Department of Environment, Land, Water and Planning
1 Spring Street
MELBOURNE VIC 3000

Dear Mr Juttner,

PROPOSED BERRYBANK WIND FARM

I refer to the proposal by Union Fenosa to develop the Berrybank Wind Farm near Berrybank, between Camperdown and Ballarat.

I am advised that the proponent has planning permission for 95 turbines with a blade tip height of 131m above ground level (AGL) but is now seeking approval for 79 turbines with a blade tip height of up to 180m AGL.

CASA has assessed the proposed Berrybank Wind Farm based on the revised maximum height of 180m AGL.

CASA recommends that the wind farm is lit with steady red low intensity lighting at night as per Section 9.4 of the CASA Manual of Standards Part 139. Characteristics for low intensity lights are stated in subsection 9.4.6. CASA agrees that the turbines that should be lit are those identified by the proponent in the drawing '100402-02 Berrybank Wind Farm Obstacle Lighting Design v0.3 151019'.

CASA recommends that the proponent makes the notifications described in the NASF Guideline D.

If you require further information, please call Mr David Alder on 131757.

Yours sincerely

Dilip Mathew
Manager Aerodromes

cc. Mr Shaq Mohajerani, Project Development Manager, Union Fenosa Wind Australia

FEBRUARY 2016

AERONAUTICAL IMPACT ASSESSMENT

BERRYBANK WIND FARM

Prepared for Berrybank Development Pty Ltd

AVIATION PROJECTS

AVIATION PROJECTS

DOCUMENT CONTROL

Document Title: Berrybank Wind Farm Aeronautical Impact Assessment

Reference: 100402-02

Release Date: 22 February 2016

Prepared by: L Hodgson

Reviewed by: K Tonkin

Released by: K Tonkin

Revision History: Release

Revision History

Version	*Description*	*Transmitted*	*Reviewed by*	*Date*
0.1	First Draft	31 October 2014		
0.2	Second Draft	16 September 2015	Union Fenosa	13 October 2015
0.3	Final draft – minor changes	19 October 2015	Union Fenosa	19 October 2015
0.4	Final draft	20 October 2015	Union Fenosa	
1.0	Final for release	22 February 2016		

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ACRONYMS

AGL	above ground level
AIP	Aeronautical Information Package
ALARP	as low as reasonably practicable
AMSL	above mean sea level
CAR	Civil Aviation Regulation (1988)
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation (1998)
CFIT	controlled flight into terrain
ERSA	En Route Supplement Australia
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions
MOS	Manual of Standards
MSA	minimum sector altitude
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
Project	Berrybank Wind Farm
Proponent	Berrybank Development Pty Ltd
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

The Berrybank Wind Farm (the Project) site is located approximately 82 km west of Geelong along the Hamilton Highway, between the townships of Lismore and Cressy in Victoria. This report has been prepared in relation to a proposed amendment for the Project. The amendment seeks to alter the scale of the approved turbines, as well as minor alterations to the siting and number of turbines, and realigned access tracks. This report assesses the potential net impacts as a result of the proposed amendment.

The Project received planning approval in 2010. On 24 August 2010, Planning Permit No. 20092820 and 20092821 were issued for the Project for the 'Use and development of land for a Wind Energy Facility'. Condition 3 of the permits detail the specifications of the Project, including the number and scale of the turbines. The permits originally specified the tower height of the wind turbines at 80 m, with an overall blade tip height of 131 m above natural ground level.

Approval is now sought to vary the turbine specifications as detailed on the permits. It is proposed to increase the tower height to 117 m, the rotor diameter to 130 m, and overall tip height to 180 m. This would result in an overall increase in height of 49 m from natural ground level. In addition, it is proposed to microsite a number of turbines and realign access tracks and ultimately, reduce the number of turbines on the Project site from the endorsed 95 to 79 wind turbines.

Given the nature of the amendment, any impacts above those approved would be limited to the change in the increase in turbine size, siting, realigned access tracks and number of turbines on the Project.

Berrybank Development Pty Ltd (the Proponent) has engaged Aviation Projects to conduct an aeronautical impact assessment with respect to the proposed amendments.

Context

The following aspects were considered in the external context:

- Stakeholders;
- Berrybank Wind Energy Facility Panel;
- Department of Environment, Land, Water and Planning;
- Environment Protection and Heritage Council;
- Civil Aviation Safety Authority;
- International Civil Aviation Organization;
- Aviation Impact Statement;
- Nearby aerodromes;
- Aircraft operator characteristics;
- Light characteristics;
- Visual impact of night lighting;

- Marking of turbines;
- Marking of wind monitoring towers;
- Marking of power lines;
- Future regulatory requirements and guidance; and
- Comparative analysis.

The following aspects were considered in the internal context:

- Project description;
- Wind turbine description;
- Wind monitoring tower description; and
- Turbine lighting design.

Conclusions

As a result of the foregoing risk assessment, the following conclusions are drawn:

Consultation

- An appropriate and justified level of consultation was undertaken with the following parties:
  - Aerial Agricultural Association of Australia;
  - Air Ambulance Victoria;
  - Airservices Australia;
  - City of Ballarat;
  - Civil Aviation Safety Authority;
  - Corangamite Shire Council;
  - Country Fire Authority Victoria;
  - Department of Defence;
  - Golden Plains Shire Council;
  - Operators of non-regulated aerodromes within the vicinity of the Project;
  - Royal Flying Doctor Service; and
  - other stakeholders where noted.

Regulatory requirements

- There is no regulatory requirement for lighting of obstacles lower than 150 m AGL (492 ft) that are not within the vicinity of an aerodrome.

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

Aviation Impact Statement

- *In summary, the Aviation Impact Statement has determined that:*

  1) The blade tip elevation of the highest WTG will not exceed 382 m (1253 ft) AHD and as such:

  - *Will not penetrate any OLS surfaces;*
  - *Will not penetrate any PAN-OPS surfaces;*
  - *Will not have an impact on nearby designated air routes;*
  - *Will not have an impact on prescribed airspace;*
  - *Is wholly contained within Class G airspace; and*
  - *Will not have an impact on existing local aviation activities.*

  2) The [wind turbine generators (WGTs)] are located outside the clearance zones associated with aviation navigation aids and communication facilities.

  3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).

  The wind farm amendment has been assessed as not having an impact on prescribed airspace. The development is considered approvable under the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.

- Airservices has determined that there will be no aviation impacts on airspace procedures that have been designed by Airservices or communication, navigation and surveillance (CNS) facilities.

Nearby aerodromes

- The impacts at nearby aerodromes are addressed in the AIS.
- A separate study report, produced by Aviation Projects, with respect to the impact on the operations at Monaro ALA due to the approved Project turbine layout concluded that operations at the ALA will remain suitable. The proposed amendment to the Project will remain suitable for operations at the ALA because there will be a net improvement in safety margins.

Aircraft operator characteristics

- Based on input during consultation activities, the Project will result in a reduced net impact on aerial agricultural operations. Moreover, the impacts may be further alleviated by an effective and functional working relationship between the Proponent and aerial agricultural operators that are likely to operate in the vicinity of the Project.
- No net impact will result from the Project on the operation of Country Fire Authority's (CFA) operation. It would be beneficial to develop procedures to stop turbines blades from rotating before CFA begins aerial firefighting operations within the Project area.
- No issues are anticipated with the Project on Air Ambulance Victoria's rotary wing operations.

Comparative analysis

- There are currently no operational wind farms in Victoria that have obstacle lighting installed and activated. Macarthur, Oaklands Hill and Waubra Wind Farms have obstacle lighting installed; however, the operators have been authorised to have them turned off.

Project description

- The Project is planned to be located approximately 82 km west of Geelong along the Hamilton Highway, between the townships of Lismore and Cressy in Victoria.
- The proposed amendment will result in the following:
  - 79 wind turbines - decreased by 16 from the endorsed 95 wind turbines;
  - Maximum blade tip height of 180 m AGL (591 ft) – increased by 49 m from 131 m AGL;
  - Maximum ground elevation of 202 m AHD (663 ft AMSL) – increased by 2 m from 200 m AHD due to micrositing; and
  - Maximum blade tip height of 382 m AHD (1253 ft AMSL) – increased by 51 from 331 m AHD (1086 ft AMSL).
- The existing wind monitoring towers at the Project site are 80 m (262 ft), 60 m (197 ft) and 40 m (131 ft) AGL, and do not require lighting. Their location and other applicable details have been advised to RAAF AIS.
- One or more hub height wind monitoring towers may be erected for turbine power curve verification within the project boundary.

Obstacle lighting and marking

- Aviation Projects has assessed 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 lighting is required, the lighting design herein is 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.

- CASA recommends that the wind farm is lit with steady red low intensity lighting at night as per Section 9.4 of the CASA Manual of Standards Part 139. Characteristics for low intensity area stated in subsection 9.4.6. CASA agrees that the turbines that should be lit are identified in the drawing '100402-02 Berrybank Wind Farm Obstacle Lighting Design v0.3, (19 October 2015)'.
- A summary of design characteristics for obstacle lighting acceptable by CASA, if required, is provided below:
    - two steady red low intensity obstacle lights should be provided;
    - 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.
- To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program will need to be established in accordance with the guidance in MOS 139 Section 9.4.10.
- With respect to marking of turbines, it is generally accepted that, as an alternative to white, an off-white or light grey colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- With respect to marking of wind monitoring towers, they will be lower than, and are likely to be within 400 m of, a turbine and are therefore not likely to require obstacle marking or lighting.
- Department of Defence advised it has no concerns with the Project subject to the following requests being met:
    - Clearance is sought from Airservices Australia and CASA and any conditions from these agencies are adhered to;
    - 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm.
    - If LED obstruction lighting is to be provided to the wind turbines, the frequency range of the LED light emitted fall within the range of wavelengths 655 to 930 nanometres. This will enable the lighting to be visible to persons using night vision devices; and
    - Defence is consulted should there be any subsequent modification in the wind turbine height or scale of development.

Risk Assessment

- A summary of the level of risk associated with the Project under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table E 1.

Table E 1 Risk assessment summary

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine	Catastrophic	Rare	6	Acceptable without obstacle lighting. Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding airports, before, during and following construction.
Aircraft collision with monitoring tower	Catastrophic	Rare	6	Acceptable without obstacle lighting. Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D). Communicate details of the wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding airports, following construction.
Harsh manoeuvring leads to CFIT	Catastrophic	Rare	6	Acceptable without obstacle lighting. Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding airports before, during and following construction.
Effect on crew	Minor	Possible	5	Acceptable without obstacle lighting. Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding airports before, during and following construction.
Visual impact from obstacle lights	Moderate	Possible	6	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact and in accordance with Planning Permits Conditions.

Recommendations

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

Notification and reporting

1. 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm.

2. Department of Defence should be consulted if there is any subsequent modification in the wind turbine height or scale of development.

3. Any obstacles above 110 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:

    - The planned operational timeframe and maximum height of the crane; and
    - Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

Operation

4. The Proponent should engage with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project. Procedures may include stopping the rotation of the wind turbine rotor blades prior to the commencement of the aircraft operations within relevant areas.

Marking of turbines

5. The rotor blades, nacelle and the supporting mast of the wind turbines should be painted white, off-white or a light grey colour.

Lighting of turbines

6. With respect to Conditions 6, 7 and 8 of Planning Permit No 20092820 and Planning Permit No 20092821, 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 is required (for example, as a requirement of CASA), obstacle lighting would be installed on the following 35 turbines: 1, 3, 9, 12, 14, 15, 18, 20, 21, 23, 31, 36, 39, 42, 44, 45, 46, 48, 52, 55, 61, 62, 66, 67, 72, 73, 75, 80, 82, 84, 86, 88, 93, 99 and 100.

8. If obstacle lighting is required (for example, as a requirement of CASA), the wind turbines should be lit with steady red low intensity lighting at night as per MOS 139 Section 9.4, while minimising visual impact. To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program should be established in accordance with the guidance in MOS 139 Section 9.4.10.

9. Department of Defence requested that if LED lighting is used for obstacle lighting, then emitted light should fall within the wavelength range of 655 to 930 nanometres for night vision devices compatibility.

10. The Proponent may consider other factors in its decision as to whether obstacle lights should be installed.

Marking of wind monitoring towers

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

Triggers for review

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

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

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

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

1. INTRODUCTION

1.1. Situation

The Berrybank Wind Farm (the Project) site is located approximately 82 km west of Geelong along the Hamilton Highway, between the townships of Lismore and Cressy in Victoria. This report has been prepared in relation to a proposed amendment for the Project. The amendment seeks to alter the scale of the approved turbines, as well as minor alterations to the siting and number of turbines, and realigned access tracks. This report assesses the potential net impacts as a result of the proposed amendment.

The Project received planning approval in 2010. On 24 August 2010, Planning Permit No. 20092820 and 20092821 were issued for the Project for the 'Use and development of land for a Wind Energy Facility'. Condition 3 of the permits detail the specifications of the Project, including the number and scale of the turbines. The permits originally specified the tower height of the wind turbines at 80 m, with an overall blade tip height of 131 m above natural ground level.

Approval is now sought to vary the turbine specifications as detailed on the permits. It is proposed to increase the tower height to 117 m, the rotor diameter to 130 m, and overall tip height to 180 m. This would result in an overall increase in height of 49 m from natural ground level. In addition, it is proposed to microsite a number of turbines and realign access tracks and ultimately, reduce the number of turbines on the Project site from the endorsed 95 to 79 wind turbines.

Given the nature of the amendment, any impacts above those approved would be limited to the change in the increase in turbine size, siting, realigned access tracks and number of turbines on the Project.

Berrybank Development Pty Ltd (the Proponent) has engaged Aviation Projects to conduct an aeronautical impact assessment with respect to the proposed amendments.

1.2. Purpose of task

The purpose of this engagement is to consider the impacts to aviation safety arising from the proposed amendments to the existing approval, including the need for obstacle lighting for the Project so that the Proponent can make an informed decision about whether or not to install obstacle lighting, in due consideration of regulatory requirements, acceptable levels of aviation safety and community concerns about the visual impact of obstacle lighting.

1.3. Scope

The scope of the task is to consider the impacts to aviation safety arising from the proposed amendments to the existing approval, including whether obstacle lighting of the wind turbines of the approved Project will be required to maintain an acceptable level of aviation safety. The risk assessment is to be conducted using the methodology outlined in AS/NZS ISO 31000:2009 *Risk Management – Principles and guidelines*.

1.4. Report structure

This report is structured around the following areas of consideration:

- external context;
- internal context;
- risk assessment;
- conclusions; and
- recommendations.

1.5. Methodology

In undertaking this task, the following activities were undertaken:

- current approvals, permits and associated planning material were reviewed to identify obstacle lighting issues;
- the current regulatory context was reviewed;
- a site visit was conducted on 11 March 2011;
- a comparative analysis of the obstacle lighting situation for Victorian wind farms was conducted;
- online resources were investigated for aircraft accidents/incidents associated with wind farms;
- current aviation activities within the vicinity of the Project were investigated;
- applicable stakeholders, including CASA were consulted;
- an Aviation Impact Statement was prepared in accordance with guidance provided by Airservices Australia; and
- the levels of risk associated with aviation activities conducted within the vicinity of the Project site were assessed, including a review of current and planned treatments and consideration of the effect that turbines with or without obstacle lighting will have on the overall level of risk to aviation safety.

1.6. Stakeholders

Stakeholders considered and/or consulted in the preparation of this report include:

- Aerial Agricultural Association of Australia;
- Air Ambulance Victoria;
- Airservices Australia;
- City of Ballarat;
- Civil Aviation Safety Authority;
- Corangamite Shire Council;
- Country Fire Authority Victoria;
- Department of Defence;
- Golden Plains Shire Council;
- Operators of non-regulated aerodromes within the vicinity of the Project;
- Royal Flying Doctor Service; and
- other stakeholders where noted.

1.7. Client material

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

- Berrybank Permit No 20092820/20092821 dated 24 August 2010;
- Email from Union Fenosa Wind Australia, with CASA's response attached, dated 19 February 2016;
- Email from Union Fenosa Wind Australia, dated 5 September 2014;
- Email from Union Fenosa Wind Australia, with attached Site Plan, dated 25 August 2015;
- Email from Union Fenosa Wind Australia, with attached revised wind monitoring tower data, dated 27 August 2015;
- Email from Union Fenosa Wind Australia, with revised wind turbine layout data attached, dated 9 July 2015; and
- others where noted.

1.8. References

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

- Aeronautical Information Package; including AIP Book effective 12 November 2015, and En Route Supplement Australia dated 12 November 2015;
- Aviation Projects, *100402 Berrybank Wind Farm Runway Approach Safety Clearance – Monaro ALA v1.1 130430*, dated 30 April 2013;
- Civil Aviation Safety Authority, *Civil Aviation Regulations 1988 (CAR)*, as amended;
- Civil Aviation Safety Authority, *Civil Aviation Safety Regulations 1998* (CASR), compilation number: 66, dated 22 December 2015;
- Civil Aviation Safety Authority, *Manual of Standards Part 139 – Aerodromes*, version 1.12, dated 13 November 2014;
- Civil Aviation Safety Authority, email from Mr Byron Sullivan re Obstacle marking and lighting of wind farms – status update, 15 July 2011;
- Department of Infrastructure and Regional Development, *The National Airports Safeguarding Framework: Guideline D,* dated 15 July 2012;
- Environment Protection and Heritage Council, *National Wind Farm Development Guidelines DRAFT*, dated July 2010;
- International Civil Aviation Organization (ICAO) Doc 8168 *Procedures for Air Navigation Services—Aircraft Operations* (PANS-OPS);
- ICAO Standards and Recommended Practices, *Annex 14—Aerodromes*;
- Victoria Department of Planning and Community Development, *Policy and planning guidelines for development of wind energy facilities in Victoria*, dated August 2011; and
- other references as noted.

2. EXTERNAL CONTEXT

2.1. Consultation

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

- Aerial Agricultural Association of Australia;
- Air Ambulance Victoria;
- Airservices Australia;
- City of Ballarat;
- Civil Aviation Safety Authority;
- Corangamite Shire Council;
- Country Fire Authority Victoria;
- Department of Defence;
- Golden Plains Shire Council;
- Operators of non-regulated aerodromes within the vicinity of the Project;
- Royal Flying Doctor Service; 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 of Australia Chief Executive Officer Phil Hurst	20 October 2015 Request for consideration sent via email phil@aerialag.com.au	Nil	Nil	Refer to discussion on Aerial Application and Obstacle Marking and Lighting.
AGA Services Rob Boaschen Company owner	Telecon 13 October 2015 Kristen advised to email the owner – Rob Boaschen rob@agaservices.com.au. Email sent on 20 October 2015.	Nil	Nil	Refer to discussion on Aerial Application and Obstacle Marking and Lighting.
Air Ambulance Victoria Anthony de Wit Manager Air Operations	20 October 2015 and 22 January 2016 Emailed request for feedback airops.manager@ambulance.vic.gov.au	Nil	Nil	Nil

Agency/Contact	Activity/Date	Response Date	Issues Raised During Consultation	Action Proposed
Airservices Australia Airport Developments Tony Aiezza	20 October 2015 Emailed request for consideration Airport.Developments@Airservices Australia.com	8 January 2016 Email response received	**Airspace Procedures** With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 382m (1254ft) AHD, the wind farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Ballarat Airport and the NDB-A procedure at Yarrowee aerodrome. Please note that procedures not designed by Airservices at Ballarat Airport were not considered in this assessment. **Air Traffic Control (ATC) Operations** No impact to ATC operations **Communications/Navigation/Surveillance Facilities** This proposal for a wind farm at Berrybank to 382m (1254ft) AHD at the locations provided will not adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.	Nil

Agency/Contact	Activity/Date	Response Date	Issues Raised During Consultation	Action Proposed
Border Air Services Pty Ltd Brett Hiflop	Telecon 13 October 2015 03 5593 1169 0428 528 640	NA	One of the biggest issues are the rotating blades of the wind turbines. If blades are not rotating, it would make the aerial application easier. Increasing height might have an impact on application of fertiliser. Mr Hiflop suggested the fertiliser would have to drop from above the towers if they were rotating. If it could be negotiated with the wind farm operators to stop the blades from rotating, aerial agricultural aircraft could operate below tower height; however, this also depends on relative tower density. Mr Hiflop agreed that, as a net impact, the decrease in tower density would be an improvement regarding the ability to operate within the wind farm site. With respect to herbicides, the application altitude is much lower and the turbines would need to be stopped from rotating in order to safely operate within the confines of the wind farm. Generally, there is an increase in cost to the farmer [the customer] due to the increase in time needed to finish the aerial application due to the extra hazards.	Refer to discussion on Aerial Application and Obstacle Marking and Lighting.

Agency/Contact	Activity/Date	Response Date	Issues Raised During Consultation	Action Proposed
City of Ballarat **John Hartigan** **Airport Manager & Program Development Officer**	20 October 2015 Emailed request for consideration ballcity@ballarat.vic.gov.au 4 November 2015 A reply email was sent to johnhartigan@ballarat.vic.gov.au noting incorrect distance of 30 km (correct distance is approx. 50 km) that was used in City of Ballarat's assessment, and clarification of its assessment. 22 January 2016 The above reply email was resent to johnhartigan@ballarat.vic.gov.au with the addition of Airservices Australia's assessment and re-requesting clarification of the City of Ballarat's assessment.	2 November 2015 Email response received johnhartigan@ballarat.vic.gov.au No response received No response received	Mr Hartigan provided the following comments: *"The Ballarat Airport is approximately 30km's from the proposed wind farm however, during low cloud at times aircrafts try to fly below the cloud. Because of this the Ballarat Airport Advisory committee have requested the new planning permit include the installation of aviation red steady lights on the highest points of the development."* *Condition on new permit:* *"Five to ten aviation red lights complying with the requirements set out by the Civil Aviation Safety Authority (CASA's Manual of Standards) must be installed on top of the turbine towers to the satisfaction of the Responsible Authority."* *Please phone me if you require further information on this matter."*	Nil. Invalid justification for requested permit condition. Refer to discussion on Obstacle Marking and Lighting.

Agency/Contact	Activity/Date	Response Date	Issues Raised During Consultation	Action Proposed
Civil Aviation Safety Authority Dilip Mathew Manager Aerodromes	20 October 2015 Letter sent to Dilip Mathew seeking CASA's position in relation to the Project with specific reference to potential aviation impacts.	19 February 2016 Responding letter addressed to Mr Michael Juttner (Senior Planner, Department of Environment, Land, Water and Planning.	CASA recommends that the wind farm is lit with steady red low intensity lighting at night as per Section 9.4 of the CASA Manual of Standards Part 139. Characteristics for low intensity are stated in subsection 9.4.6. CASA agrees that the turbines that should be lit are those identified in the drawing *'100402-02 Berrybank Wind Farm Obstacle Lighting Design v0.3 151019'.* CASA recommends that the proponent makes the notifications described in the NASF Guideline D.	Refer to discussion on Obstacle Marking and Lighting.
Corangamite Shire Council	20 October 2015 Emailed request for consideration shire@corangamite.vic.gov.au	Nil.	Nil.	Nil.

Agency/Contact	Activity/Date	Response Date	Issues Raised During Consultation	Action Proposed
Country Fire Authority Victoria Wayne Rigg CFA Aviation Officer	Telecon 21 October 2015 Ph: 0439 577 151	Email response 22 October 2015 W.Rigg@cfa.vic.gov.au	Mr Rigg advised that wind farms are hazards, but they are not as bad as wires because wind turbines are much more visible. The positions of wind turbines are not an issue as long as the blades are not rotating. Mr Rigg stated that experience with operating around Waubra Wind Farm has shown that there are no issues. CFA aerial operation crews deal with the obstacles under visual flight rules. Individual wind turbines are treated as just another hazard regardless of overall height. Mr Rigg agreed that there is no net impact significant to CFA aerial operations and generally there is no issue on the condition that wind turbines are able to be stopped rotating. "As discussed from an aerial fire fighting perspective wind towers are treated like any other hazard that we encounter when flying and all of our fire fighting is undertaken under Visual Flight Rules. Procedures must be in place with the operators for the towers to be turned off before beginning aerial fire fighting operations."	Put in place procedures to turn off the rotation of the wind turbines before the beginning of aerial firefighting operations in the vicinity of the Project.

Agency/Contact	Activity/Date	Response Date	Issues Raised During Consultation	Action Proposed
County Helicopters Helicopter Agricultural Services Ashley	Telecon 20 October 2015 03 5338 1999 0417 442 980	NA	Ashley advised that his organisation does quite a lot of work around wind farms and it has an effective working relationship with wind farm operators. County Helicopters only operates during day light hours. The company can achieve 100% coverage of aerial application tasks around wind farms. Regarding wind turbine height issues, there is generally a lot of clearance between the rotor and operating height, which is about 2 m above crop height. Ashley agreed that an increase in the clearance between the ground and the lower part of the rotor would result in a reduced overall impact to aerial application operations.	Refer to discussion on Aerial Application and Obstacle Marking and Lighting

Agency/Contact	Activity/Date	Response Date	Issues Raised During Consultation	Action Proposed
Department of Defence Estate Planning QVT	Request for consideration sent on 20 October 2015 to lpsi.directorate@defence.gov.au	Letter response received on 17 December 2015	There is an ongoing requirement to obtain and maintain accurate information about tall structures, which relates to the erection, extension or dismantling of tall structures the top of which is: a) 30 m or more AGL within 30 km of an aerodrome; or b) 45 m or more AGL elsewhere. The Project will meet the above definition of a tall structure. As tall structures, wind farms can have the potential to pose a number of concerns for Defence, particularly with regard to aircraft safety, military low flying and radar interference. The risk posed by a tall structure to aircraft safety can be minimised if information on the tall structure is conveyed to pilots so that they can fly at a safe margin above the structure. Defence does not object to this Project subject to certain conditions, some of which relate to other agency requirements.	'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm. If LED obstruction lighting is to be provided to the wind turbines, ensure the frequency range of the LED light emitted fall within the range of wavelengths 655 to 930 nanometres, thus being visible to persons using night vision devices. Consult Defence should there be any subsequent modification in the wind turbine height or scale of development.

Agency/Contact	Activity/Date	Response Date	Issues Raised During Consultation	Action Proposed
Field Air Group of Companies Steve Rossington Chief Pilot	Telecon 19 October 2015 03 5330 9300	NA	Mr Rossington advised that his position in regards to wind farms is aligned with AAAA's position. He indicated that wind monitoring towers are the biggest danger. He stated that "if you don't know where to look, you cannot see them." Mr Rossington stated that wind monitoring towers are raised without notice and in some cases in close proximity to air strips that are used by aerial agricultural operators. He advised that one time, when he could not get back to Ballarat Airport due to weather, he had turned final approach to land at an airstrip (that is used sometimes when weather closes in) and he noticed a wind monitoring tower a few hundred metres away, which he had no idea was there. If he had made a right hand circuit, he would have collided with it. Mr Rossington was not sure of the solution regarding the conspicuity of wind monitoring towers, whether there should be balls put on the supporting wires, a light to be installed or to make the towers different colours, but he concluded that "the wind monitoring towers just need to stand out more".	Refer to discussion on Aerial Application and Obstacle Marking and Lighting

Agency/Contact	Activity/Date	Response Date	Issues Raised During Consultation	Action Proposed
Golden Plains Shire Council	Request for consideration sent on 20 October 2015 to Enquiries@gplains.vic.gov.au	Received notification of email receipt on 20 October 2015. No response to the request for consideration was received.	Nil.	Nil.
Royal Flying Doctor Service	13 October 2015 03 8412 0400 Allison 0936 – requested callback	No response received.	Nil.	Nil.
Western Aerial Tod Miller	19 October 2015 0418 306 448 10:45 left message.	Nil.	Nil.	Nil.

2.2. Conclusions of the Berrybank Wind Energy Facility Panel Report

A Wind Energy Facility Panel was appointed under Section 97E, 153 and 155 of the Planning and Environment Act 1987 to consider submissions and make recommendations to the Minister for Planning. The Panel released a report titled Berrybank Wind Energy Facility dated May 2010. With respect to obstacle lighting, the report made the following recommendation:

> *The Panel concludes that 'all-night' aviation obstacle lighting is unnecessary and an unacceptable impost on the regional community. If the aviation regulatory authority or other body requires aviation obstacle lighting then it should only be illuminated on demand, whether in the detected presence of aircraft or in low visibility daytime situations (fog or smoke).*
>
> *The Panel recommends:*
>
> > *27. Aviation obstacle lighting of the Berrybank Wind Farm should in the first instance be prohibited via condition, and only allowable via secondary consent on the basis of 'on demand' illumination.*
>
> *The Panel has recommended a draft condition accordingly.*

The Planning Permits reflect this recommendation.

2.3. Department of Environment, Land, Water and Planning

The proposed development was the subject of Planning Permits 20092820/20092821, approved in 2010 with the Victorian Department of Planning (now called Department of Environment, Land, Water and Planning).

On 1 October 2007 the Victorian Department of Planning and Community Development issued an Inquiry Direction – Aviation Lighting, in which it was directed that a lighting plan for the Project, if it was required to be lit, was to be exhibited.

On 24 August 2010 the Minister for Planning issued Planning Permits 20092820/20092821 for the proposed construction and operation of a wind farm consisting of a total of up to 99 turbines and associated infrastructure, as described in the Planning Permits.

Conditions 6, 7 and 8 address lighting.

> *6. Except in the case of an emergency or any operational call-out, no external lighting of infrastructure associated with the wind energy facility, other than low-level, low-intensity security lighting and aviation obstacle lighting in accordance with Condition 8 below, may be installed or operated without the further written consent of the Minister for Planning.*
>
> *7. Aviation obstacle lighting must not be installed unless the written consent for the Minister for Planning has been obtained.*
>
> *8. If consent to install aviation obstacle lighting is obtained, it must be installed under the following conditions:*
>
> *a) the aviation obstacle lighting must be installed such that it is activated only:*
>
> > *i. if at night, when an aircraft is in the immediate vicinity of the wind energy facility; and*

ii. during low visibility daytime conditions such as the existence of smoke and fog;

b) for each lit turbine, the lighting must consist of a pair of lights mounted above the nacelle so that one is visible from an aircraft approaching from any direction;

c) each light must be a red medium intensity, flashing light as defined by Civil Aviation Safety Authority; each light must be shielded so as the restricted the vertical spread of light to not more than 3 degrees and light spread below the horizontal to not more than 1.0 degree;

d) all lights must flash in unison;

e) the duration of the light flash must be the minimum period recommended by CASA and the duration of the period between the flashes must be the maximum period recommended by CASA; and

f) before the wind farm is commissioned, a lighting maintenance plan must be prepared to the satisfaction of the Minister for Planning.

2.4. Environment Protection and Heritage Council

The Environment Protection and Heritage Council (EPHC) has produced Draft National Wind Farm Development Guidelines, dated July 2010, to complement existing planning and development processes. The Guidelines are intended to be best practice and not mandatory. The twelve month evaluation period has concluded, but no revision or final version of the Guidelines was available at the time of writing.

Guidance notes provided under section 3.7 Aircraft safety state as follows:

> *The physical intrusion of towers and blades into the airspace used by aircraft is addressed by the Civil Aviation Safety Authority (CASA) guidelines, which are currently under review. The CASA guidelines, once finalised, may indicate that night lighting should be installed on some or all turbines within the wind farm. This, in turn, may pose a visual impact that will need to be considered in the landscape assessment and in the birds and bats assessment.*

2.5. Civil Aviation Safety Authority

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

2.5.1. 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 (AGL) to inform CASA. This requirement is to allow CASA, under CASR 139.370, to assess the effect of the structure on aircraft operations and determine whether or not the structure will be a hazardous object because of its location, height, or lack of marking or lighting.

On 20 October 2015 a letter was addressed to Dilip Mathew (Manager Aerodromes of CASA), seeking CASA's position in relation to the proposed development, with specific reference to potential aviation impacts. On 19 February 2016, Mr Mathew responded in a letter to Mr Michael Juttner (Senior

Planner, Department of Environment, Land, Water and Planning). An extract of the correspondence is copied below:

> *...*
>
> *CASA has assessed the proposed Berrybank Wind Farm based on the revised maximum height of 180m AGL.*
>
> *CASA recommends the wind farm is lit with steady red low intensity lighting at night as per Section 9.4 of the CASA Manual of Standards Part 139. Characteristics for low intensity lights are stated in subsection 9.4.6. CASA agrees that the turbines that should be lit are those identified in the drawing '100402-02 Berrybank Wind Farm Obstacle Lighting Design v0.3 151019'.*
>
> *CASA recommends that the proponent makes the notifications described in the NASF Guideline D.*
>
> *...*

CASA recommends that the Proponent makes the notifications described in the NASF Guideline D. Extracts of the paragraphs in the NASF Guideline D publication that are applicable to the Project are copied below:

> *21. The Aeronautical Information Service of the Royal Australian Air Force (RAAF AIS) maintains a database of tall structures in the country. The RAAF AIS should be notified of all tall structures meeting the following criteria:*
>
> - *30 metres or more above ground level for structures within 30km of an aerodrome; or*
> - *45 metres or more above ground level for structures located elsewhere.*
>
> *40. There is no requirement for CASA to be notified if a proposed wind turbine or wind monitoring tower is less than 150m in height and does not infringe the OLS of an aerodrome. However, they should still be reported for inclusion in the national database of tall structures maintained by the Royal Australian Air Force (RAAF). Information on reporting of tall structures may be found in an advisory circular issued by CASA 'AC 139-08(0) Reporting of Tall Structures'.*

Mr Mathew did not provide any of CASA's analysis or conclusions of its assessment in order to provide an explanation for its recommendation to have the Project lit with steady red low intensity lighting.

2.5.2. Manual of Standards 139--Aerodromes

Chapter 7 of MOS 139 sets out the standards applicable to obstacle restriction and limitation.

Section 7.1.5 deals with objects outside the obstacle limitation surfaces (OLS):

7.1.5 Objects Outside the OLS

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

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

9.4.2.2 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.

9.4.2.5 High intensity obstacle lights are flashing white lights used on obstacles that are in excess of 150 m in height. The turbines will be located outside the obstacle limitation surfaces of an aerodrome and will be more than 150 m AGL (up to 180 m AGL). The risk assessment prepared for this report concluded that there will be an acceptable level of aviation safety without obstacle lighting and therefore there will be no requirement for obstacle lighting under the provisions of MOS 139 Chapter 9.

2.5.3. Advisory Circular 139-18(0) *Marking and lighting of wind farms*

CASA previously provided guidance on the marking and lighting of wind farms in Advisory Circular (AC) 139-18(0) *Obstacle Marking and Lighting of Wind Farms*, dated July 2007. This document was withdrawn from publication in 2008.

No replacement guidance has been developed or published by CASA since the withdrawal of AC 139-18(0).

It can be concluded that there is no regulatory obligation to conform to the guidance provided in AC 139-18(0), since it has been withdrawn from publication.

2.6. International Civil Aviation Organization

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

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

6.4 Wind turbines

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

Note.— See 4.3.1 and 4.3.2.

Markings

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

Lighting

6.4.3 **Recommendation.—** *When lighting is deemed necessary, medium-intensity obstacle lights should be used. In the case of a wind farm, i.e. a group of two or more wind turbines, it should be regarded as an extensive object and the lights should be installed:*

a) to identify the perimeter of the wind farm;

b) respecting the maximum spacing, in accordance with 6.3.14 [900 m], between the lights along the perimeter, unless a dedicated assessment shows that a greater spacing can be used;

c) so that, where flashing lights are used, they flash simultaneously; and

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

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

Sections 4.3.1 and 4.3.2 of Annex 14 state as follows:

4.3 Objects outside the obstacle limitation surfaces

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

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

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

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

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

Where these SARPs are not met, a difference must be filed.

Under the provisions of ICAO Annex 14 4.3.2 recommendation (and MOS 139 7.1.5.2), the proposed turbines would be considered as obstacles because the heights of the turbines are proposed to be greater than 150 m (492 ft) AGL.

Concerning ICAO Annex 14 4.3.1 recommendation, CASA (the appropriate authority) must be consulted because the turbines are proposed to reach a height of greater than 110 m AGL.

The risk assessment prepared for this report concludes that there will be an acceptable level of aviation safety without obstacle lighting and therefore there will be no requirement for obstacle lighting under the provisions of ICAO Annex 14 section 6.4.1.

2.7. Aviation Impact Statement

An Aviation Impact Statement (AIS) for the Project was produced in support of this risk assessment by IDS Australasia, dated 15 October 2015. The AIS made the following conclusions:

> *In summary, the Aviation Impact Statement has determined that:*
>
> *1) The blade tip elevation of the highest WTG will not exceed 382 m (1253 ft) AHD and as such:*
>
> - *Will not penetrate any OLS surfaces;*
> - *Will not penetrate any PAN-OPS surfaces;*
> - *Will not have an impact on nearby designated air routes;*
> - *Will not have an impact on prescribed airspace;*
> - *Is wholly contained within Class G airspace; and*
> - *Will not have an impact on existing local aviation activities.*
>
> *2) The [wind turbine generators] are located outside the clearance zones associated with aviation navigation aids and communication facilities.*
>
> *3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).*
>
> *The wind farm amendment has been assessed as not having an impact on prescribed airspace. The development is considered approvable under the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.*

A copy of the AIS is provided at Annexure 1.

In an email from Airport Developments (Airservices Australia), dated 8 January 2016, it was determined that there will be no aviation impacts on airspace procedures that have been designed by Airservices or communication, navigation and surveillance (CNS) facilities. An extract of the email is copied below:

> *I refer to the application for Berrybank Wind Farm Project in Victoria.*
>
> *Airspace Procedures*
>
> *With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 382m (1254ft) AHD, the wind farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Ballarat Airport and the NDB-A procedure at Yarrowee aerodrome.*
>
> *Please note that procedures not designed by Airservices at Ballarat Airport were not considered in this assessment.*
>
> *Air Traffic Control (ATC) Operations*
>
> *No impact to ATC operations*
>
> *Communications/Navigation/Surveillance Facilities*
>
> *This proposal for a wind farm at Berrybank to 382m (1254ft) AHD at the locations provided will not adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.*

Based on the information provided by Airservices Australia and IDS Australasia, it can be concluded that the Project will not have an impact on airspace procedures or communication, navigation and surveillance (CNS) facilities.

2.8. Nearby aerodromes

Ballarat Airport

Ballarat Airport is a registered aerodrome, with two main runways 05/23 (1265 m) and 18/36 (1245 m), and an unrated/unsealed runway 13/31 (568 m). The aerodrome is located approximately at bearing 032 degrees 49.6 km from the closest proposed turbine at the Project.

The AIS has addressed the matters associated with the operational airspace at the aerodrome.

The aerodrome has approximately 49 000 runway movements per year. However, the aerodrome has the capacity to process up to approximately 60 000 movements per year, which is constrained by its G Class airspace, otherwise the aerodrome has the capacity of up to 100 000 movements per year. The main flying operation at the aerodrome is flying training, accounting for approximately 2/3 of aircraft movements, and includes local and visiting flying schools. Other operations conducted at the aerodrome include recreational aviation uses, community clubs, emergency services and other aviation businesses operating aircraft below 5700 kg maximum take-off weight. No regular public transport operations are conducted at Ballarat Airport.

In an email sent on 20 October 2015, the City of Ballarat was requested to provide its consideration of the Project. In a responding email sent on 2 November 2015, Mr John Hartigan provided the following comments:

> *...The Ballarat Airport is approximately 30km's from the proposed wind farm however, during low cloud at times aircrafts try to fly below the cloud. Because of this the Ballarat Airport Advisory*

committee have requested the new planning permit include the installation of aviation red steady lights on the highest points of the development.

Condition on new permit:

> *"Five to ten aviation red lights complying with the requirements set out by the Civil Aviation Safety Authority (CASA's Manual of Standards) must be installed on top of the turbine towers to the satisfaction of the Responsible Authority. ..."*

In a responding email dated 4 November 2015, Aviation Projects clarified to Mr Hartigan that the Project is located approximately 50 km from Ballarat Airport and not 30 km as noted. In addition, Aviation Projects provided Mr Hartigan with the conclusions made in the AIS (see Section 2.7 of this report). Aviation Projects also stated the following:

...We are very interested in finding out more about the circumstances in which aircraft would fly below cloud, and the benefit that would be provided by low intensity steady red obstacle lighting.

It should be noted that the hub height for the proposed turbines, on which any obstacle lighting would be mounted, is planned to be approximately 117 m (383 ft) above ground level (AGL).

Would you please provide some further details:

1. *What types of aircraft are likely to be affected?*
2. *What type of operations would be conducted by these aircraft?*
3. *To what height would aircraft be descending below cloud– during the day and/or at night?*
4. *Would aircraft be descending below cloud during the day and/or at night?*
5. *What minimum visibility requirements apply to these aircraft/operations?*
6. *What minimum obstacle clearance requirements apply to these aircraft/operations?*
7. *What is the connection between these aircraft and Ballarat Airport?*

On 22 January 2016, Aviation Projects provided Mr Hartigan with an additional email with the response by Airservices Australia (see Section 2.7 of this report).

No responding email has been received at the time of finalising this report.

Monaro ALA

In photographs taken from various angles at different positions on Monaro aeroplane landing area (ALA), which is on a property of a participating land owner (Mr Glover), it can be seen that the area of the Project consists of relatively flat and gently rolling terrain. The photographs are shown in Figure 1.

Figure 1 View of Monaro ALA within the Project location

The location of Monaro ALA relative to the project area is shown in Figure 2.

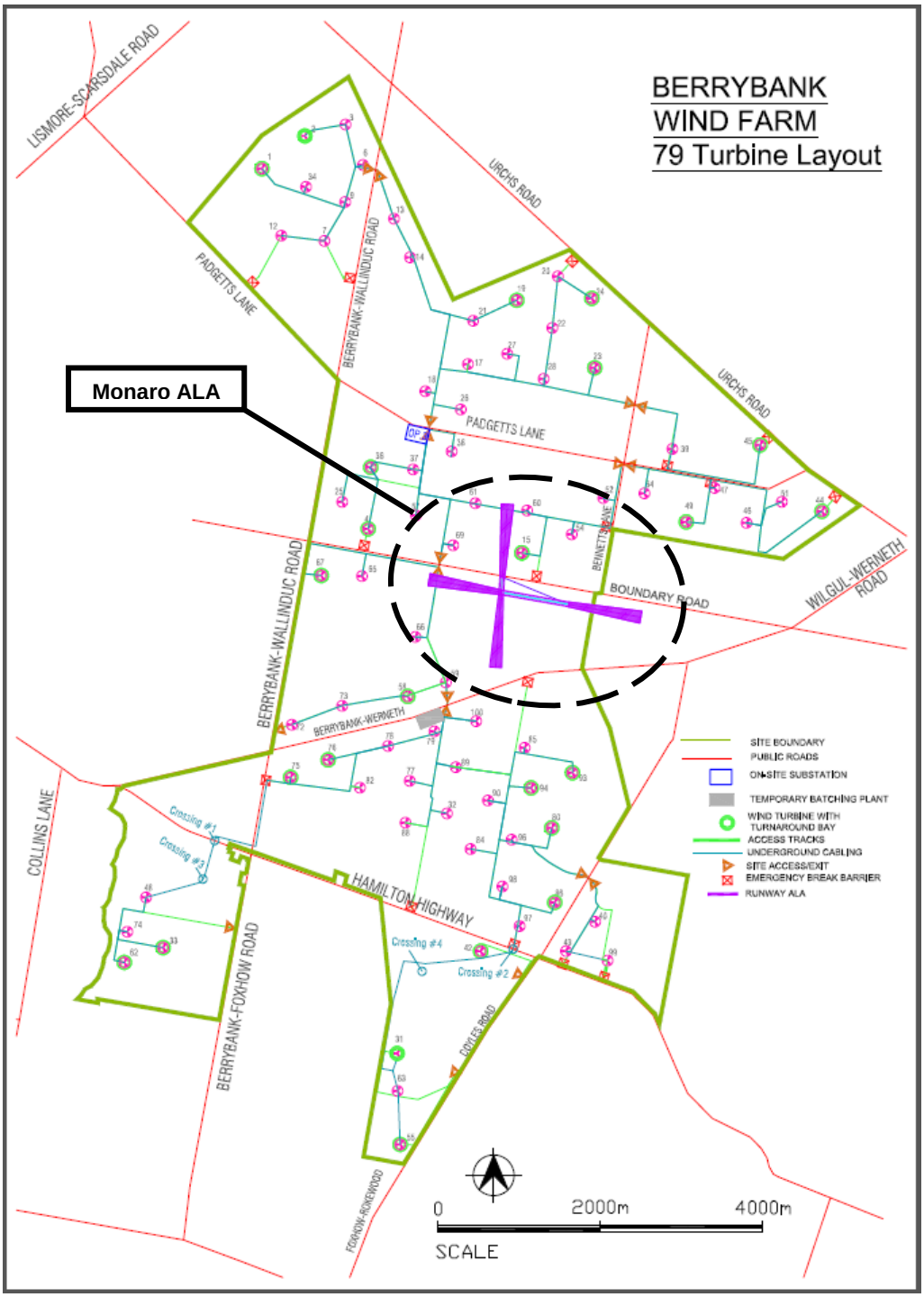

Figure 2 Monaro ALA relative to the project area

A separate study report produced by Aviation Projects, titled *100402 Berrybank Wind Farm Runway Approach Safety Clearance – Monaro ALA v1.1 130430*, dated 30 April 2013, recorded the following conclusions:

> *If the wind turbines of Berrybank Wind Farm are constructed in their approved locations, the physical characteristics and approach and take-off areas of runway 09/27 of the Monaro ALA will meet the guidelines provided in CAAP 92-1(1). It will therefore be suitable for Mr Glover's operations.*
>
> *To provide a greater margin of safety, it is suggested that turbine 65 be moved south the maximum distance permitted under the current approval (understood to be 100 m). Consideration should also be given to widening the current runway by duplicating its width to the north. This will not only provide the recommended 15 m runway width, but allow a slight clockwise re-orientation of the runway centreline which will provide greater clearance along the extended centreline from turbines 68, 16, 65 and 67.*
>
> *Application of the recommended approach and take-off areas virtually invalidates runway 17/35 for operational use under the guidance provided in CAAP 92-1(1). However, the approach and take-off areas (if properly located on the runway so that they were clear of other obstacles such as trees) would be clear of the turbines if they are located as proposed (subject to the inclusion/final location and blade length of turbine 15).*
>
> *Notwithstanding the limited utility and marginal safety associated with operations on runway 17/35, consideration should be given to moving turbine 15 further to the east to reduce the potential for infringement of the northern approach/take-off area.*

With respect to the turbines in the abovementioned conclusion, the proposed amendment to the approved Planning Permits has resulted in a net improvement in safety margins, as shown in Table 2.

Table 2 Net impact of proposed amendment on Monaro ALA

Turbine ID	Recommendation from previous study	Proposed amendment	Remarks
15	Move turbine 15 further to the east	Microsited 94 m northeast	Improvement in safety margin
16	Re orientation of the runway 09/27 centreline	Removed	Improvement in safety margin
65	Turbine 65 be moved south the maximum distance permitted	Microsited 85 m southeast	Improvement in safety margin
67	Re orientation of the runway 09/27 centreline clockwise	Microsited 74 m northeast	No improvement in safety margin, but sufficiently distant
68	Re orientation of the runway 09/27 centreline clockwise	Removed	Improvement in safety margin

2.9. Aircraft operator characteristics

2.9.1. Passenger transport operations

Regular public transport (RPT) and passenger carrying charter operations are generally operated under the Instrument Flight Rules (IFR). The AIS has determined that no IFR aircraft operations will be impacted by the Project.

2.9.2. Private operations

Private operations are generally conducted under the Visual Flight Rules (VFR) during day light hours or at night, and some under IFR. 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). It is expected that the wind turbines will be sufficiently visually conspicuous to pilots conducting VFR operations to enable appropriate obstacle avoidance manoeuvring if transiting the area of the Project.

Night VFR aircraft operations are required to conform to IFR applicable altitude requirements, which are not impacted by the Project as stated in the AIS.

2.9.3. 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 turbines and transmission line was assessed.

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.

Local aerial application operators consulted during the consultation activities have stated that a wind farm would, in all likelihood, prevent aerial agricultural operations in that particular area, and that fixed wing aircraft are limited to a greater degree than rotary wing aircraft. However, one operator that was consulted advised that it frequently operates around wind farms and can achieve 100% coverage within the wind farm with rotary wing aircraft. Properties adjacent to the Project would have to be assessed on an individual basis.

Generally, it was found that the most significant issues with operating around wind farms are the following:

(1) **The rotating blades of the wind turbines** – stopping the blade rotation of the wind turbines may allow aerial agricultural operations below tower height, subject to the density of with turbines. Herbicides are required to be applied at lower altitudes and this application would be hindered more significantly by wind turbine blade rotation. If wind turbine rotations were stopped during agricultural operations in the Project's vicinity, the impact on aerial agricultural operations due to this issue is likely to be alleviated.

(2) **The height margin between the rotor blade at its lowest point and the ground** – the greater clearance between the aerial agricultural operation heights (determined by ground level) and the lowest part of the wind turbine rotor diameter, the lesser the impact on aerial agricultural operations. As the Project will result in an increased height margin between the wind turbine blades and ground level, the impact on aerial agricultural operations due to this issue will be reduced.

(3) **Wind turbines density –** reducing the number of wind turbines, thereby reducing the number of turbines per unit area, would result in a net improvement with respect to impacts on aerial agricultural operations. As the Project will result in a reduced number of turbines within the same project area, the wind turbine density is reduced and therefore the impact due to this issue on aerial agricultural operations is reduced.

(4) **Visibility of wind monitoring towers (WMT) –** WMTs are generally very difficult to see unless the pilot is aware of their location. The locations of the WMTs in this Project area have been notified to RAAF AIS.

Based on the information provided during the consultation activities, it is reasonable to conclude that there will be a reduced net impact of the changes of the existing wind farm approval on aerial agricultural operations. Moreover, the impacts may be further alleviated by an effective and functional working relationship between the Proponent and aerial agricultural operators that are likely to operate in the vicinity of the Project.

2.9.4. Aerial fire fighting

On 21 October 2015, a teleconference was conducted with Wayne Rigg (Country Fire Authority (CFA) Aviation Officer). Mr Rigg advised that wind farms are hazards, but they are not as bad as wires because wind turbines are much more visible. The wind turbines are not an issue as long as they are turned off (the rotors are not rotating).

Mr Rigg stated that experience with operating around Waubra Wind Farm has shown that there are no issues. CFA aerial operation crew deal with the obstacles under visual flight rules. The wind monitoring towers are treated as just another hazard, regardless of overall height.

Mr Rigg agreed that there is no net impact significant to CFA aerial operations and generally there is no issue on the condition that wind turbines are able to be stopped rotating.

Mr Rigg provided the following comments in an email dated 22 October 2015:

> *As discussed from an aerial fire fighting perspective wind towers are treated like any other hazard that we encounter when flying and all of our fire fighting is undertaken under Visual Flight Rules.*
>
> *Procedures must be in place with the operators for the towers to be turned off before beginning aerial fire fighting operations.*

Based on the information provided during this consultation activity, it is reasonable to conclude that there is no additional impact significant to aerial fire lighting and generally no issue subject to the ability to stop the wind turbine blades from rotating.

2.9.5. Emergency services

On 20 October 2015, a request for consideration was sent to Mr de Wit, who is the Air Manager Air Operations for Air Ambulance Victoria. A follow-up email was sent on 22 January 2016. No response was received.

However, Mr de Wit provided responding emails to a request for consideration of impacts of Hawkesdale and Ryan Corner wind farms in Victoria on Air Ambulance Victoria's operation. The advice provided in this correspondence includes advice that applies to wind farms generally. It is reasonable to conclude that this general advice also applies to the Project.

On 14 October 2015, Mr de Wit provided a responding email to the request for consideration of Hawkesdale and Ryan Corner wind farms, which included comments the Air Ambulance Victoria's rotary wing aircraft service provider. An extract of the general advice provided in the email is copied below:

> *"I have received the following feedback from Australian helicopters in relation to ... [the Project]:*

> *AHPL* [Australian Helicopters Pty Ltd] *do not have any specific operating protocols in regards to wind turbine farms. Wind farms are annotated as obstacles on our operational maps. As the new proposed turbines will be above 360 feet (110m) I think there will be a requirement for them to have an obstacle light placed on top. Any man made obstacle above 360 feet will also be registered with Air services Australia and will be annotated on aviation maps. This is an advantage to us over other wind farms that do not exceed the 360' limit and are therefore not shown on our documents.*
>
> *…"*

On 31 December 2015, Mr de Wit provided a second responding email to the request for consideration of Hawkesdale and Ryan Corner wind farms, which included comments by Trent Edmonds (Flight Operations Manager – Ambulance Victoria Contract) of Pel-Air Essendon, which is the fixed wing service provider for Air Ambulance Victoria. An extract of the email is copied below:

> *"Both proposed wind farms [Ryan Corner and Hawkesdale] will have little, to no affect, on the service delivery of the fixed wing operations.*
>
> *Given the height of the proposed obstacles, the winds farms will need to be reported to Airservices Australia for inclusion in the aeronautical maps and charts for the area.*
>
> *…*
>
> *In regards to operational procedures; as we conduct all flights IFR, pilots will either comply with published minimum descent altitudes published on the Instrument Approach plates or, when operating by visual reference, operate not lower than 500 feet above the highest obstacle within 600 metres of the aircraft (Civil Aviation Regulation 157 refers). This ensures obstacle and terrain clearance at all times."*

In consideration of the general advice provided in the feedback from Air Ambulance Victoria with respect to Hawkesdale and Ryan Corner wind farms, which would reasonably apply to the Project, it can be concluded that the Project will not have a significant impact of the operations of Air Ambulance Victoria.

2.10. Light characteristics

If obstacle lighting is required, installed lights should be designed according to the criteria set out in the applicable regulatory material. Previously, the generally accepted lighting design characteristics includes two flashing red medium intensity obstacle lights which would have been recommended to be provided. However, for the Project, CASA has recommended steady red low intensity lighting.

A summary of design characteristics acceptable by CASA is provided below:

- two steady red low intensity obstacle lights should be provided;
- the light fixtures should be mounted sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction; and
- the characteristics of the obstacle lights should be in accordance with the applicable standards in MOS 139.

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

- MOS 139 section 9.4.6 outlines Characteristics of Low Intensity Obstacle Lights.

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

  (a) fixed lights showing red;

  (b) a horizontal beam spread that results in 360° coverage around obstacle;

  (c) a peak intensity of 100 cd minimum;

  (d) a vertical beam spread (to 50% of peak intensity) of 10°;

  (e) a vertical distribution with 100 cd minimum at +6° and +10° above the horizontal; and

  (f) not less than 10 cd at all elevation angles between –3° and +90° above the horizontal.

  Notes:

  1. The intensity level is higher than ICAO standards because in Australia only obstacles assessed as significant to aircraft operations are required to be provided with obstacle lighting.

  2. Currently the intensity requirement is normally met by a double-bodied light fitting which also provides a degree of redundancy.

  3. Double-bodied light fittings should be orientated so that they show the maximum illuminated surface towards the predominant, or more critical, direction of aircraft approach.

  4. For objects that do not infringe the obstacle limitation surfaces, and where CASA has not determined that obstacle lights are required, if the object owner wishes, of their own volition, to provide obstacle lights, it is sufficient for these low intensity obstacle lights to have the following intensity distribution: peak intensity 32 cd minimum, vertical beam spread of 10°, and 32 cd minimum at +6° and +10° elevation.

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

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

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

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

  9.4.7.3 The peak effective intensity is to be 2,000 ± 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.

2.11. Visual impact of night lighting

Generally accepted considerations regarding minimisation of visual impact are provided below for consideration in the 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.
- All obstacle lights on a wind farm should be synchronised so that they flash simultaneously.
- A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the rotor blades of light from the obstacle lights, without compromising the daytime conspicuity of the overall turbine.

2.12. Marking of turbines

ICAO Annex 14 Vol 1 Section 6.4.2 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, as an alternative to white, an off-white or light grey colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.

2.13. Marking of wind monitoring towers

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

> *8.10.2.6 Masts, poles and towers must be marked in contrasting bands with the darker colour at the top, as shown in Figure 8.10-3. The bands must be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less.*
>
> *8.10.2.8 Wires or cable obstacles must be marked using three-dimensional coloured objects such as spheres and pyramids, etc; of a size equivalent to a cube with 600 mm sides, spaced 30 m apart.*

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

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

2.14. Future regulatory requirements and guidance

The National Airports Safeguarding Advisory Group (NASAG), comprising of Commonwealth, State and Territory Government planning and transport officials, the Australian Government Department of Defence, the Civil Aviation Safety Authority (CASA), Airservices Australia and the Australian Local Government Association (ALGA), has developed the National Airports Safeguarding Framework (the Framework).

The National Airports Safeguarding Framework is a national land use planning framework that aims to:

- improve community amenity by minimising aircraft noise-sensitive developments near airports; and
- improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions through guidelines being adopted by jurisdictions on various safety-related issues.

Guideline D of the Framework deals with wind farm developments: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms) / Wind Monitoring Towers.*

The Framework and any future development or amendment of regulations or guidance could potentially affect the requirement for lighting and/or applicable design specifications.

Consideration of the need for obstacle lighting and the final layout and design specification is therefore subject to confirmation of applicable regulatory requirements and guidance. This consideration, in the form of an updated aeronautical study (a detailed and thorough risk assessment using internationally recognised standards) as previously described, should occur once the final layout is known and prior to installation of the lights during construction.

2.15. Comparative analysis

Publicly available information and telephone conversations with applicable developers and/or operators revealed that none of the wind farms that were identified and noted in Table 3 operated obstacle lighting on the wind turbines.

Waubra previously operated obstacle lighting. In 2012 the Minister for Planning issued consent for the obstacle lighting to be switched off at the Waubra Wind Farm. This consent followed the advice of an aviation risk assessment prepared on behalf of the proponent, which determined that 'the wind farm did not require aviation obstacle lighting and switching the lights off would not pose an unacceptable risk to aircraft'.

Oaklands Hill and Macarthur also have obstacle lighting installed but not operated. A representative of the project owner advised that CASA requested that the lights be turned off.

A non-exhaustive list of the wind farms with wind turbines that have the greatest overall blade tip heights in Victoria and the status of obstacle lighting on the wind farms is provided in Table 3.

Table 3 Obstacle lighting on Victorian wind farms

Wind Farm Name	*Status*	*Maximum blade tip height*	*Obstacle Lighting*
Ararat	Construction	135 m	Not yet determined.
Bald Hills	Operational	125 m	Status not determined.
Berrimal	Approved	185 m	Not yet determined.
Berrybank	Approved	131 m	No obstacle lighting (permit condition).
Bulgana	Approved	196 m	Not yet determined.
Cape Nelson North	Operational	126.3 m	No obstacle lighting.
Cape Sir William Grant	Operational	126.3 m	No obstacle lighting.
Chepstow	Construction	126.3 m	Not yet determined.
Cherry Tree	Approved	159 m	Not yet determined.
Coonooer Bridge	Construction	150 m	Not yet determined.

Wind Farm Name	Status	Maximum blade tip height	Obstacle Lighting
Crowlands	Approved	147 m	Not yet determined.
Hawkesdale	Approved	126.3 m	Not yet determined.
Lal Lal	Approved	130 m	Not yet determined.
Macarthur	Operational	140 m	Lighting installed but not used. CASA authorised that the lights be turned off.
Moorabool	Approved	150 m	Not yet determined.
Mortlake South	Approved	141 m	Not yet determined.
Mount Mercer	Construction	126 m	No obstacle lighting.
Mt Gellibrand	Approved	150 m	Not yet determined.
Oaklands Hill	Operational	124 m	Lighting installed but not used. CASA authorised that the lights be turned off.
Ryan Corner	Approved	126.3 m	Not yet determined.
Salt Creek	Approved	150 m	Not yet determined.
Waubra	Operational	119.8 m	Lights installed, non-operative. Minister for Planning issued consent in 2012 for obstacle lighting to be switched off.
Woolsthorpe	Approved	135 m	Proponent advises no obstacle lighting to be installed.

3. INTERNAL CONTEXT

3.1. Project description

The Project is planned to be located approximately 82 km west of Geelong along the Hamilton Highway, between the townships of Lismore and Cressy in Victoria.

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

The planned Project location is shown in the World Aeronautical Chart extract in Figure 3 (source OzRunways).

Figure 3 Site Map

A preliminary turbine layout, sourced from the Proponent dated 25 August 2015, is shown in Figure 4.

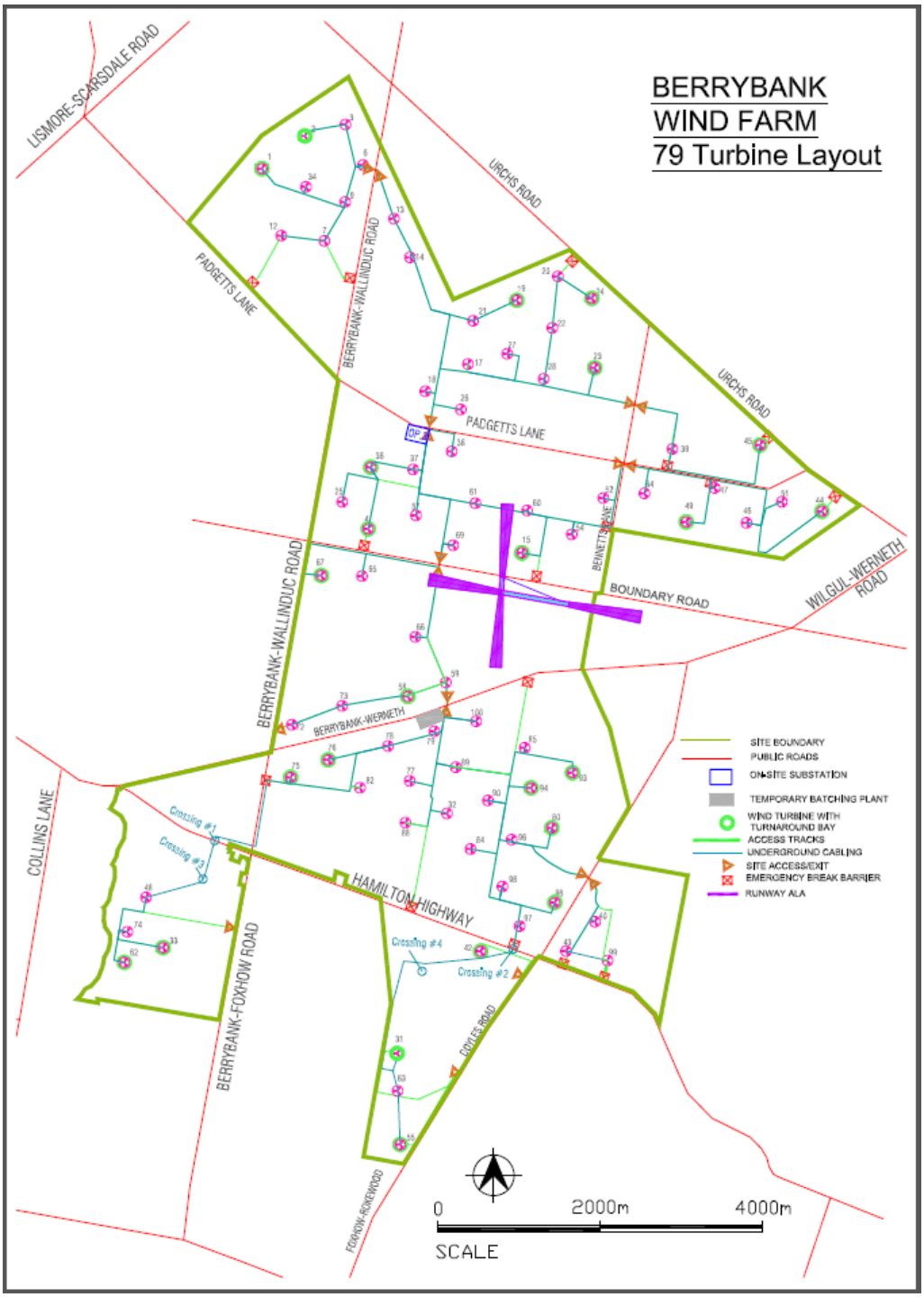

Figure 4 Preliminary turbine layout

3.2. Wind turbine description

The approved planning permits (Planning Permits 20092820/20092821) specify that the wind turbines, nacelles and rotor blades must be of a colour or have such markings that minimises ground level impact, and the colours and finishes of all other buildings and ancillary equipment must be such as to minimise the impact, to the satisfaction of the Minister for Planning. Furthermore, it specifies that the wind turbines are to have a maximum height of 131 m (429.8 ft) AGL.

However, the Proponent advises that the proposed wind turbine maximum heights at the Project have been revised and is now 180 m AGL (591 ft) to the top of the blade tip, with a maximum hub height of 117 m AGL (384 ft) and a rotor diameter of up to 130 m.

The maximum ground elevation, located at the proposed wind turbines identified as 3, 6 and 14, is 202 m AHD (663 ft above mean sea level (AMSL)), resulting in a maximum blade tip height of 382 m AHD (1253 ft AMSL).

The proposed amendment will result in the following changes:

- The number of turbines decreased by 16;
- The maximum blade tip height increased by 49 m;
- The maximum ground elevation increased by 2 m due to micrositing; and
- The maximum blade tip height increased by 51 m.

A list of the wind turbine coordinates, base heights and hub heights is provided at Annexure 2.

3.3. Wind monitoring tower description

The Proponent advises there are four wind monitoring towers in the Project – one 40 m (131 ft), two 60 m (197 ft) and one 80 m (262 ft) AGL. They are not marked or lit, nor are they required to be. Their location and other applicable details have been advised to RAAF AIS. Removal or retention of these wind monitoring towers is subject to final micrositing of the wind turbines (in accordance with any Planning Permits Conditions).

Table 4 shows the wind monitoring tower data applicable to the Project.

Table 4 Wind monitoring tower data

Tower ID	Datum	Zone	UTM X	UTM Y	Elevation (m)	Type	Height (m)
BB_2	WGS84	54H	721533	5797727	182	Tubular	40m
BB_3	WGS84	54H	719770	5800681	184	Tubular	60m
BB_4	WGS84	54H	720762	5794592	180	Lattice	80m
BB_5	WGS84	54H	723066	5798446	190	Tubular	60m

The Proponent also advises that it is considering erection of one or more hub height wind monitoring towers for turbine power curve verification. The location of these towers is yet to be determined, although it is envisaged that they would be positioned within rather than on the perimeter of a cluster of turbines.

3.4. Turbine lighting design

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

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

In addition, the lighting proposal has been based on:

- the specific configuration of the Project 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.

Due to the proposed configuration of the Project, however, not all lit turbines are within 900 m of each other—although the apparent intermediate distance (approaching from any direction) is minimised (and retained under approximately 1 nm) due to the location of intermediate lights set further back from turbines on the perimeter.

Given the minimum requirement for 5000 m visibility for flight under the visual flight rules, the lighting design should provide sufficient warning to pilots that they will be able to manoeuvre their aircraft to avoid the turbines.

If obstacle lighting is required, obstacle lighting would be installed on the following 35 turbines: 1, 3, 9, 12, 14, 15, 18, 20, 21, 23, 31, 36, 39, 42, 44, 45, 46, 48, 52, 55, 61, 62, 66, 67, 72, 73, 75, 80, 82, 84, 86, 88, 93, 99 and 100.

This lighting design is 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.

A graphic representation of the lighting design which identifies those turbines proposed to be lit is provided in Annexure 3.

4. 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.

4.1. Likelihood

Likelihood is defined in AS/NZS ISO 3100:2009 as the chance of something happening. Likelihood descriptors used in this report are as indicated in Table 5.

Table 5 Likelihood Descriptors

No	Descriptor	Description
1	Rare	The event may occur only in exceptional circumstances
2	Unlikely	The event could occur at some time (not known to have occurred)
3	Possible	The event might occur at some time in the future
4	Likely	The event will probably occur in most circumstances (has occurred infrequently)
5	Almost certain	The event is expected to occur in most circumstances (has occurred frequently)

4.2. 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 6.

Table 6 Consequence Descriptors

No	Descriptor	People Safety	Property	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	Fatal or 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 or fatal 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.

4.3. Risk matrix

The risk matrix, which correlates likelihood and consequence to determine a level of risk, used in this report is shown in Table 7.

Table 7 Risk Matrix

		CONSEQUENCE				
		INSIGNIFICANT 1	MINOR 2	MODERATE 3	MAJOR 4	CATASTROPHIC 5
LIKELIHOOD	ALMOST CERTAIN 5	6	7	8	9	10
	LIKELY 4	5	6	7	8	9
	POSSIBLE 3	4	5	6	7	8
	UNLIKELY 2	3	4	5	6	7
	RARE 1	2	3	4	5	6

4.4. Actions required

Actions required according to the derived level of risk are shown in Table 8.

Table 8 Actions Required

9-10	Unacceptable Risk -	Immediate action required by either treating or avoiding risk. Refer to executive management.
7-8	Manageable Risk -	Treatment action is required to manage risk to an acceptable level. Refer to operational management.
5-6	Manageable 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	Acceptable Risk -	Managed by routine procedures, and can be accepted with no action.

4.5. Risk Identification

The primary risk being assessed is that of aviation safety. In this case, risk is considered to be manifested by the Project in the following ways:

- there is potential for an aircraft to collide with a wind turbine;
- there is potential for an aircraft to collide with a wind monitoring tower;
- there is potential for a pilot to initiate harsh manoeuvring in order to avoid colliding with a wind turbine or monitoring tower resulting in controlled flight into terrain (CFIT); 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 operations conducted by major RPT airlines. The risk is associated with smaller aircraft likely to be flying under the VFR, and so the maximum number of passengers 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.

4.6. 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.

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.

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.

One example of a reported collision with a wind turbine occurred in France. The pilot decided to descend below the cloud base in the attempt to find the aerodrome. At the time of the collision, the pilot was attempting to find the runway as the ground was visible. In addition, 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.

Other examples of collisions occurred in VMC, where turbines would have been unobscured by weather, where it was reported that pilots were flying in the vicinity of wind farms for operations associated with testing wind farm impacts on the environment or where pilots were transiting near the wind farms en route to their destination.

If these recorded collisions were taken to be an exhaustive list of occurrences since 2000, it can be deduced that aircraft collisions with wind turbines occur very infrequently.

Based on research conducted during the preparation of this Aviation Impact Assessment, it was found that there is a relatively low rate of aircraft activity in the vicinity of the Project, with the exception of agricultural aviation operations.

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, 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. It is assessed that collision with a wind turbine resulting in multiple fatalities and damage beyond repair would only occur in exceptional circumstances, which is classified as rare.

Untreated Likelihood	Rare

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. The proposed turbines will be a maximum of 180 m AGL (591 ft) at the top of the blade tip, so the rotor blade at its maximum height will be 27.6 m (91 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 (in this case 117 m AGL (384 ft)), 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 pale grey or off white so they should be visible during the day.
- The 'as constructed' details of wind turbines are required to be notified to RAAF AIS so that the location and height of wind farms can be noted on aeronautical maps and charts.
- The turbines are proposed to be a maximum of 180 m AGL (591 ft) at the blade tip. This is 70 m (230 ft) higher than the height below which there would be no statutory requirement to report the turbines to CASA in any case.

Level of Risk

The level of risk associated with a Rare likelihood of a Catastrophic consequence is 6.

Current Level of Risk	6 - Manageable

Risk Decision

A risk level of 6 is classified as Manageable: Treatment action possibly required to achieve a risk as low as reasonably practical (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 there being only four recorded occurrences of an aircraft colliding with a wind turbine since 2000 the likelihood of this outcome is so low that there is likely to be little additional safety benefit to be gained by installing obstacle lighting.

However, the following treatment which can be implemented at little cost will provide an additional margin 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. • Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, such as Ballarat Airport.	
Residual Risk With or without further treatment, the likelihood of an aircraft collision with a wind turbine resulting in multiple fatalities and damage beyond repair remains Rare, and the consequence remains Catastrophic, resulting in an overall risk level of 6. In the circumstances, this level of risk is considered acceptable. It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of the Project. However, the Proponent may consider other factors in its decision as to whether obstacle lighting should be installed.	
Residual Risk	6 - Manageable

Risk ID:	2. Aircraft collision with wind monitoring tower

Discussion

An aircraft collision with a wind monitoring tower would result in harm to people and damage to property.

The Proponent advises there are four wind monitoring towers in the Project – ranging from 40 m (131 ft) to 80 m (262 ft) high. They are not marked or lit, nor are they required to be. Their location and other applicable details have been advised to RAAF AIS.

These four wind monitoring towers are planned to be dismantled during the construction phase of the project, and one or more new permanent steel lattice masts (at the new hub height) will be installed at different locations (within the perimeter of the cluster of turbines) on the site.

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

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

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

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 operational significance.

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

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

Untreated Likelihood	Rare

Current Treatments (without lighting)

- The existing wind monitoring towers at the Project are 80 m (263 ft), 60 m (197 ft) and 40 m (131 ft) AGL, and do not require lighting. Their location and other applicable details have been advised to RAAF AIS.
- Removal or retention of these wind monitoring towers is subject to final micrositing of the wind turbines (in accordance with any Planning Permits Conditions).
- One or more hub height wind monitoring towers may be erected for turbine power curve verification. The locations of these towers are yet to be determined, but it will be positioned within rather than on the perimeter of a cluster of turbines.

- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The highest wind monitoring tower is 80 m AGL (263 ft), so there is at least 237 ft (72.4 m) vertical separation from an aircraft flying at this height.
- In the event that descending cloud forces an aircraft lower than 152.4 m AGL (500 ft), the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of the tower.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The towers are constructed from grey steel.

Level of Risk

The level of risk associated with a Rare likelihood of a Catastrophic consequence is 6.

Current Level of Risk	6 - Manageable

Risk Decision

A risk level of 6 is classified as Manageable: 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

Within the current regulatory regime, the level of risk to aviation safety associated with the wind monitoring towers is considered acceptable without further treatment. However, the following treatments which can be implemented at a relatively low additional cost will provide an additional margin of safety:

- Details of the existing wind monitoring tower, and future wind monitoring towers when they are constructed, should be advised to RAAF AIS.
- It is likely that the wind monitoring tower will be within 400 m of the taller turbines and, therefore, not likely to require obstacle marking.
- Although there is no obligation to do so, consideration could be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D). Specifically:
    - 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. • Details of the wind monitoring towers should be communicated to local and regional aircraft operators and arrangements should be made to publish details in ERSA for surrounding aerodromes following construction to heighten awareness of their location. • It should also be noted that when the Project is constructed, the wind monitoring towers will be surrounded by wind turbines which are significantly more visible, and pilots should therefore be deterred from flying near the wind monitoring tower which will further reduce the likelihood of a collision.	
Residual Risk Notwithstanding the current level of aviation safety risk is considered acceptable, the additional treatment, which will eventuate as a result of constructing the Project, will enhance aviation safety. In the circumstances, the risk level of 6 is considered acceptable. It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for collision with the wind monitoring towers, without obstacle lighting on the turbines of the Project.	
Residual Risk	6 - Manageable

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

Discussion

An aircraft colliding with terrain as a result of harsh manoeuvring to avoid colliding with a wind turbine would result in harm to people and damage to property.

There are a few CFIT accidents resulting from manoeuvring to avoid wind farms, but none in Australia, and all were during the day.

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

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 CFIT accidents resulting from manoeuvring to avoid wind farms, but none in Australia, and all were during the day. It is assessed that a CFIT accident following harsh manoeuvring to avoid a wind turbine may only occur in exceptional circumstances, which is classified as Rare.

Untreated Likelihood	Rare

Current Treatments (without lighting)

- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The proposed turbines will be a maximum of 180 m AGL (591 ft) at the top of the blade tip, so the rotor blade at its maximum height will be 27.6 m (91 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 (in this case 117 m AGL (384 ft)), 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 pale grey or off white so they should be visible during the day.
- The 'as constructed' details of wind turbines are required to be notified to RAAF AIS so that the location and height of wind farms can be noted on aeronautical maps and charts.
- The turbines are proposed to be a maximum of 180 m AGL (591 ft) at the blade tip. This is 70 m (230 ft) higher than the height below which there would be no statutory requirement to report the turbines to

CASA in any case.	
Level of Risk The level of risk associated with a Rare likelihood of a Catastrophic consequence is 6.	
Current Level of Risk	6 - Manageable
Risk Decision A risk level of 6 is classified as Manageable: 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 there has been one recorded example of a CFIT accident arising from harsh manoeuvring to avoid a wind turbine since 2000 (none in Australia), the likelihood of this outcome is so low that there is likely to be little additional safety benefit to be gained by installing obstacle lighting. However, the following treatment which can be implemented at little cost will provide an additional margin 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. • Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, such as Ballarat Airport.	
Residual Risk Notwithstanding the current level of risk is considered acceptable, the additional recommended treatment will enhance aviation safety. In the circumstances, the risk level of 6 is considered acceptable. It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for CFIT resulting from harsh manoeuvring to avoid a wind turbine, without obstacle lighting on the turbines of the Project. However, the Proponent may consider other factors in its decision as to whether obstacle lighting should be installed.	
Residual Risk	6 - Manageable

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.

There is a relatively low rate of aircraft activity 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. This would be a Minor consequence.

Consequence	Minor

Untreated Likelihood

The likelihood of the imposition of operational limitations is Possible – might occur at some time in the future.

Untreated Likelihood	Possible

Current Treatments (without lighting)

- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The proposed turbines will be a maximum of 180 m AGL (591 ft) at the top of the blade tip, so the rotor blade at its maximum height will be 27.6 m (91 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 (in this case 117 m AGL (384 ft)), 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 pale grey or off white so they should be visible during the day.
- The 'as constructed' details of wind turbines are required to be notified to RAAF AIS so that the location and height of wind farms can be noted on aeronautical maps and charts.
- The turbines are proposed to be a maximum of 180 m AGL (591 ft) at the blade tip. This is 70 m

(230 ft) higher than the height below which there would be no statutory requirement to report the turbines to CASA in any case.	
Level of Risk The level of risk associated with a Possible likelihood of a Minor consequence is 5.	
Current Level of Risk	5 - Manageable
Risk Decision A risk level of 5 is classified as Manageable: 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. However, the following treatment which can be implemented at little cost will provide an additional margin 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. • Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, such as Ballarat Airport.	
Residual Risk Notwithstanding the current level of risk is considered acceptable, the additional recommended treatment will enhance aviation safety. In the circumstances, the risk level of 5 is considered acceptable. 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. However, the Proponent may consider other factors in its decision as to whether obstacle lighting should be installed.	
Residual Risk	5 - Manageable

Risk ID:	5. Effect of obstacle lighting on neighbours

Discussion

Installation and operation of obstacle lighting on wind turbines can have an effect on neighbours' visual amenity and enjoyment.

As the wind turbines are proposed to 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.

Waubra previously operated obstacle lighting. In 2012 the Minister for Planning issued consent for the obstacle lighting to be switched off at the Waubra Wind Farm. This consent followed the advice of an aviation risk assessment prepared on behalf of the proponent, which determined that 'the wind farm did not require aviation obstacle lighting and switching the lights off would not pose an unacceptable risk to aircraft'.

Oaklands Hill and Macarthur also have obstacle lighting installed that are not operated. The wind farm owner advised that CASA determined the lighting as a visual obstacle and more being a benefit for the pilots. Subsequently, CASA requested that the lights be turned off.

Consequence

The worst credible effect of obstacle lighting 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 Likely - the event will probably occur in most circumstances (has occurred infrequently).

Untreated Likelihood	Likely

Current Treatments

As the Project wind turbines are proposed to be higher than 150 m AGL (492 ft), the 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.

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

The Planning Permits specify the following requirements under conditions 6, 7 and 8:

> *6. Except in the case of an emergency or any operational call-out, no external lighting of infrastructure associated with the wind energy facility, other than low-level, low-intensity security lighting and aviation*

obstacle lighting in accordance with Condition 8 below, may be installed or operated without the further written consent of the Minister for Planning.

7. Aviation obstacle lighting must not be installed unless the written consent for the Minister for Planning has been obtained.

8. If consent to install aviation obstacle lighting is obtained, it must be installed under the following conditions:

a) the aviation obstacle lighting must be installed such that it is activated only:

i. if at night, when an aircraft is in the immediate vicinity of the wind energy facility; and

ii. during low visibility daytime conditions such as the existence of smoke and fog;

b) for each lit turbine, the lighting must consist of a pair of lights mounted above the nacelle so that one is visible from an aircraft approaching from any direction;

c) each light must be a red medium intensity, flashing light as defined by Civil Aviation Safety Authority; each light must be shielded so as the restricted the vertical spread of light to not more than 3 degrees and light spread below the horizontal to not more than 1.0 degree;

d) all lights must flash in unison;

e) the duration of the light flash must be the minimum period recommended by CASA and the duration of the period between the flashes must be the maximum period recommended by CASA; and

f) before the wind farm is commissioned, a lighting maintenance plan must be prepared to the satisfaction of the Minister for Planning.

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

- reducing the number of wind turbines with obstacle lights;
- specifying an obstacle light that minimises light intensity at ground level;
- specifying an obstacle light that matches light intensity to meteorological visibility; and
- mitigating light glare from obstacle lighting through measures such as baffling.

Level of Risk

The level of risk associated with a Likely likelihood of a Moderate consequence is 7.

Current Level of Risk	7 - Manageable

Risk Decision

A risk level of 7 is classified as Manageable: Treatment action is required to manage the risk to an acceptable level. Refer to operational management.

Risk Decision	Reject – Treatment action required

Proposed Treatments Not installing obstacle lighting would completely remove the source of the impact. If lighting is required, there are Planning Permits Conditions and impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours. These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to those on the ground.
Residual Risk Not installing obstacle lights would clearly be an acceptable outcome to those affected by visual impact. Consideration of visual impact in the lighting design should enable installation of lighting that produces an acceptable impact to neighbours, which reduces the likelihood of a Moderate consequence to Possible – the event might occur at some time in the future, resulting in a risk level of 6 – Manageable. 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	6 - Manageable

4.7. Summary of risks

A summary of the level of risk associated with the approved Project, under the proposed treatment regime, is provided in Table 9.

Table 9 Summary of risks

Risk Element	Consequence	Likelihood	Risk	Actions Required
Aircraft collision with wind turbine	Catastrophic	Rare	6	Acceptable without obstacle lighting. Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding airports, before, during and following construction.
Aircraft collision with monitoring tower	Catastrophic	Rare	6	Acceptable without obstacle lighting. Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D). Communicate details of the wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding airports, following construction.
Harsh manoeuvring leads to CFIT	Catastrophic	Rare	6	Acceptable without obstacle lighting. Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding airports before, during and following construction.
Effect on crew	Minor	Possible	5	Acceptable without obstacle lighting. Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding airports before, during and following construction.
Visual impact from obstacle lights	Moderate	Possible	6	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact and in accordance with Planning Permits Conditions.

5. CONCLUSIONS

As a result of the foregoing risk assessment, the following conclusions are drawn:

5.1. Consultation

- An appropriate and justified level of consultation was undertaken with the following parties:
  - Aerial Agricultural Association of Australia;
  - Air Ambulance Victoria;
  - Airservices Australia;
  - City of Ballarat;
  - Civil Aviation Safety Authority;
  - Corangamite Shire Council;
  - Country Fire Authority Victoria;
  - Department of Defence;
  - Golden Plains Shire Council;
  - Operators of non-regulated aerodromes within the vicinity of the Project;
  - Royal Flying Doctor Service; and
  - other stakeholders where noted.

5.2. Regulatory requirements

- There is no regulatory requirement for lighting of obstacles lower than 150 m AGL (492 ft) that are not within the vicinity of an aerodrome.
- With respect to MOS 139 7.1.5.1, the proposed wind turbines and wind monitoring towers must be reported to CASA if they will be higher than 110 m AGL.
- With respect to MOS 139 7.1.5.2, the wind turbines must be regarded as obstacles if they are higher than 150 m AGL, unless CASA assesses otherwise. Obstacle monitoring includes the PANS-OPS surface which extends beyond the OLS of the aerodrome.
- With respect to MOS 139 9.4.1.2 (b), the wind turbines will need to be lit if they will be outside the OLS and above 110 m AGL, unless an aeronautical study assesses they are of no operational significance.

5.3. Aviation Impact Statement

- *In summary, the Aviation Impact Statement has determined that:*

  1) The blade tip elevation of the highest WTG will not exceed 382 m (1253 ft) AHD and as such:

  - *Will not penetrate any OLS surfaces;*
  - *Will not penetrate any PAN-OPS surfaces;*
  - *Will not have an impact on nearby designated air routes;*
  - *Will not have an impact on prescribed airspace;*
  - *Is wholly contained within Class G airspace; and*
  - *Will not have an impact on existing local aviation activities.*

  2) The [wind turbine generators (WGTs)] are located outside the clearance zones associated with aviation navigation aids and communication facilities.

  3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).

  The wind farm amendment has been assessed as not having an impact on prescribed airspace. The development is considered approvable under the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.

- Airservices has determined that there will be no aviation impacts on airspace procedures that have been designed by Airservices or communication, navigation and surveillance (CNS) facilities.

5.4. Nearby aerodromes

- The impacts at nearby aerodromes are addressed in the AIS.
- A separate study report, produced by Aviation Projects, with respect to the impact on the operations at Monaro ALA due to the approved Project turbine layout concluded that operations at the ALA will remain suitable. The proposed amendment to the Project will remain suitable for operations at the ALA because there will be a net improvement in safety margins.

5.5. Aircraft operator characteristics

- Based on input during consultation activities, the Project will result in a reduced net impact on aerial agricultural operations. Moreover, the impacts may be further alleviated by an effective and functional working relationship between the Proponent and aerial agricultural operators that are likely to operate in the vicinity of the Project.
- No net impact will result from the Project on the operation of Country Fire Authority's (CFA) operation. It would be beneficial to develop procedures to stop turbines blades from rotating before CFA begins aerial firefighting operations within the Project area.

- No issues are anticipated with the Project on Air Ambulance Victoria's rotary wing operations.

5.6. Comparative analysis

- There are currently no operational wind farms in Victoria that have obstacle lighting installed and activated. Macarthur, Oaklands Hill and Waubra Wind Farms have obstacle lighting installed; however, the operators have been authorised to have them turned off.

5.7. Project description

- The Project is planned to be located approximately 82 km west of Geelong along the Hamilton Highway, between the townships of Lismore and Cressy in Victoria.
- The proposed amendment will result in the following:
  - 79 wind turbines - decreased by 16 from the endorsed 95 wind turbines;
  - Maximum blade tip height of 180 m AGL (591 ft) – increased by 49 m from 131 m AGL;
  - Maximum ground elevation of 202 m AHD (663 ft AMSL) – increased by 2 m from 200 m AHD due to micrositing; and
  - Maximum blade tip height of 382 m AHD (1253 ft AMSL) – increased by 51 from 331 m AHD (1086 ft AMSL).
- The existing wind monitoring towers at the Project site are 80 m (262 ft), 60 m (197 ft) and 40 m (131 ft) AGL, and do not require lighting. Their location and other applicable details have been advised to RAAF AIS.
- One or more hub height wind monitoring towers may be erected for turbine power curve verification within the project boundary.

5.8. Obstacle lighting and marking

- Aviation Projects has assessed 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 lighting is required, the lighting design herein is 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.
- CASA recommends that the wind farm is lit with steady red low intensity lighting at night as per Section 9.4 of the CASA Manual of Standards Part 139. Characteristics for low intensity area stated in subsection 9.4.6. CASA agrees that the turbines that should be lit are identified in the drawing '100402-02 Berrybank Wind Farm Obstacle Lighting Design v0.3, (19 October 2015)'.
- A summary of design characteristics for obstacle lighting acceptable by CASA, if required, is provided below:
  - two steady red low intensity obstacle lights should be provided;

  - 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.
- To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program will need to be established in accordance with the guidance in MOS 139 Section 9.4.10.
- With respect to marking of turbines, it is generally accepted that, as an alternative to white, an off-white or light grey colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- With respect to marking of wind monitoring towers, they will be lower than, and are likely to be within 400 m of, a turbine and are therefore not likely to require obstacle marking or lighting.
- Department of Defence advised it has no concerns with the Project subject to the following requests being met:
  - Clearance is sought from Airservices Australia and CASA and any conditions from these agencies are adhered to;
  - 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm.
  - If LED obstruction lighting is to be provided to the wind turbines, the frequency range of the LED light emitted fall within the range of wavelengths 655 to 930 nanometres. This will enable the lighting to be visible to persons using night vision devices; and
  - Defence is consulted should there be any subsequent modification in the wind turbine height or scale of development.

5.9. Risk assessment

- A summary of the level of risk associated with the proposed amendment to the approved Project, under the proposed treatment regime, is provided in Table 10.

Table 10 Summary of risks

Risk Element	Consequence	Likelihood	Risk	Actions Required
Aircraft collision with wind turbine	Catastrophic	Rare	6	Acceptable without obstacle lighting. Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding airports, before, during and following construction.
Aircraft collision with monitoring tower	Catastrophic	Rare	6	Acceptable without obstacle lighting. Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D). Communicate details of the wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding airports, following construction.
Harsh manoeuvring leads to CFIT	Catastrophic	Rare	6	Acceptable without obstacle lighting. Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding airports before, during and following construction.
Effect on crew	Minor	Possible	5	Acceptable without obstacle lighting. Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding airports before, during and following construction.
Visual impact from obstacle lights	Moderate	Possible	6	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact and in accordance with Planning Permits Conditions.

6. RECOMMENDATIONS

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

Notification and reporting

1. 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm.

2. Department of Defence should be consulted if there is any subsequent modification in the wind turbine height or scale of development.

3. Any obstacles above 110 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:

    - The planned operational timeframe and maximum height of the crane; and
    - Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

Operation

4. The Proponent should engage with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project. Procedures may include stopping the rotation of the wind turbine rotor blades prior to the commencement of the aircraft operations within relevant areas.

Marking of turbines

5. The rotor blades, nacelle and the supporting mast of the wind turbines should be painted white, off-white or a light grey colour.

Lighting of turbines

6. With respect to Conditions 6, 7 and 8 of Planning Permit No 20092820 and Planning Permit No 20092821, 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 is required (for example, as a requirement of CASA), obstacle lighting would be installed on the following 35 turbines: 1, 3, 9, 12, 14, 15, 18, 20, 21, 23, 31, 36, 39, 42, 44, 45, 46, 48, 52, 55, 61, 62, 66, 67, 72, 73, 75, 80, 82, 84, 86, 88, 93, 99 and 100.

8. If obstacle lighting is required (for example, as a requirement of CASA), the wind turbines should be lit with steady red low intensity lighting at night as per MOS 139 Section 9.4, while minimising visual impact. To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program should be established in accordance with the guidance in MOS 139 Section 9.4.10.

9. Department of Defence requested that if LED lighting is used for obstacle lighting, then emitted light should fall within the wavelength range of 655 to 930 nanometres for night vision devices compatibility.

10. The Proponent may consider other factors in its decision as to whether obstacle lights should be installed.

Marking of wind monitoring towers

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

Triggers for review

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

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

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

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

ANNEXURES

1. Aviation Impact Statement
2. Turbine coordinates and heights
3. Obstacle lighting design

ANNEXURE 1 – AVIATION IMPACT STATEMENT

IDS Australasia, Aviation Impact Statement, Berrybank Wind Farm, Victoria, Australia (Final), dated 15 October 2015.

IDS AUSTRALASIA
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AVIATION IMPACT STATEMENT
BERRYBANK WIND FARM
VICTORIA, AUSTRALIA

KEYWORDS BERRYBANK, WIND FARM, AIS

SUMMARY This document contains the Aviation Impact Statement (AIS) considerations as detailed by Airservices Australia in relation to the proposed Berrybank Wind Farm, Victoria, Australia.

CLASSIFICATION **COMMERCIAL IN CONFIDENCE**

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DATE 15 October 2015

FINAL REPORT

Document Evolution		
Revision	Date	Reason of change
V1	18/08/2015	New Report
V1.1	10/09/2015	Updated Report
V1.2	14/09/2015	IDS Internal review (TT) & draft issuance
V1.3	16/09/2015	Final draft
V1.4	15/10/2015	Finalised Report

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Notes

Vertical datum used is the Australian Height Datum unless specified otherwise.

Horizontal datum used is the World Geodetic System 1984 (WGS84) unless specified otherwise.

1. Acronyms & Abbreviations

Acronym / Abbreviation	Description
AGL	Above Ground Level
AHD	Australian Height Datum
AIP	Aeronautical Information Publication
AIS	Aviation Impact Statement
AMSL	Above Mean Sea Level
ATC	Air Traffic Control
CASA	Civil Aviation Safety Authority (Australia)
ERC	Enroute Chart
ERSA	Enroute Supplement Australia
FIA	Flight Information Area
FIS	Flight Information Service
FPDAM	Flight Procedure Design & Airspace Management (software package)
GNSS	Global Navigation Satellite System
IAP	Instrument Approach Procedure
IFR	Instrument Flight Rules
LSALT	Lowest Safe Altitude
MOS	Manual of Standards
MSA	Minimum Sector Altitude
NDB	Non-directional Beacon
NOTAM	Notice to Airmen
OLS	Obstacle Limitation Surface
PANSOPS	Procedures for Air Navigation Services – Aircraft Operations
PSR	Primary Surveillance Radar
SSR	Secondary Surveillance Radar
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
WGS84	World Geodetic System 1984
WTG	Wind Turbine Generator

2. Executive Summary

IDS Australasia Pty Ltd has been engaged by Aviation Projects Pty Ltd to undertake an Aviation Impact Statement (AIS) for proposed amendments to the approved Berrybank Wind Farm (hereafter referred to as the "wind farm") located approximately 49 km south west of Ballarat aerodrome in Victoria.

This report has been prepared in relation to a proposed amendment for the wind farm. The amendment seeks to alter the scale of the approved turbines, as well as minor alterations to the siting and number of turbines and realigned access tracks. This report assesses the potential impacts as a result of the proposed amendment.

The Berrybank wind farm received planning approval in 2010. On 24 August 2010, Planning permit No. 20092820 and 20092821 were issued for Berrybank for the '*Use and development of land for a Wind Energy Facility'.* Condition three of the permits details the specifications of the wind farm, including the number and scale of the turbines. The permits originally specified the tower height of the wind turbines at 80 metres, with an overall height of 131 metres above natural ground level.

Approval is now sought to further vary the turbine specifications as detailed on the permits. It is proposed to increase the tower heights to 117 metres, the rotor diameter to 130 metres and overall tip height to 180 metres. This would result in an overall increase in height of 49 metres from natural ground level. In addition, it is proposed to microsite a number of turbines and realign access tracks and ultimately reduce the number of turbines on the Berrybank wind farm site from 95 to 79.

Given the nature of the amendment, any impacts above those approved would be limited to the change in the increase in turbine size, siting, realigned access tracks and the number of turbines on the wind farm.

This evaluation of the potential aviation impact has been undertaken with reference to applicable industry guidelines and relevant civil aviation safety regulations. This report details considerations within a bounding area of 30NM radius from the wind farm.

One registered airport with instrument approach procedures exists within the bounding area. Ballarat Airport is located approximately 26.9 NM /49.8 km to the north east. There is also a radio navigation aid at Yarrowee (YWE) with an instrument procedure. This procedure is not associated with any aerodrome and is published for daylight operations only. The WTG's lie outside this procedure and no further assessment is required.

Other unregistered/uncertified private airstrips and landing grounds may be located within the bounding area, none of which have an OLS and are not noted in aeronautical charts or documents for the region. Pilots operating at such airstrips retain sole responsibility for ensuring that they are aware of the conditions on and surrounding these landing sites.

In summary, the Aviation Impact Statement has determined that:

1) The blade tip elevation of the highest WTG will not exceed 382 m (1253 ft) AHD and as such:
    - Will not penetrate any OLS surfaces;
    - Will not penetrate any PAN-OPS surfaces;

- Will not have an impact on nearby designated air routes;
- Will not have an impact on prescribed airspace;
- Is wholly contained within Class G airspace; and
- Will not have an impact on existing local aviation activities.

2) The WTG's are located outside the clearance zones associated with aviation navigation aids and communication facilities.
3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).

The wind farm amendment has been assessed as not having an impact on prescribed airspace. The development is considered approvable under the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.

3. Overview, Methodology & Reference Criteria

Berrybank Development Pty Ltd seeks to develop a wind farm known as the Berrybank Wind Farm, approximately 49 km south west of Ballarat. The wind farm is to comprise 79 wind turbine generators (WTG's) with a maximum blade tip height not exceeding 180 m above ground level (AGL). The highest terrain on which a WTG is to be located has a maximum elevation of 202 m (WTG 3,6,14) resulting in a maximum elevation of 382 m (1253ft) at the blade tip. Proposed WTG location and elevations are listed in APPENDIX A.

The following table identifies aerodromes with published instrument approach and landing procedures within the vicinity of the wind farm. One registered aerodrome with published instrument approach and landing procedures exists within the 30 NM (55 km) bounding area.

Aerodrome	Status	Distance to Closest WTG	IAPs Avail
Ballarat	Registered	26.8 NM/49.6km	Yes
Yarrowee (NDB)	**No Aerodrome**	14.6 NM/27.2km	Yes

Table 1: Aerodromes with published instrument procedures

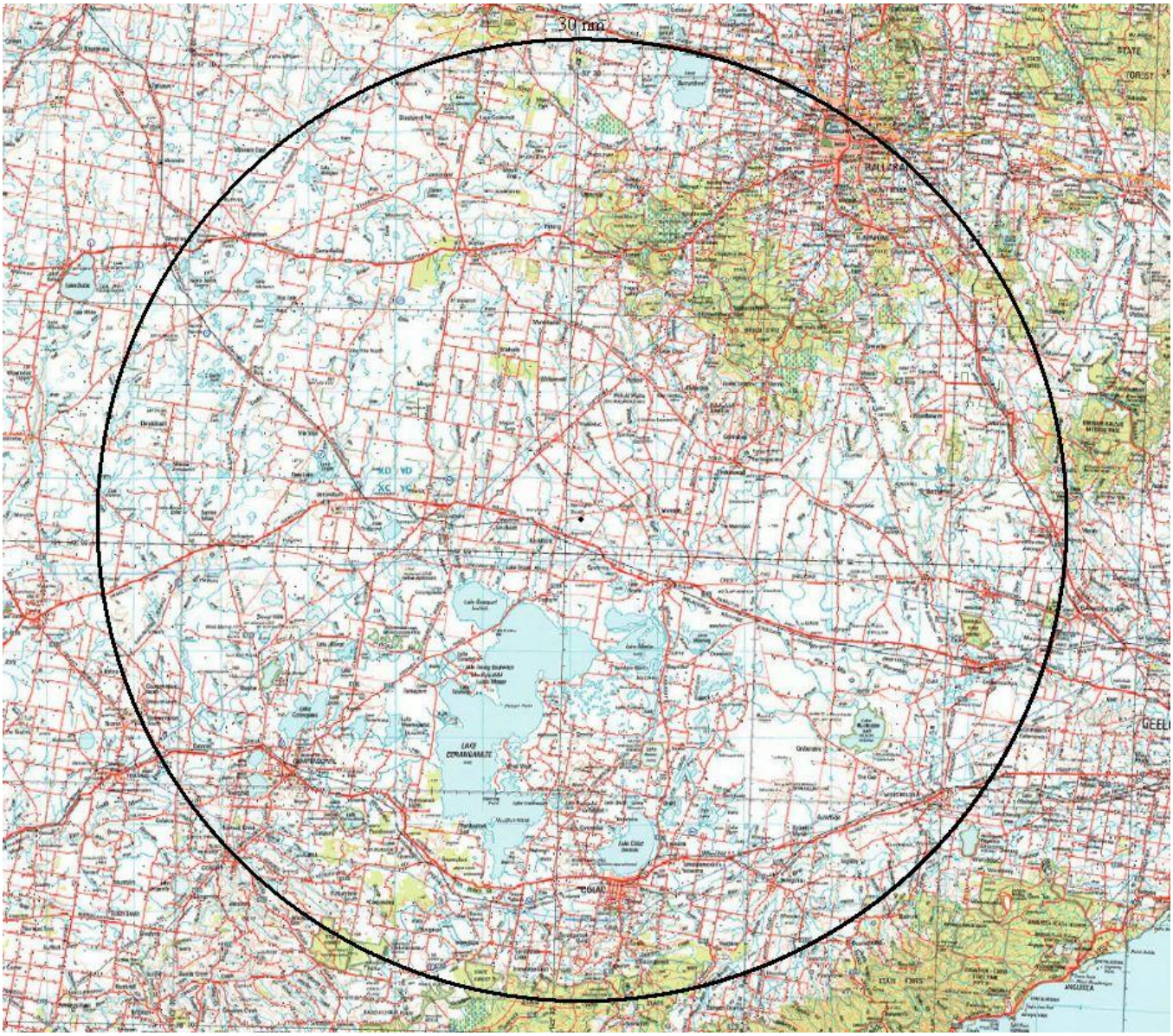

Figure 1: Aviation Impact Statement Bounding Area

The reference criteria on which impact assessments were made include the following:

- Civil Aviation Safety Regulations (CASR) 1988
    - Part 139 Manual of Standards (MOS) – Aerodromes, particularly:
        - Chapter 7: Obstacle Restriction and Limitation; and
        - Chapter 11: Standards for Other Aerodrome Facilities;
    - MOS Part 173 – Standards Applicable to Instrument Flight Procedure Design, particularly:
        - Section 1.1: General; and
        - Chapter 8: Design Standards;
- Civil Aviation Order 20.7.1B
- Civil Aviation Legislation Amendment (Part 175) 2014 (Effective 5 Mar 2015)
- ICAO Procedures for Air Navigation — Air Operations, Volume II - Construction of Visual and Instrument Flight Procedures, DOC 8168-OPS/611 Volume II
- ICAO Annex 14 Volume 1, Chapter 6 "Visual Aids for Denoting Obstacles"
- Airservices Australia publication "Airservices Aviation Assessments for Wind Farm Developments"
- EUROCONTROL Guidelines on how to Assess the Potential Impact of Wind Turbines on Surveillance Sensors

The methodology used in preparing the AIS has taken the following factors into consideration:

- Proximity of the wind farm to controlled airspace (both terminal and enroute);
- Proximity of the wind farm to PRD (prohibited, restricted and danger) classified airspace;
- Existing IFR (instrument flight rules) air routes were examined to determine the influence of any route lowest safe altitudes as published on various aeronautical charts and publications;
- Instrument approach procedures for aerodromes listed in Table 1 were examined in detail to determine whether the wind farm obstacles would penetrate any PANSOPS surfaces. Any restriction on instrument approach procedures would have to be examined by the CASR Part 173 provider responsible for the procedure to determine if a change is possible to the procedures without imposing a restriction on aviation;
- Published instrument approach procedures only depict a "nominal" track, and not the airspace protection areas that exist around the nominal tracks for these procedures. Analysing the impact of the wind farm on these procedures requires generating the three dimensional buffers (as defined by ICAO PANS-OPS and CASA MOS Part 173) around these tracks and assessing if any obstacles will penetrate the buffers. IDS certified procedure designers use the FPDAM (flight procedure design and airspace management) software tool to conduct these analyses.
- Annex 14 Obstacle Limitation Surfaces (OLS) were examined to determine whether the wind farm obstacles would penetrate any Annex 14 surfaces. Any restriction on the Annex 14

surfaces would have to be examined by the aerodrome operator and Airservices Australia to determine if a change is possible to the procedures without imposing a restriction on aviation;

- Civil Aviation Order 20.7.1B relates to the minimum requirements for clearance of obstacles by an aircraft that has suffered a failure of a critical engine during take-off. The contingency procedures analyse the minimum safe altitudes (and therefore relate to the maximum allowable obstacle height) required in such an event. The influence that the development would have on contingency procedures was considered;
- A preliminary assessment of potential impacts on aviation navigation aids, communication facilities and ATC radar installations.

A summary was made of the findings and conclusion as to whether the proposal should be approved from an aeronautical impact and aviation safety aspect.

The obstacle marking and lighting requirements specified in CASA MOS139/ICAO Annex 14, Chapter 6 are not detailed as part of this report. The applicability of these requirements is contingent on subsequent determination by CASA as to whether or not the wind farm constitutes a "hazard to aviation".

4. Potential Impacts, Risk Analysis & Mitigation

4.1 Aircraft Operators

4.1.1 Airspace

In Australia, all airspace that is not promulgated as Class A, C, D, and E (or restricted) is Class G airspace.

Class G airspace is non-controlled airspace. Both VFR and IFR aircraft are permitted, and neither requires ATC clearance to operate in class G airspace. Air Traffic Control directed separation is not provided, but IFR aircraft will receive information about other IFR aircraft operating in the vicinity.

The wind farm is located in Class G airspace with an upper limit of 8500 feet. Above that level is Class E airspace. There are no Danger/Restricted Areas in the vicinity of the wind farm.

4.2 IFR (Instrument Flight Rules) Operations

4.2.1 Enroute Airways

Airways are used in IFR operations and consist of defined corridors that connect specific locations. Historically they allowed aircraft to easily navigate between successive ground-based navigational aids, but with the advent of more advanced navigation systems such as RNAV and GNSS/GPS, airways can be defined without being dependent on a ground based navigation facility. IFR airways have a published lowest safe altitude (LSALT) which guarantees a minimum clearance from ground obstacles.

The figure below depicts IFR airways in close proximity to the wind farm.

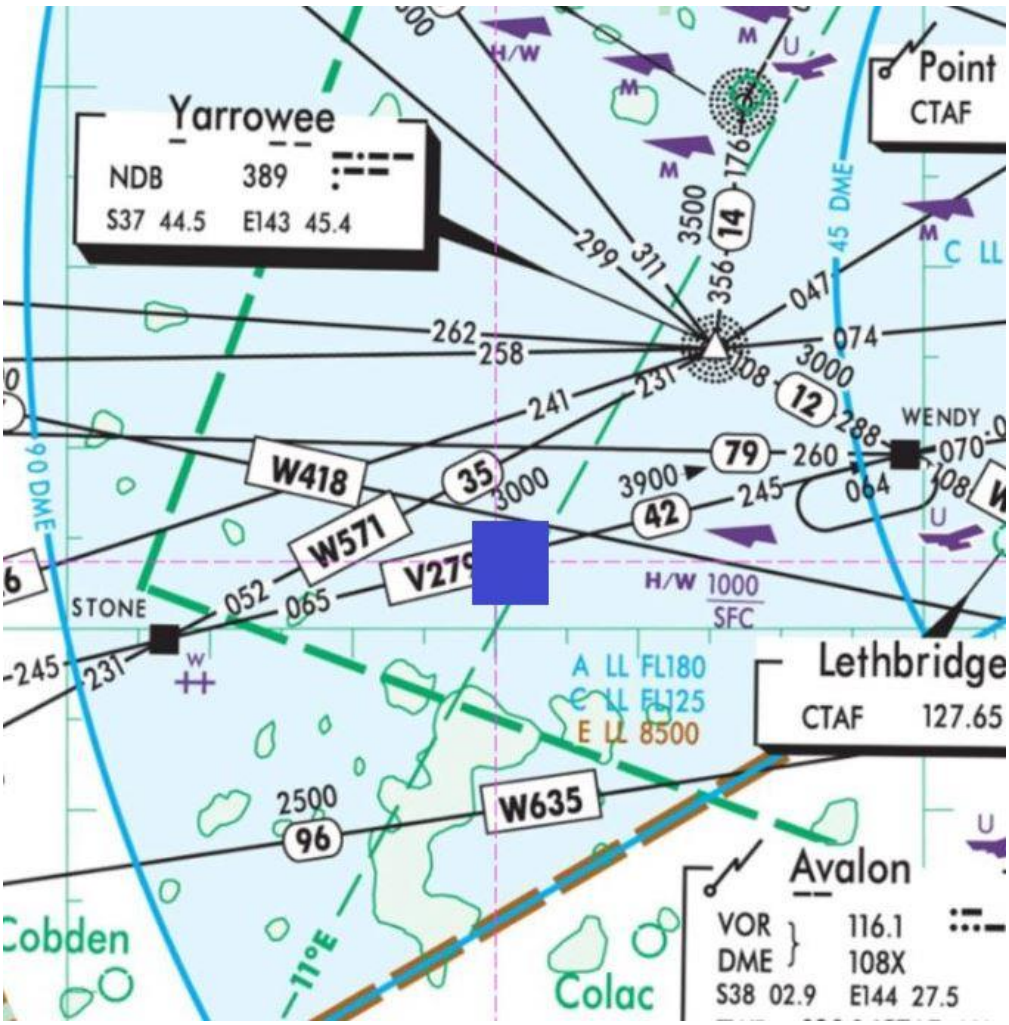

Figure 2: IFR airways in proximity to wind farm

Table 2 (below) details the airways reviewed and the route lowest safe altitudes for each segment. The air routes were assessed with reference to Airservices Australia AIP enroute and terminal area charts effective 28th May 2015.

ROUTE NUMBER	Waypoint Names on Route	Published Route Lowest Safe
V279	STONE – WENDY	3900
W418	HML – AV	4100
W571	STONE – YWE	3000
V126	YWE – POD	3000

Table 2: Route numbers, Waypoints & Published LSALT

3000 ft is lowest of the LSALTs for the airways that overfly, or are in the vicinity of the wind farm. A minimum obstacle clearance of 1000ft below the published LSALT must be maintained along each airway. The controlling obstacles (WTG's 3,6,14) are approximately 747 ft below the protection area surface which starts at an altitude of 2000 ft.

A “grid” LSALT is specified on IFR charts that provides a LSALT for operations away from defined airways. The grid LSALT in the vicinity of the wind farm is 3700ft. The protection surface starts at 2700 ft and the controlling WTG’s are 1447 ft below this surface.

The WTG’s do not infringe any grid LSALT or airway route segment protection areas. No other adjacent airway protection areas are penetrated by the WTG’s. High level routes are for aircraft at or above FL200 (20,000ft). The wind farm at Berrybank does not affect high level routes.

4.2.2 Instrument Procedures

The nearest airfield with PANS-OPS surfaces is Ballarat aerodrome, located approximately 26.6 NM (49.6 km) to the north east of the wind farm.

The following table details the published instrument flight procedure assessed.

Aerodrome	Procedure Title	Detailed Assessment required	Rationale	Wind Farm Impact on Procedure
Ballarat	NDB RWY 36	**NO**	Procedure is to the north east of Ballarat aerodrome and is not impacted by the windfarm.	**Protection area not penetrated**
	RNAV-Z (GNSS) RWY 18	**NO**	The procedure and associated protection areas are not within proximity of the windfarm	**Protection area not penetrated**
	RNAV-Z (GNSS) RWY 36	**YES**	The wind farm lies below the protection area for the holding procedure	**Protection area not penetrated**
	MSA	**YES**	Wind farm lies below the protection surfaces	**Protection area not penetrated**
Yarrowee NDB (No Aerodrome)	NDB-A	**NO**	Wind farm lies outside the protection surfaces	**Protection area not penetrated**
	MSA	**YES**	Wind farm lies below the protection surface	**Protection area not penetrated**

Table 3: Assessed Procedures Matrix

4.2.3 YBLT (Ballarat)

Ballarat airport is a registered airport located approximately 50km north east of the wind farm. It is restricted to Categories A and B aircraft for instrument procedures only. It is presently not served by any RPT (regular public transport) operators. The airport is equipped with three runways, one of which has non-precision instrument approach capability.

4.2.4 YBLT 10 & 25 NM MSA (Minimum Sector Altitude)

The protection areas for the YBLT 25 NM and 10 NM MSA were generated using FPDAM and assessed with reference to the WTG's. The 25NM MSA has three minimum altitudes of 4700, 4000 and 3100 ft and the 10 NM MSA has an altitude of 3700 ft. The wind farm site lies on the outer perimeter of the 25NM MSA in the 3100 FT and 4000 sectors. A minimum obstacle clearance of 1000ft below the published MSA must be maintained within each protection area. The highest WTG's are 847 ft below the MSA protection surface for the lowest sector.

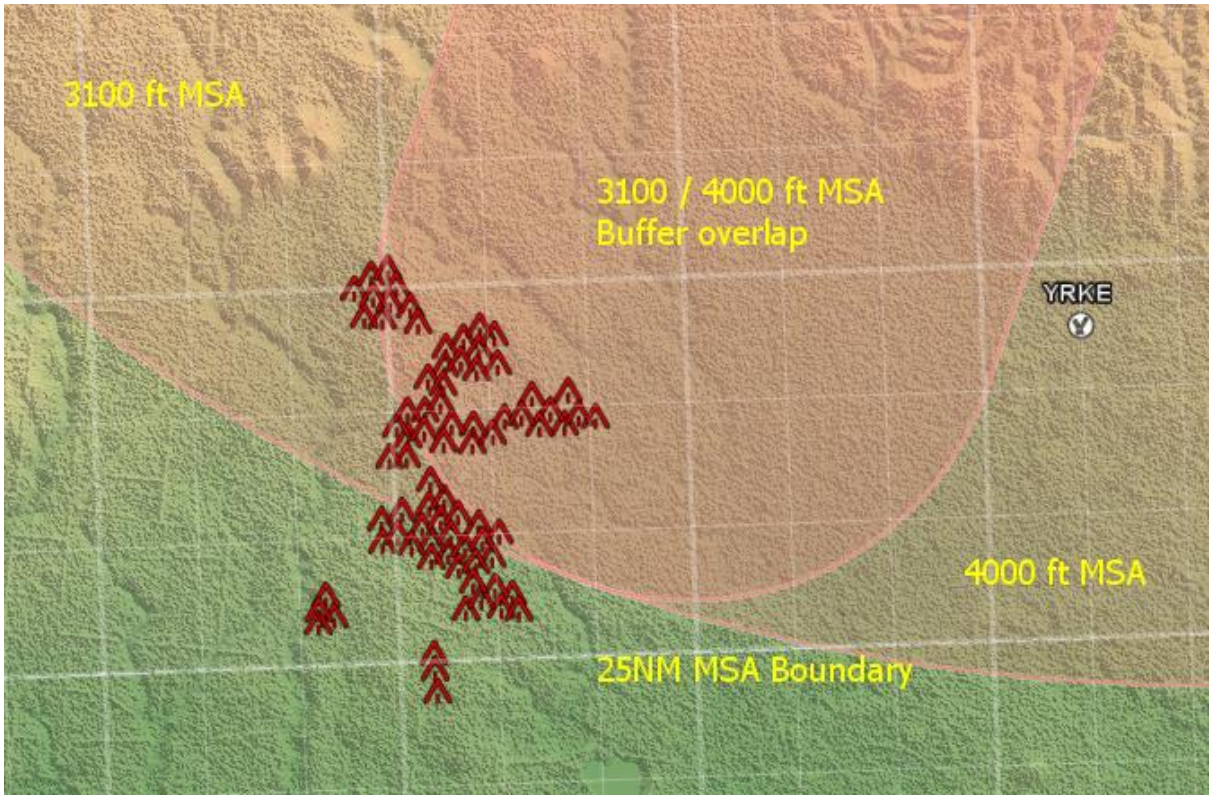

Figure 3: YBLT 10 & 25NM MSA protection areas

4.2.5 YBLT NDB RWY 36 Procedure

The protection areas associated with this procedure were generated using FPDAM and assessed with reference to the WTG's. The holding and procedure primary areas lie to the north east of the wind farm and the protection surfaces are not impacted.

4.2.6 YBLT RNAV-Z (GNSS) RWY 18 Procedure

The protection areas for this procedure were generated FPDAM and assessed with reference to the WTG's. The procedure protection areas do not overlay the wind farm and are not impacted.

4.2.7 YBLT RNAV-Z (GNSS) RWY 36 Procedure

The protection areas for this procedure were generated by FPDAM and assessed with reference to the WTG's. The protection areas are outside of the wind farm and the protection surfaces are not impacted by the wind farm obstacles.

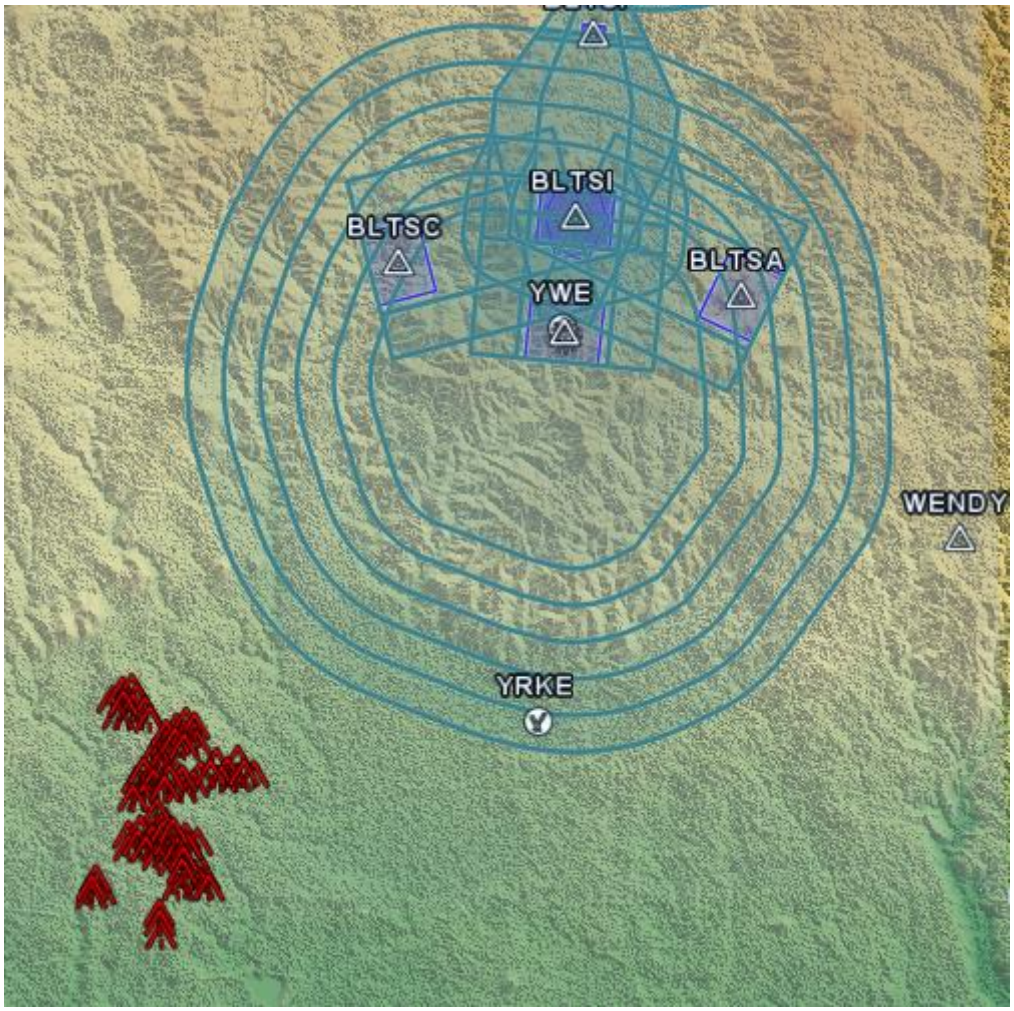

Figure 4: YBLT RNAV-Z (GNSS) RWY 36

4.2.8 Yarrowee (YWE) NDB-A Procedure

Yarrowee is an NDB positioned approximately 52 NM west of Melbourne and approximately 26.8 NM south west of Ballarat aerodrome. It is primarily used as an entry waypoint for aircraft flying into either Melbourne or Essendon airports. There is an overlying NDB procedure at YWE that is restricted to daylight VMC operations only. The NDB is approximately 14.7 NM from the nearest WTG and the missed approach protection area is outside of the wind farm.

4.2.9 YWE 25 NM MSA

The Yarrowee NDB procedure is one which was designed under earlier PANS-OPS criteria (1971) and as such does not have a 10NM MSA. The 25 NM MSA overlays the wind farm and has a minimum altitude of 4000 ft. The highest WTG's are 1747 ft below the associated protection surface.

4.3 Engine Inoperative Flight Paths

The wind farm is considered to be sufficiently distant from nearby airfields to not have an impact on contingency procedures and engine inoperative flight paths.

5. Air Navigation Service Provider

Airservices Australia is the sole provider of civil air navigation services for Australia. They are responsible for the provision of aeronautical data, telecommunications, navigation services and aviation rescue and firefighting services. The impact of the wind farm on their relevant areas of responsibility is described below.

6. Protection of Air Navigation Facilities

6.1 Surveillance Radar

Wind turbines can negatively impact on surveillance radars, particularly when in the line of sight of the radar facility and the turbine blades are rotating. Turbines can reflect radio frequency energy which may mask legitimate targets and as a result, display of false targets or generate "clutter".

CASA MOS 139 11.1.14.4 clearance requirements for radar sensor sites describe the required clearance area as follows: "No intrusion within 1 km of the radar into a height surface 5 m below the bottom of the antenna. No intrusion between the radar and the possible location of any desired targets, i.e. roughly speaking above 0.5 degrees elevation at any distance." Due to the distance from this radar facility, none of the WTG's penetrate the MOS139 protection area.

Airservices Australia require additional assessment of wind farms against EUROCONTROL guidelines. These guidelines categorise WTG's in a given zone depending on certain parameters. The zoning of a given WTG dictates the level of assessment required. The zoning criteria are listed in APPENDIX B.

6.2 Mt Macedon RSR (SSR) Facility

Radar line of sight analysis (LOS) was performed to ascertain the zoning of WTG's with respect to the Mt Macedon SSR facility. This analysis was performed using Global Mapper v16 using the following parameters:

Mt. Macedon Radar Facility	
Latitude (WGS84)	-37.3833
Longitude (WGS84)	144.575
Antenna elevation (m AHD)	1047
Receiver (Turbine) height AGL (m)	180.0m
View Radius	120km
Earth Curvature Correction	Enabled
Atmospheric Correction Factor	1.333
DEM model	Geoscience Australia 1sec SRTM DEM

Table 4: LOS analysis parameters

Mt. Macedon is approximately 58 NM from the wind farm and preliminary assessment indicates that no LOS is present between the Mt Macedon RSR (SSR) facility and any WTG's. EUROCONTROL guidelines advise that no further assessment is required.

NOTE: EUROCONTROL guidelines recommend safeguarding of the area for the radar far-field monitor (FFM). At time of writing, information regarding this sensor had not yet been received from Airservices Australia. The potential impact of the wind farm on any FFM has not yet been established.

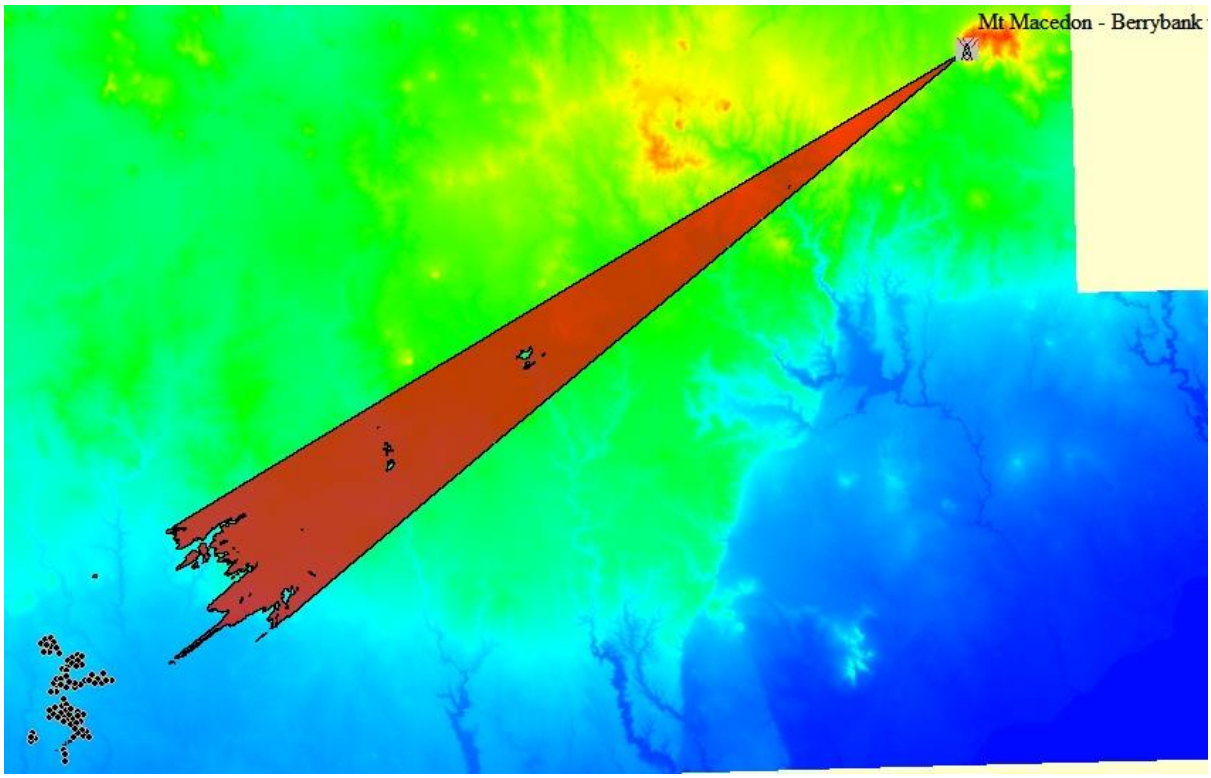

Figure 5: Mt Macedon RSR – Berrybank Wind Farm LOS Analysis

6.3 Ground Based Navigation Aids

The potential impact on aviation navigation aids was assessed in accordance with CASR MOS Part 139. The wind farm is located outside the clearance zones associated with the nearest aviation navigation aids.

The following table identifies aviation navigation aids and approximate distances to the boundary of the wind farm.

NAVAID Type	Range	Distance to Closest WTG	MOS 139 Reference
NDB (BLT)	30 NM	26.8 NM (49.6km)	11.1.13
NDB (YWE)	40 NM	14.7 NM (27.3km)	11.1.13

Table 5: Aviation Navigation Aids

6.4 Communication Facilities

The potential impact on communication facilities was assessed in accordance with CASR MOS Part 139 11.1.15.2. There will be no impact as the wind farm will not affect the line of sight path between aircraft and ground based communication facilities.

7. Aerodrome Operators

7.1 Annex 14 OLS (Obstacle Limitation Surfaces)

Annex 14 OLS defines the airspace around aerodromes to be maintained free from obstacles so as to permit the intended aeroplane operations at the aerodromes to be conducted safely and to prevent the aerodromes from becoming unusable by the growth of obstacles around the aerodromes. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.

Annex 14 surfaces are applicable to aerodromes where instrument approach procedures are conducted.

The wind farm is located beyond the distance from YBLT (Ballarat) where Annex 14 surface applies. As the surface is not penetrated by the WTG's no further analysis is required.

8. Conclusion

The assessments and reviews contained in this Aviation Impact Statement were conducted in accordance with the relevant aviation and aeronautical regulations and standards. In summary, the Aviation Impact Statement has determined that:

1) The blade tip elevation of the highest WTG will not exceed 382 m (1253 ft) AHD and as such:
    - Will not penetrate any OLS surfaces;
    - Will not penetrate any PAN-OPS surfaces;
    - Will not have an impact on nearby designated air routes;
    - Will not have an impact on prescribed airspace;

- Is wholly contained within Class G airspace; and
- Will not have an impact on existing local aviation activities.

2) The WTG's are located outside the clearance zones associated with aviation navigation aids and communication facilities.
3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).

The wind farm amendment has been assessed as not having an impact on prescribed airspace. The development is considered approvable under the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.

APPENDIX A. Berrybank Wind Farm – Proposed WTG Coordinates & Elevation

Blade Length (m)	Rotor Diameter (m)	Hub Height (m)	Tip Height (m)
64	130	117	180

Assumptions:

- 2M has been added to terrain base elevation for microsited WTG's
- Tip elevation based on assumed WTG maximum blade tip height 180m AGL.

Turbine No.	Easting (GDA94)	Northing (GDA94)	Height (AHD)
1	718723	5802176	372
2	719252	5802580	379
3	719751	5802721	382
4	720031	5797730	362
6	719967	5802221	382
7	719492	5801285	374
9	719747	5801765	379
12	718962	5801349	371
13	720348	5801559	380
14	720545	5801081	382
15	721921	5797435	362
17	721258	5799760	372
18	720733	5799429	372
19	721859	5800552	370
20	722364	5800847	372
21	721322	5800299	374
22	722296	5800211	370
23	722817	5799718	366
24	722780	5800575	372
25	719710	5798063	362
26	721169	5799204	372
27	721740	5799891	369
28	722189	5799582	368
31	720387	5791255	341
32	721000	5794218	350
33	717508	5792561	334
34	719266	5801952	374
36	720062	5798490	364
37	720583	5798464	369
38	721057	5798686	370
39	723772	5798717	361
40	722821	5792881	337
42	721414	5792516	343
43	722465	5792519	339
44	725612	5797947	340
45	724851	5798766	350
46	724683	5797804	347
47	724291	5798236	351
48	717298	5793181	339
49	723942	5797816	350

Turbine No.	Easting (GDA94)	Northing (GDA94)	Height (AHD)
51	725119	5798064	345
52	722922	5798109	360
54	722535	5797663	355
55	720424	5790132	332
57	720523	5797897	362
58	720518	5795662	355
59	720985	5795834	356
60	721985	5797957	361
61	721349	5798047	364
62	717031	5792379	332
63	720391	5790792	339
64	723429	5798169	356
65	719954	5797147	362
66	720611	5796396	358
67	719453	5797154	362
69	721076	5797527	363
72	719092	5795312	351
73	719710	5795545	355
74	717068	5792757	331
75	719076	5794661	352
76	719538	5794878	352
77	720541	5794620	350
78	720275	5795050	351
79	720845	5795231	353
80	722289	5794039	343
82	719929	5794535	352
84	721290	5793778	346
85	721955	5795028	346
86	722325	5793119	340
88	720489	5794103	352
89	721109	5794788	352
90	721503	5794377	348
93	722543	5794720	342
94	722034	5794531	345
96	721796	5793893	343
97	721893	5792827	342
98	721681	5793316	344
99	722975	5792402	335
100	721359	5795356	350

APPENDIX B. EUROCONTROL Assessment Zones

Zone	Zone 1	Zone 2	Zone 3	Zone 4
Description	0 - 500 m	500 m - 15 km and in radar line of sight	Further than 15 km but within maximum instrumented range **and in** radar line of sight	Anywhere within maximum instrumented range but **not in** radar line of sight or outside the maximum instrumented range.
Assessment Requirements	**Safeguarding**	**Detailed assessment**	**Simple assessment**	**No assessment**

PSR Recommended Ranges (Source: EUROCONTROL)

Zone	Zone 1	Zone 2	Zone 4
Description	0 - 500 m	500 m - 16 km but within maximum instrumented range **and in** radar line of sight	Further than 16 km **or not** in radar line of sight
Assessment Requirements	**Safeguarding**	**Detailed assessment**	**No assessment**

SSR Recommended Ranges (Source: EUROCONTROL)

ANNEXURE 2 – TURBINE COORDINATES AND HEIGHTS

Berrybank Development Pty Ltd, 20150709 - BBWF, List of Revised Turbine Coordinates (GDA94) v4-1, dated 22 June 2015.

Note: add 2 m to the base height for any wind turbine that has moved from its original position.

Turbine ID	Approved Locations 24 August 2010			Microsited Locations from Original Approved Locations 26 June 2015			Comments (From Original)	Hub Height (m)
	Eastings GDA94 (m)	Northings GDA94 (m)	Height of base (m ASL)	Eastings GDA94 (m)	Northings GDA94 (m)	Movement From Original (m)		
1	718652	5802179	190	718723	5802176	71	East	117
2	719235	5802626	197	719252	5802580	49	South-East	117
3	719733	5802777	200	719751	5802721	59	South-East	117
4	719936	5797730	180	720031	5797730	95	East	117
6	719874	5802200	200	719967	5802221	95	North-East	117
7	719492	5801285	194	719492	5801285	0	~	117
9	719732	5801689	197	719747	5801765	77	North	117
12	718962	5801349	191	718962	5801349	0	~	117
13	720348	5801559	200	720348	5801559	0	~	117
14	720538	5801008	200	720545	5801081	73	North	117
15	721874	5797354	180	721921	5797435	94	North-East	117
17	721257	5799665	190	721258	5799760	95	North	117
18	720639	5799429	190	720733	5799429	94	East	117
19	721859	5800552	190	721859	5800552	0	~	117
20	722425	5800859	190	722364	5800847	62	West	117
21	721248	5800291	192	721322	5800299	74	East	117
22	722296	5800211	190	722296	5800211	0	~	117
23	722885	5799651	184	722817	5799718	95	North-West	117
24	722859	5800594	190	722780	5800575	81	West	117

Turbine ID	Approved Locations 24 August 2010			Microsited Locations from Original Approved Locations 26 June 2015			Comments (From Original)	Hub Height (m)
	Eastings GDA94 (m)	Northings GDA94 (m)	Height of base (m ASL)	Eastings GDA94 (m)	Northings GDA94 (m)	Movement From Original (m)		
25	719616	5798063	180	719710	5798063	94	East	117
26	721074	5799204	190	721169	5799204	95	East	117
27	721740	5799891	189	721740	5799891	0	~	117
28	722189	5799497	186	722189	5799582	85	North	117
31	720422	5791181	159	720387	5791255	82	North-West	117
32	721000	5794218	170	721000	5794218	0	~	117
33	717508	5792561	154	717508	5792561	0	~	117
34	719266	5801952	194	719266	5801952	0	~	117
36	719980	5798538	182	720062	5798490	95	South-East	117
37	720501	5798512	187	720583	5798464	95	South-East	117
38	720993	5798686	188	721057	5798686	64	East	117
39	723772	5798807	179	723772	5798717	90	South	117
40	722821	5792881	157	722821	5792881	0	~	117
42	721414	5792432	161	721414	5792516	84	North	117
43	722465	5792519	159	722465	5792519	0	~	117
44	725612	5797947	160	725612	5797947	0	~	117
45	724851	5798766	170	724851	5798766	0	~	117
46	724753	5797738	165	724683	5797804	96	North-West	117
47	724224	5798169	169	724291	5798236	95	North-East	117
48	717298	5793181	159	717298	5793181	0	~	117
49	724010	5797749	168	723942	5797816	95	North-West	117
51	719235	5802626	197	725119	5798064	0	~	117
52	719733	5802777	200	722922	5798109	95	South-East	117

Turbine ID	Approved Locations 24 August 2010			Microsited Locations from Original Approved Locations 26 June 2015			Comments (From Original)	Hub Height (m)
	Eastings GDA94 (m)	Northings GDA94 (m)	Height of base (m ASL)	Eastings GDA94 (m)	Northings GDA94 (m)	Movement From Original (m)		
54	720688	5799940	192	722535	5797663	94	West	117
55	719874	5802200	200	720424	5790132	0	~	117
57	720804	5800436	193	720523	5797897	0	~	117
58	719732	5801689	197	720518	5795662	80	South-West	117
59	718676	5800842	190	720985	5795834	89	South-West	117
60	719731	5800833	194	721985	5797957	75	South	117
61	718962	5801349	191	721349	5798047	95	North	117
62	720348	5801559	200	717031	5792379	90	North	117
63	720538	5801008	200	720391	5790792	95	North-West	117
64	721874	5797354	180	723429	5798169	95	South	117
65	720318	5796959	180	719954	5797147	85	South-East	117
66	721257	5799665	190	720611	5796396	92	North-West	117
67	720639	5799429	190	719453	5797154	74	North-East	117
69	722425	5800859	190	721076	5797527	85	East	117
72	722885	5799651	184	719092	5795312	0	~	117
73	722859	5800594	190	719710	5795545	95	South-East	117
74	719616	5798063	180	717068	5792757	0	~	117
75	721074	5799204	190	719076	5794661	95	North-East	117
76	721740	5799891	189	719538	5794878	95	South-East	117
77	722189	5799497	186	720541	5794620	0	~	117
78	723033	5799194	180	720275	5795050	0	~	117
79	723214	5800286	189	720845	5795231	35	North-West	117
80	720422	5791181	159	722289	5794039	40	North-West	117

Turbine ID	Approved Locations 24 August 2010			Microsited Locations from Original Approved Locations 26 June 2015			Comments (From Original)	Hub Height (m)
	Eastings GDA94 (m)	Northings GDA94 (m)	Height of base (m ASL)	Eastings GDA94 (m)	Northings GDA94 (m)	Movement From Original (m)		
82	717508	5792561	154	719929	5794535	95	South-East	117
84	719142	5800615	191	721290	5793778	0	~	117
85	719980	5798538	182	721955	5795028	0	~	117
86	720501	5798512	187	722325	5793119	0	~	117
88	723772	5798807	179	720489	5794103	95	North-East	117
89	722821	5792881	157	721109	5794788	93	North-East	117
90	723294	5792785	151	721503	5794377	95	North	117
93	725612	5797947	160	722543	5794720	0	~	117
94	724851	5798766	170	722034	5794531	95	North-West	117
96	724224	5798169	169	721796	5793893	68	North	117
97	717298	5793181	159	721893	5792827	95	North-West	117
98	724010	5797749	168	721681	5793316	95	North-West	117
99	718652	5802179	190	722975	5792402	0	~	117
100	719235	5802626	197	721359	5795356	0	~	117

ANNEXURE 3 – OBSTACLE LIGHTING DESIGN

Aviation Projects, 100402-02 Berrybank Wind Farm Obstacle Lighting Design v0.3 151019, dated 19 October 2015.

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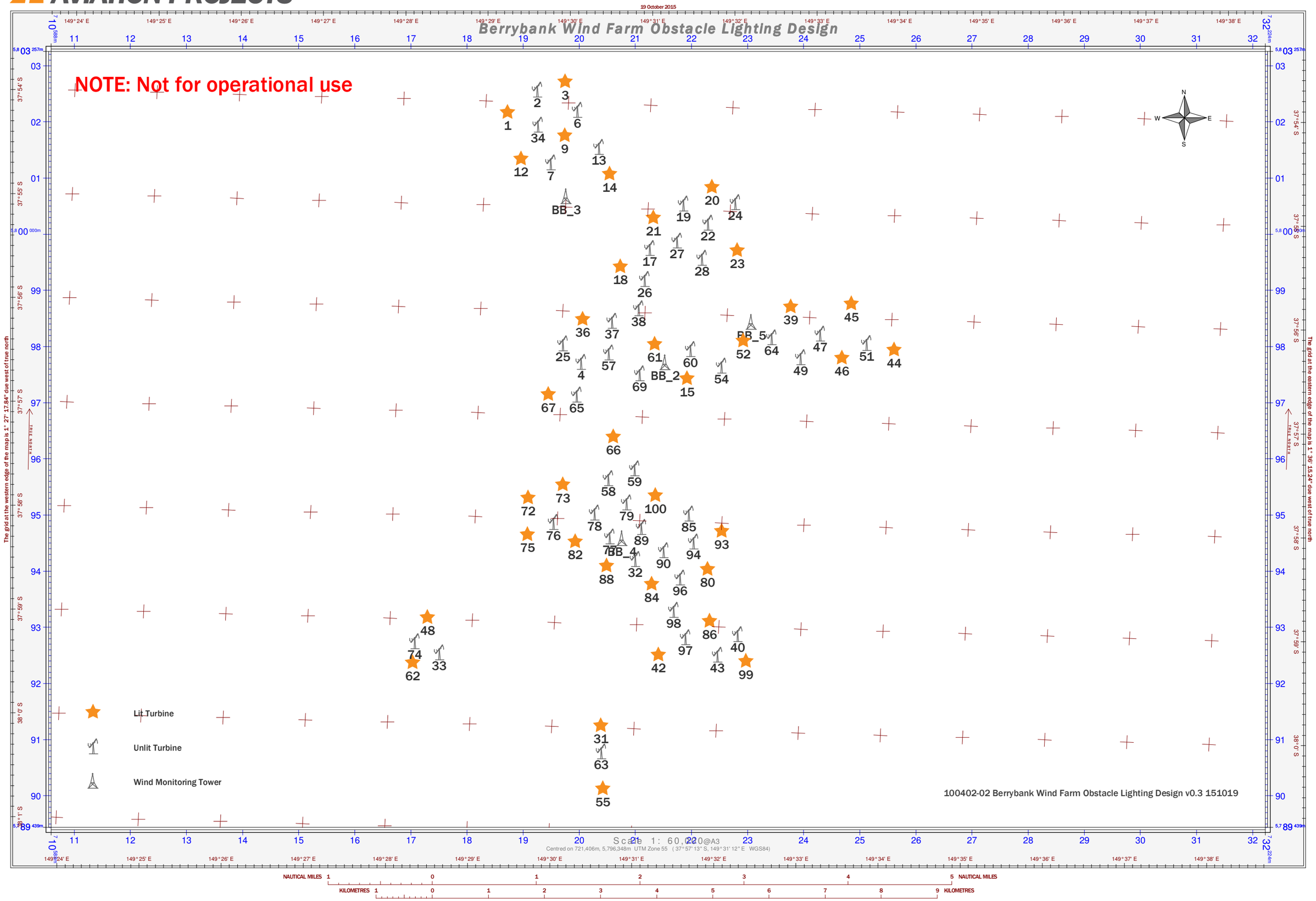
19 October 2015

Berrybank Wind Farm Obstacle Lighting Design



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