REHBEIN AIRPORT CONSULTING

DATE 3 FEBRUARY, 2012

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# Collector Wind Farm Aviation Assessment

## For RATCH Australia Corporation Ltd

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| 1 | 17/12/2010 | Final | KM | | MW | | BH | |
| 2 | 19/01/2011 | Final | KM | | MW | | BH | |
| 3 | 29/04/2011 | Final | MW | | KM | | BH | |
| 4 | 10/01/2012 | Final | MW | | KM | | BH | |
| 5 | 03/02/2012 | Final | MW | | KM | | BH | |

# 1.0 EXECUTIVE SUMMARY

RATCH Australia Corporation Ltd is proposing to locate up to 68 wind turbine generators (WTG) at Collector, New South Wales. The site is approximately 35 km southwest of Goulburn, 50 km northeast of Canberra on a long ridge 880m above mean sea level (AMSL) to the north of Lake George. A number of turbine models are being considered by RATCH Australia to populate the wind farm. The blade tips of the largest turbine are 150m above ground level. This height has been used for assessment purposes to represent a worst case scenario.

This study considered in detail the likely impact of the location, height and blade rotation of the proposed wind turbines on the nearest aerodromes; air navigation and air traffic management services; transiting air routes; designated airspace such as Danger, Restricted or Prohibited areas; any other aviation activity; and electromagnetic interference (EMI) with airborne radio.

The study concludes that the proposed wind farm will not impact upon aircraft operations to and from Canberra or Goulburn airports or the private aerodromes at Gundaroo and Winderadeen. Nor will the wind farm interfere with radio or navigation aid performance. Flights operating under the Visual Flight Rules (VFR) should not be affected by the proposed wind farm as these flights are required to be conducted at a minimum height of 500 ft above ground level outside populous areas and will be above the level of the turbines. The structures will be sufficiently conspicuous by day, and at night local en route lowest safe altitudes (LSALTs) will provide clearance required for flights under the Instrument Flight Rules (IFR) and night operations under the Visual Flight Rules (Night VFR).

Investigation undertaken by REHBEIN Airport Consulting suggests the impact, if any, of the proposed wind farm upon radar and radio performance in the region will not be of operational significance. However it would be prudent to confirm whether Airservices Australia has any concerns about the potential impact of the wind farm.

Low level flying operations such as agricultural aerial spreading and spraying operations or power transmission line inspections may be affected on the downwind side of the turbines over land on which the turbines are directly positioned, or over portions of some adjoining properties that are sited downwind from the turbines. This is due to wind shear, turbulence and downdrafts in the wake of the turbine rotors presenting a critical hazard to aircraft such as agricultural aircraft operating at low level and high weights during application of chemicals and seeding. However, agricultural spraying operations are normally conducted at very low levels and often require calm or very light wind conditions of less than 8 knots (15km/h). At these wind speeds it is reasonable to assume the wake can extend for a distance of 6 rotor diameters or 600m downwind of the nearest turbine based on the proposed rotor diameter of approximately 100m.

Hang gliding in the vicinity of Collector is not likely to be adversely affected by the proposal as hang gliding will only be conducted during daylight hours when the turbines are clearly visible and the

prevailing winds in the area are from the north west which are unsuitable for hang gliding. Model aircraft flying at Lake George should not be affected because the site used for this activity is remote from the wind farm.

Apart from aerial agricultural operations over the wind farm and hang gliding in close vicinity to the wind farm the risk to civil aviation activities if any that this wind farm may pose is trivial. However, as with any reported tall structure that may pose a risk, regardless of its triviality, the position of the proposed wind farm should be shown on appropriate air navigation charts to assist pilots operating in the region. Additionally, subject to the results of a risk assessment to be undertaken by RATCH-Australia, hazard lighting in accordance with MOS 139, Chapter 9, Section 9.4 may need to be installed on sufficient turbines in the Collector wind farm to define the extremities of the site. The lighting should be operated in a manner consistent with a general duty of care towards aviation, such as during the period 1 hour before sunset to 1 hour after sunrise, and during conditions of reduced visibility caused by smoke, dust or haze. Implementation of such mitigation measures will ensure all the safeguards put in place by CASA to reduce the risk posed by tall structures, including wind turbines, to the safety of civil aircraft operations are satisfied.

# 2.0 INTRODUCTION

RATCH Australia Corporation Ltd is proposing to locate a cluster of 68 wind turbine generators at Collector in New South Wales between Goulburn and the Australian Capital Territory. The site is on a north-south ridge to the west of the Federal Highway. Terrain in the area ranges from 609m to 914m (2,000 ft to 3,000 ft AMSL) and includes spot height elevations of 2913 ft and 3091 ft AMSL. The site location is shown in Appendix A and is approximately 30 km southwest of Goulburn Airport, 50 km northeast of Canberra Airport and 200 km southwest of Sydney. The largest turbine being considered has a maximum height of 150m above ground level, consisting of a mast 94m high and rotor blade length of 56 metres. The turbine generators used will be decided during the tender process.

As the proposed wind turbines will be greater than 110m in height, they must be reported to the Civil Aviation Safety Authority (CASA) for assessment of the risk the proposed structure may pose to civil aircraft operations. The Royal Australian Air Force (RAAF) also has an interest in assessing tall structures and it can be expected that CASA in its assessment will consider the impact upon military flying operations and if required, advice from the Australian Defence Force will be sought.

# 3.0 LEGISLATIVE BACKGROUND

Under the provisions of the *Civil Aviation Act 1998,* the *Civil Aviation Regulations* (CAR) or the *Civil Aviation Safety Regulations* (CASR), CASA is not empowered to approve or oppose the erection of structures on or near an aerodrome. If deemed necessary, CASA has limited power to order the removal of an object which is classified as an obstruction or hazardous to aircraft operations within 3,000m of an aerodrome (CAR 95).

CASR Part 139.E promulgates the requirements to be met in relation to obstacles and hazards. CASR 139.365 requires the proponent of a proposed structure *"…the top of which will be 110m or more above ground level..."* to notify CASA of their intention and to provide the proposed height and location of the building or structure.

In accordance with CASR 139.370 CASA may determine after conducting an aeronautical assessment that an obstacle, building or structure is, or will be hazardous to aircraft operations. If the proposed obstacle, building or structure is deemed to be hazardous to aircraft operations CASA may direct the proponent to light or mark the hazard in accordance with the *Manual of Standards (MOS) - Part 139 Aerodromes*. With respect to the lighting of wind farms CASA formerly provided guidance material in Advisory Circular AC 139-18(0) *Obstacle Marking and Lighting of Wind Farms,* subsequently withdrawn. Other means of providing lighting and / or marking can be proposed to CASA such as those detailed in advice from European agencies and the International Civil Aviation Organisation (ICAO).

Following a 2009 risk review of man made objects located away from regulated aerodromes CASA is contemplating the development of a regulatory framework similar to that of the United States Federal Aviation Administration for marking and lighting of obstacles. The United States regulations define obstacles as buildings, objects and structures of 150m or more in height. In conjunction with rulemaking activity, CASA intends to review Advisory Circular 139-08(0) on reporting of tall structures and will consider reviewing the withdrawn Advisory Circular 139-18(0) on lighting of wind turbines to refer to lighting requirements for structures 150m or more above ground level. Guidance material is normally released with new regulations in a process that may require up to two years to complete. However, guidance contained in withdrawn AC 139-18(0) on lighting of wind turbines to fulfil duty of care obligations continues to be relevant.

CASA may determine that a particular activity is dangerous to aircraft operations and declare the area encompassing the activity a danger zone.

If a wind turbine is found to penetrate prescribed airspace surrounding an airport, it will be defined as an obstacle and shall be dealt with in accordance with the requirements set out in Chapters 7, 8 and 9 of the *Manual of Standards* (MOS), Part 139 – *Aerodromes*. If the aerodrome is used for night operations, lighting of the obstacle must be in accordance with the provisions of Chapter 9 of the MOS.

The legislative instruments protecting civil aircraft safety can be assumed to replicate the interests of the Australian Defence Force (ADF) aircraft operations and as such input from the ADF could be expected if the proposed activity has a potential impact on military flying operations. CASA may liaise with the RAAF Aeronautical Information Service (AIS) as that organisation maintains the tall structure database on behalf of the aviation community.

Likewise Airservices Australia, the provider of Air Traffic Control and Air Navigation services has an interest in assessing proposed tall structures to ensure there is no impact upon the performance of ground based navigation aids and radar facilities.

# 4.0 METHODOLOGY

In carrying out the assessment REHBEIN Airport Consulting has considered the likely impact of the location, height and blade rotation of the proposed wind turbines on:

- The nearest aerodromes and:
  - the types of flying activities conducted there;
  - their airspace protection requirements established by the Obstacle Limitation Surfaces (OLS);
  - any existing aircraft instrument procedures published in the Aeronautical Information Publication – Departure and Approach Procedures (AIP-DAP); and
  - prescribed airspace;
- Air navigation and air traffic management services including:
  - radar; and
  - ground based navigation aids;
- Transiting air routes, including:
  - routes used by civil pilots operating under instrument flight rules (IFR);
  - routes used by civil pilots operating under visual flight rules (VFR); and
  - routes used by military aircraft;
- Designated Airspace such as Danger, Restricted or Prohibited areas;
- Any other aviation activity; and
- Electromagnetic interference (EMI) with airborne radio.

# 5.0 IDENTIFIED ISSUES

Each individual stakeholder will have differing concerns regarding a proposed development. Below is a breakdown of the stakeholder issues REHBEIN Airport Consulting has identified which are addressed in this aeronautical assessment.

## 5.1 CIVIL & MILITARY AIRCRAFT PILOTS

REHBEIN Airport Consulting has considered the effect of the proposed wind farm on aircraft transiting the region, arriving and departing from local aerodromes and on aircraft flying instrument approaches into Goulburn and Canberra Airports. This consideration has addressed visual flight rules (VFR) and instrument flight rules (IFR) operations.

## 5.2 AIRPORT OPERATORS

REHBEIN Airport Consulting has assessed the types of flying activities conducted at the private Aeroplane Landing Areas at Gundaroo and Winderadeen in close proximity to the proposed wind farm. An assessment of the impact of the wind farm on each aerodrome has been undertaken.

## 5.3 AIRSERVICES AUSTRALIA

REHBEIN Airport Consulting has undertaken an assessment of the impact of the proposed wind farm on the performance on both ground based navigation aids and radar facilities.

## 5.4 OTHER AVIATION ACTIVITY

### 5.4.1 AERIAL APPLICATION

REHBEIN Airport Consulting has undertaken an assessment of the likely type of agricultural activities conducted in the area of the proposed wind farm and the impact of the turbines on aerial agricultural operations.

### 5.4.2 RECREATIONAL AVIATION

Because of the proximity of the wind farm site to hang gliding along the ridge to the west of Lake George, consideration has been given to the effect of the proposed wind farm on recreational aviation in the region.

# 6.0 POTENTIAL RISKS TO AVIATION ACTIVITIES

As with any proposed obstacle, building or structure, wind turbines must be assessed for any potential hazard/risk to aircraft operations.

## 6.1 AIRSPACE AROUND AERODROMES

There are two key airspace surfaces which may be relevant dependent on the category of operations into the aerodrome.

### 6.1.1 OBSTACLE LIMITATION SURFACE (OLS)

The OLS is a set of imaginary surfaces associated with an aerodrome. They define the volume of airspace that should ideally be kept free from obstacles in order to minimise the danger to aircraft during an entirely visual approach or during the final visual segment of an instrument approach procedure. These surfaces are of a permanent nature and comprise the reference datum which defines an obstacle. Anything above the vertical limits of the OLS is regarded as an obstacle. Obstacles are reported so that CASA can determine if they are “hazardous” and therefore need to be marked and/or lit to ensure they are prominently identified.

Airspace requirements will depend on the nature and scale of activities at an aerodrome but could extend to a radius of 15 km. The OLS also need to be considered in relation to both current and future aerodrome developments and activities.

Wind turbines may be acceptable in the areas covered by the OLS but will need to be assessed in relation to critical manoeuvres such as the approach to land and possible low level missed approaches, and a reduced power take-off following an engine failure.

### 6.1.2 PANS-OPS SURFACES

Airspace associated with aircraft instrument approach and departure procedures is defined by the PANS-OPS surfaces for an aerodrome. These surfaces are ascertained in accordance with the criteria in the International Civil Aviation Organisation (ICAO) *Procedures for Air Navigation Services - Aircraft Operations* (Doc 8168, PANS-OPS).

The PANS-OPS surfaces are intended to safeguard an aircraft from collision with obstacles when the pilot is flying by reference to instruments. The designer of an instrument procedure determines the lateral extent of areas needed for an aircraft to execute a particular manoeuvre. The designer then applies minimum obstacle clearance to structures, terrain and vegetation within that area to determine the lowest altitude at which the manoeuvre can be safely executed. As a result, PANS-OPS surfaces cannot be infringed in any circumstances.

These airspace requirements will depend on the nature and scale of activities at an aerodrome but could determine the acceptable obstacle heights to a radius of 10 - 20 km from the aerodrome.

## 6.2 RADAR

Tall structures may interfere with electromagnetic transmissions. Steel towers and rotating turbine blades can cause reflection and/or deflection of radiated waves and cause interference with aviation communication, navigation and surveillance (CNS) systems established for air traffic management. The CNS system includes aerodrome based and enroute navigation aids (navaids) and radar used for air traffic control at an aerodrome and/or enroute surveillance.

Two types of radar are used for air traffic control (ATC) and surveillance – primary radar and secondary surveillance radar (SSR).

Primary radar works by radiating electromagnetic energy and detecting a return signal from reflecting objects. Comparison of the return signal with the original transmission provides information such as the direction and range of the target from the radar site. ATC radars are designed to filter returns from stationary objects to avoid moving targets, primarily aircraft, being obscured by radar clutter. Other than this means of differentiating between stationary and moving targets, primary radar cannot determine the type of object detected and has no means of determining the height of the object.

SSR emits radio frequency (RF) interrogation messages that trigger automatic responses from a transponder onboard an aircraft. The transponder reports aircraft identification and altitude.

Primary radar can detect aircraft up to 50 NM from the radar sensor while TAR SSR and RSR can detect aircraft up to 250 NM. This is referred to as the radar coverage. Radar coverage extends along the eastern seaboard from Cairns to Adelaide and is provided for Perth, Darwin and Tindal.

Airservices Australia provides a network of 19 radars. Those associated with major airports – 8 in total – are combined primary and SSR units. These are referred to as Terminal Area Radar (TAR). These are augmented by 11 SSR or route surveillance radars (RSR) strategically located along the busier air corridors. Their coverage is augmented by radar data from 6 military radar sites.

Vertical coverage depends on the line of sight of each radar which may be interrupted by terrain or tall structures. Coverage must be guaranteed within controlled airspace which extends from ground level in airport control zones (CTR) and from 8500 ft in enroute airspace. Only aircraft equipped with transponders are permitted to operate in controlled airspace, and should therefore be detected by SSR. The primary radar is provided at busy airports as a back-up to detect non-transponder equipped aircraft that may accidentally stray or deliberately fly into a control zone.

ATC utilises radar to ensure the required horizontal and vertical separations are maintained between aircraft operating in controlled airspace. As workload and/or radar coverage permits ATC will provide suitably equipped VFR flights in adjoining non-controlled airspace with a radar /ADS-B information service (RIS). The service provides traffic information to assist pilots in detecting other traffic. Subject to ATC workload the service also provides position and / or navigation information on request.

The blades of a wind turbine may be detected if within the coverage and line of sight of primary radar. A grouping of blades will return intermittent reflections that create the impression of a moving target. Since the primary radar gives no height information, reflections from wind turbine blades may cause an air traffic controller to divert aircraft which may be in the vicinity of the wind farm within primary radar coverage regardless of their flight level.

The turning blades may also reflect or deflect the primary radar signals and prevent aircraft flying in their “shadow” from being detected. In this case the co-located SSR would also detect the aircraft but even then the reflection of SSR transmissions in some instances could cause the aircraft to be wrongly identified or its position to be inaccurately shown on ATC radar.

Weather radar can similarly be affected, and this too impacts on flight safety which relies on accurate forecasting of major weather events and wind shear at higher altitudes.

## 6.3 RADIO NAVIGATION AIDS

Ground based radio navigation aids could suffer from similar reflection and deflection effects as with radar. The effect of this may be that an aircraft is not tracking accurately towards the aid on the designated air route. This false tracking can cause the aircraft to deviate too far from the intended flight track and expose it to obstacles which infringe on the clearances defined in the design of the particular flight procedure in instrument conditions. Similarly, visually navigated aircraft may track erroneously due to a conflict of navigation data available from maps and navigation aids.

Line of sight principles again apply but this type of facility will normally be protected by preventing new structures if they will extend above an elevation angle of 1 degree as seen from the site of the radio navigation aid.

This means that on level ground a 150m high wind turbine could be safely located at around 8 km from the site of the aid.

## 6.4 VISUAL & INSTRUMENT FLIGHT RULES

### 6.4.1 INSTRUMENT FLIGHT RULES (IFR)

Aircraft operating under IFR are navigated by reference to cockpit instruments which process data from aircraft systems, ground-based navaids or satellites. All regular public transport (RPT) jet aircraft operating into or between major Australian cities operate only in controlled airspace and under IFR.

In contrast, turboprop or piston engine regional RPT aircraft travelling to or from a regional city may operate route sectors outside controlled airspace (OCTA) and even under VFR.

Charter and business aircraft may operate in controlled airspace under IFR or VFR, or OCTA under VFR. General aviation training aircraft are most likely to operate under VFR. Military aircraft may operate anywhere and may be flying at very low levels.

Aircraft operating under IFR may do so either OCTA or within controlled airspace. If flying below 10,000 ft pilots must select, or will be assigned, cruising altitudes which are multiples of 1,000 ft – odd thousands if their track is 0 - 179ºM and even thousands if their track is 180 - 359ºM. IFR traffic must select or be assigned to a designated air route depicted on air navigation charts.

Since IFR pilots may be relying solely on cockpit instruments and have no outside visual reference, a lowest safe altitude (LSALT) is published for each air route. It is determined by adding 1,000 ft minimum vertical clearance to the highest terrain or known structure enroute.

It is conceivable that a new wind farm, if located on prominent terrain, may require an increase in LSALT for a particular air route.

### 6.4.2 VISUAL FLIGHT RULES (VFR)

Aircraft operating under VFR may do so only in visual meteorological conditions (VMC) defined as an average range of visibility of 5,000m forward of the cockpit, horizontal cloud clearance of 1,500m and vertical cloud clearance of 1,000 ft.

VFR traffic is most likely to operate OCTA but may fly in Class E controlled airspace without reference to ATC. VFR pilots may fly a designated air route in which case they must select altitudes which are multiples of 500 ft - odd thousands plus 500 ft if their track is 0 - 179ºM and even thousands plus 500 ft if their track is 180 - 359ºM. This rule ensures there should be a minimum 500 ft separation between IFR and VFR traffic using the same air route.

The minimum statutory height for VFR flight is 500ft above ground level or clear of obstacles in non-populous areas. Night VFR pilots must fly at or above the LSALT for the route. Night VFR pilots must use either a published LSALT for the area or if on a dead reckoning (DR) track then a calculated LSALT taking into account any point within 10 NM of the nominated track.

VFR traffic in daylight hours is not confined to air routes and these aircraft may operate anywhere provided they do so in VMC and observe the same rules for selecting their cruising altitude.

In these conditions wind farms should be easily visible and have no impact on VFR flying activity.

## 6.5 MILITARY LOW FLYING

Military pilots must conduct low level flying training so that the skill becomes second nature. Low level flying exercises are carried out by military aircraft from a number of Defence aerodromes. Routes at or below 5,000 ft AGL used by military jet aircraft for low level, high speed navigation or terrain following exercises are designated as Military Low Jet Routes (MLJR).

Routes are planned to avoid controlled airspace, civil restricted areas and danger areas, civil aerodromes by at least 5 NM laterally and 4000 ft vertically, and Common Traffic Advisory Frequency – Radio (CTAF-R) airspace unless aircraft are equipped with the appropriate radio frequency.

Routes and duration of MLJR operations are advised by the Notice to Airmen (NOTAM) system. This policy means that MLJRs are more flexible and new installations such as wind farms would be considered by the Australian Defence Force (ADF) when planning low level flights.

## 6.6 DESIGNATED AIRSPACE

Special use airspace, extending to varying heights, is defined on air navigation charts and identified as P (Prohibited), R (Restricted) or D (Danger). For safety reasons flight into this airspace may be prohibited or restricted or the airspace may be designated as a danger area to warn pilots to take additional care.

Wind turbines will not be permitted within prohibited or restricted areas as these are usually set aside for military training, weapons firing or security sensitive structures.

Danger areas will usually relate to mining or quarrying sites, chimneys or stacks with high velocity or high temperature discharges, special aviation activities such as aerobatic training and the like. While pilots may elect to avoid these areas there is no restriction on entry.

Wind turbines may not be compatible with some activities conducted within a designated Danger Area but, more importantly, CASA may elect to designate a Danger Area around a wind farm in order to alert pilots to avoid low altitude flying.

## 6.7 OTHER AVIATION ACTIVITIES

Aerial agricultural operations may be affected by the presence of wind turbines depending on the spacing between turbines and cluster orientation. Turbulence produced by the rotors can present a hazard to agricultural aircraft conducting operations at very low levels, particularly when manoeuvring at high weights. The vortices may persist for a considerable distance downwind from the rotors and may cause an upset that is extremely hazardous to a heavily loaded agricultural aircraft operating at low level. Overseas studies[1] suggest that the plume behind a wind turbine can

[1] L.J Vermeer, J.N. Sorenson, A Cresp, *Wind Turbine Wake Aerodynamics,* Progress in Airspace Sciences 39 (2003).

Hand M, Simms D, Finger L, Jager D, Coteril J, Schreck S, Larwood S *Unsteady aerodynamics experiments phase VI: Wind tunnel test configuration and available data campaigns.* Technical Report BREL/TP-500-29955, NREL (December 2001).

*Wind Turbine Wakes – Control and Vortex Shedding* by Davide Medici. Technical Reports from KTH Mechanics Royal Institute (2004)

persist for distances of at least six times the rotor diameter. For a 90m rotor the distance could be 540m or greater. The extraction of wind energy by a turbine causes a velocity deficit in the air flow behind the turbine, producing significant shear between the free stream wind and the turbine wake. The wake exhibits rotational flow at the blade rate and can contain turbulent high speed flows when the turbine is operating at maximum power extraction. However, because aerial spraying and spreading operations are conducted in calm wind conditions when the turbine blades are stationary, agricultural aircraft are unlikely to encounter hazardous turbulence generated by wind turbines when operating near them.

Special use areas for hang-gliding, parachuting or radio controlled model aircraft flying are marked by symbols on air navigation charts. Although these do not usually justify the designation of a Danger Area the symbol serves to alert pilots to over-fly these sites at a safe height. Since a wind farm shares low level airspace it could seriously curtail these types of recreational activities. Wind farms are now being indicated on charts by a symbol in the same manner as other tall masts.

## 6.8 ELECTROMAGNETIC INTERFERENCE WITH AIRBORNE RADIO

Large scale power generation activities may cause electromagnetic interference (EMI) with on-board radio communication equipment in aircraft overflying and/or flying in the vicinity of the wind farm.

The available literature indicates that this effect may be considered negligible because of the standards which apply to wind turbine construction. Wind turbines have been installed world wide with very few instances of EMI being recorded.

# 7.0 AERONAUTICAL RISK ANALYSIS

Having considered the potential risks to aviation activities as outlined in Section 5.0 as part of an overall analysis of the proposed wind farm, the following risk assessments are detailed.

## 7.1 AERODROMES

The proposed site is approximately 30 km to the southwest of Goulburn airport, and 50 km north east of Canberra airport. Local Aeroplane Landing Areas (ALAs) shown on Canberra Visual Terminal Chart (VTC) within 30 km of the proposed wind farm site include Gundaroo, 11.5 km to the southwest of the site and Winderadeen, 1.5 km south of Collector township and 3 km east of the site. Both are uncertified, unregistered private aerodromes that are not regulated by the Civil Aviation Safety Authority.

Lower level controlled airspace in the area of the proposed wind farm is well above the planned heights for the wind turbines. Airspace in the Collector region is Class G and is not controlled (i.e. not subject to Air Traffic Control clearances / separation) below 5,500 feet between 16 and 20 NM by DME from Canberra, and below 6,500 feet beyond 20 NM by DME. ATC may provide a Flight Information Service (FIS) in Class G airspace if resources allow. VFR aircraft operating in Class G airspace are not required to maintain radio contact below 5,000 ft or to operate with a serviceable transponder below 10,000ft.

### 7.1.1 CANBERRA AIRPORT

Canberra Airport is a certified aerodrome operated by Canberra Airport Pty Ltd. Sealed runways aligned 117 / 297 degrees magnetic and 168 / 348 degrees magnetic are used for international, domestic and regional regular public transport operations, military jet transport operations, and general aviation. Runway 12 / 30 is 1,679m long and 45m wide and runway 17 / 35 is 3283m long and 45m wide. Runway 17 / 35 is used mainly by heavy jet and turboprop aeroplanes, while runway 12 /30 is used by regional turboprop and general aviation aircraft. Runway 12 / 30 is equipped with low intensity runway lighting and visual approach slope guidance. Runway 17 / 35 is equipped with medium intensity runway lighting, Category I high intensity approach lighting and visual approach slope guidance. The overlying airspace is Class C but outside ATC hours of operation the airspace within 30 NM of Canberra reverts to Class G at and below 8500 ft.

Because Canberra Airport is approximately 50 km from the proposed wind farm site while the greatest possible extent of any OLS for any aerodrome is 15 km there will be no penetration of the Canberra Airport OLS by the proposed wind farm.

Based on the information provided by RATCH Australia in Table 1 at Appendix B, the highest wind turbine will be (2887 + 492) ft or 3379 ft AMSL. The wind farm site is located beneath a Class C controlled airspace step with a lower limit of 6,500 ft beyond 20 NM by DME from Canberra, and

5500 ft inside 20 DME. IFR aircraft conducting a DME or GPS Arrival to Canberra are limited to 7000 ft overflying the wind farm site. Other instrument approach procedures for Canberra will not be affected because the site is remote from Canberra airport. The wind farm will not impact on Canberra Airport PANS-OPS surfaces.

### 7.1.2 GOULBURN AIRPORT

Goulburn Airport is a registered aerodrome approximately 30 km north east of the proposed Collector wind farm. The aerodrome has one 1283m x 30m sealed runway aligned 040 / 220 degrees magnetic, and a 676m x 30m grassed runway aligned 080 / 220 degrees magnetic. The aerodrome is used by general aviation aircraft, some of which have a maximum take-off weight in excess of 5,700 kg. Overlying airspace is Class G to 8,500 ft.

Since the greatest possible extent of any OLS for any aerodrome is 15 km there will be no penetration of the Goulburn OLS by turbines in the proposed Collector wind farm.

The 25 NM minimum sector altitude (MSA) of 4,700 ft provides a minimum obstacle clearance of 1,000 ft above all obstacles within 25 NM of the NDB in the sector to the north, west and south of the NDB bounded by inbound tracks of 325 degrees magnetic clockwise to 235 degrees magnetic. The 1,000 ft MOC provided at 4,700 ft will not be infringed by the highest turbine blade zenith at 3379 ft.

Instrument approach procedures for Goulburn Airport comprise GPS Arrivals which overfly the wind farm site at 4700ft; an NDB approach with an initial approach altitude of 4700 ft; and an RNAV (GNSS) approach to runway 04 with an initial approach altitude of not below 4700 ft to each of the initial approach fixes. The initial approach altitude provides 1,000 ft MOC at 4,700 ft. As the assumed height of the highest wind turbine is 3379 ft, the wind turbine will not infringe the 1,000 ft MOC provided at the initial approach altitude.

The NDB approach procedure comprises a teardrop procedure with an outbound track of 166 degrees magnetic for category A and B aircraft, 181 degrees magnetic for Category C aircraft. After 1.5 to 2 minutes outbound from the NDB, aircraft turn left to approach the aerodrome from the south. The wind farm will not impact on Goulburn Airport PANS-OPS surfaces.

The Collector wind farm will be appropriately visible to VFR traffic operating in the area during daylight hours.

### 7.1.3 GUNDAROO ALA

Gundaroo ALA has a bitumen runway of 1106m aligned 180 / 360 degrees magnetic and a grass runway of 548m aligned 090 / 270 degrees magnetic. The aerodrome is used by business jet aircraft in private and business operations and by general aviation light aircraft. The runway is equipped with low intensity runway edge lighting and a visual approach slope indication system for

night operations but no radio navigation aids are installed and no instrument approach procedures are published in AIP - DAP.

The minimum take-off and approach OLS recommended for these aerodromes in Civil Aviation Advisory Publication (CAAP) 92-1(1) — *Guidelines for Aeroplane Landing Areas* published by the Civil Aviation Safety Authority (CASA) do not exceed 900m from the end of the runway strip. If the OLS criteria for a non-instrument runway Code 2 as described in the CASA *Manual of Standards*, Part 139 — *Aerodromes* were applied to the main runway, the approach and take-off surface length would not exceed 2500 m. As Gundaroo is 11.5 km from the wind farm site, the wind turbines will not affect the OLS. Radio equipped aircraft overflying Gundaroo ALA at or below 3,500 ft within 10 NM are required to monitor the Common Traffic Advisory Frequency (CTAF) 126.7 MHz. The presence of the turbines will not affect VHF radio reception in the CTAF area.

Since Gundaroo has no published instrument approach procedures, the wind farm will not affect PANS –OPS protection surfaces for this aerodrome.

### 7.1.4 WINDERADEEN ALA

Winderadeen ALA is marked on the Canberra VTC and on VNC-2 Sydney but REHBEIN Airport Consulting has been informed[2] that the ALA is permanently closed. The wind farm will not have any effect on this site.

## 7.2 RADAR & RADIO NAVIGATION AIDS

### 7.2.1 RADAR

The closest radar to the proposed wind farm is the Canberra Terminal Area radar located at Mount Majura, approximately 30 km to the south west of the proposed Collector wind farm. This sensor comprises primary radar and SSR.

The 3036 ft elevation of the Mt Majura radar site ensures that the highest turbine blade zenith at 3379 ft located approximately 20 NM from the sensor will not penetrate the 0.5 degree radar protection surface originating from the base of the antenna. Shielding of primary radar returns from targets in Class C airspace is therefore considered unlikely. Given that there is overlap of SSR from the Mount Bobbara and Mt Majura sensors there should be no impact upon SSR in the vicinity of the proposed wind farm. Also it should be noted that since the lower level of controlled airspace is 6,500ft in the region of the proposed wind farm, there is no requirement to provide SSR coverage below this level because VFR aircraft operating in Class G airspace below 10,000ft are not required to carry and operate transponders.

[2] Notified by R.Berry, Winderadeen 5 November 2010.

### 7.2.2 RADIO NAVIGATION AIDS

The closest radio navigation aid to the proposed wind farm site is the Goulburn non-directional beacon (NDB), 35 km to the north east. At this distance the wind farm will not have any impact on the performance of the NDB.

The NDB, VOR, DME and ILS at Canberra Airport are approximately 50 km from the proposed wind farm. At this distance there should be no adverse effects on the performance of the aids.

### 7.2.3 AIRSERVICES AUSTRALIA

It would be prudent to confirm whether Airservices Australia has any concerns about the impact of the proposed wind farm upon radar and radio performance in the region although investigation undertaken by REHBEIN Airport Consulting suggests the impact, if any, will not be of operational significance. Early consultation is recommended in order to provide an opportunity for any objections to be addressed before the planning permit application process and to avoid delays during final planning. Apart from site plans and location of the proposed wind farm, Airservices Australia requires the following information to complete technical and operational assessments:

- Exact dimensions of proposed structures (turbine or wind monitoring mast).
- Maximum blade tip heights in AHD (Australian Height Datum) and above ground height for each turbine.
- The exact location including coordinates and datum for each turbine/wind monitoring mast extracted by survey:
  - Accurate Coordinates in latitude/longitude (Degrees, Minutes, Seconds)
  - Datum – WGS84 (or MGA94 can be received)
- A description of each structure to be built, including details of proposed external cladding materials, and proposed use (in this case, wind monitoring mast or wind turbine).
- Where possible, MicroStation .dgn files or AutoCAD .dwg files.

The information can be forwarded to:

Joe Doherty
Manager Airport Development Section
Executive Officer, Land Use Planning
Airservices Australia
P: 02 6268 5101
joseph.doherty@airservicesaustralia.com

## 7.3 TRANSITING AIR ROUTES

### 7.3.1 IFR AIR ROUTES

IFR routes W122, W138 and W423 pass over or near the site of the Collector wind farm. The relevant route segments have lowest safe altitudes (LSALTs) of 5100 ft, 4800 ft and 4600 ft respectively. Information provided by RATCH Australia indicates a maximum site elevation of 880m (2,887 ft) within the proposed wind farm (Appendix B, Table 1 refers).The maximum turbine height within the Collector wind farm will be 3379 ft AMSL. This would dictate a minimum en route altitude of 4379 ft. Rounded up to the next hundred feet this would produce a LSALT of 4400 ft. The turbines will not be a critical obstacle as the LSALTs for the adjacent IFR route segments are higher, indicating the presence of higher obstacles within the route navigation tolerance areas.

IFR aircraft operating on the foregoing IFR routes are adequately protected by the published route LSALTs. The proposed wind farm will not affect current published LSALTs.

### 7.3.2 VFR AIR ROUTES

The Collector wind farm will be clearly visible to VFR traffic operating in the area during daylight hours. VFR flights operating at or below 10,000 ft AMSL require a minimum flight visibility of 5000 m. There are no published VFR routes for aircraft operating in the Collector region. However, VFR aircraft flying from Goulburn to Canberra will normally track via the VFR approach point at Lake George North and the Sutton Overpass on the Federal Highway. As the proposed wind farm will be sufficiently conspicuous during daylight operations, as indicated in CASA Advisory Circular AC 139-08(0) there would be no requirement for specific marking of the wind turbines as there will be no impact on VFR aircraft operating in the area.

Aircraft operating at night under the Visual Flight Rules (NVFR) are required to fly at or above the route LSALT for the flight planned track. LSALTs for NVFR flights are determined in a similar manner to those for IFR flights described in Section 7.3.1. The position and heights of the turbines will be shown on VNC-2 Sydney and the Canberra VTC, enabling pilots to take them into account when planning Night VFR flights over or near the wind farm. The maximum turbine height of 3379 ft will dictate a Night VFR route LSALT of 4400 ft in the vicinity of the wind farm.

Night VFR cross country operations conducted from Goulburn in the direction of the proposed wind farm are required to reach en-route lowest safe altitude (LSALT) before leaving the vicinity of the aerodrome. Night VFR flights inbound to Goulburn are required to maintain en-route LSALT until the aerodrome is in sight and the aircraft is within the prescribed circling area of 3 NM from the aerodrome.

The wind turbines will have no effect on VFR or Night VFR en route flying activity.

As the wind farm site is remote from aerodromes that are likely to be used for Night VFR operations, and the structures will not exceed 150m in height, CASA has recommended in recent

policy advice concerning a risk review of man made structures remote from aerodromes that hazard lighting should be installed only on sufficient turbines to define the extremities of the wind farm. The lighting should be operated in a manner consistent with a general duty of care towards aviation, such as during the period 30 minutes before and after sunrise and sunset, and during conditions of reduced visibility caused by smoke, dust or haze.

### 7.3.3 MILITARY LOW FLYING OPERATIONS

The Department of Defence (DoD) should be informed of the wind farm proposal and any wind monitoring towers and other associated infrastructure of height. Early consultation is recommended before the planning permit application process. This will allow the Department time to undertake a formal assessment of the likely impact of the wind farm on military flying operations and on military aviation infrastructure including communications. To assess the proposal the following information will need to be provided to the DoD:

- Location map showing the wind farm land boundary, locations of WTGs and other infrastructure (i.e. wind monitoring masts, concrete batching plants, overhead wires etc.) and their orientation in relation to populated areas in the vicinity;
- WTG tower and blade dimensions; and
- WTG and associated infrastructure elevations.

The information can be forwarded to:

Brenin Presswell
Executive Officer, Land Use Planning
Estate Planning Branch - Infrastructure Division
Department of Defence
P: 02 6266 8138
F: 02 6266 8294
lpsi.directorate@defence.gov.au

RAAF Aeronautical Information Services (RAAF AIS) is informed of any structure taller than 30 m AGL prior to construction and again once construction is complete. This will enable monitoring masts, turbines, etc to be appropriately charted and help maintain safe flying. The RAAF AIS website at http://www.raafais.gov.au/ includes a form for submission of this data.

## 7.4 RESTRICTED AREAS

There are no published Danger (D) or Prohibited (P) areas in the region of the wind farm.

## 7.5 OTHER AVIATION ACTIVITY

### 7.5.1 AERIAL AGRICULTURAL OPERATIONS

Aerial application of chemicals to properties in the vicinity of the wind farm is unlikely because of the limited size of the properties and the agricultural activities that they support. No aerial spraying operations have been conducted over the largest property within the wind farm site during the past 12 years. The most recent aerial spraying operations in the area were conducted during 2010 on a property at Cullerin to the north of the proposed wind farm. This was necessary because of unusually high seasonal rainfall that precluded the usual practice of spraying from the ground using a tractor.

Agricultural aerial spreading and spraying operations are normally conducted during daylight hours at very low levels and often require calm or very light wind conditions of less than 8 knots (15km/h). Pasture seeding or spreading of fertilisers typically conducted at a height of 90m above ground level would have to be performed under similar atmospheric conditions in order to avoid the substances contacting the rotors, possibly causing contamination and damage. At these wind speeds it is reasonable to assume the wake can extend for a distance of 6 rotor diameters or 600m downwind of the nearest turbine based on the proposed rotor diameter of approximately 100m. Aerial spraying conducted over properties within or on the downwind side of the proposed wind farm are therefore unlikely to encounter turbulence generated by the turbines.

Consultation with the Aerial Agricultural Aviation Association (AAAA) and selected regional aerial agricultural operators suggested that aerial application could be considered impractical over properties located in or near the wind farm. However, aerial agricultural operators are not required to belong to the AAAA or to adopt AAAA policy in regard to wind farms.

### 7.5.2 SPORT AVIATION

Symbols on VNC-2 Sydney and on the Canberra VTC indicate that hang gliding is conducted along the western edge of Lake George, from 5 km west of Collector to the southern end of the lake, above the range proposed for the wind farm site. Hang gliding in the vicinity of Collector is not likely to be adversely affected by the proposal as hang gliding will only be conducted during daylight hours when the turbines are clearly visible and the prevailing winds in the area are from the north west which are unsuitable for hang gliding.

Model aeroplane flying is conducted from the midpoint of the western shoreline of Lake George. This activity should not be adversely affected by the proposal as the site is 15 km from the wind farm area.

## 7.6 ELECTROMAGNETIC INTERFERENCE WITH AIRBORNE RADIO

Available literature indicates that this effect may be considered negligible because of the standards which apply to wind turbine construction. Wind turbines have been installed world wide with very

few instances recorded of EMI affecting aircraft radio systems. Wind turbines that presently operate near the south eastern shore of Lake George evidently do not cause interference with airborne radio.

# 8.0 CONCLUSIONS AND RECOMMENDATIONS

The proposed wind farm will not impact upon aircraft operations to and from Canberra or Goulburn airports or Gundaroo ALA. Nor will it interfere with airborne radio or navigation aid performance.

Analysis undertaken by REHBEIN Airport Consulting indicates that there will be no impact upon IFR traffic transiting the area on routes W122, W138 and W423. Traffic operating under the VFR should not be affected by the proposed wind farm as the structures will be sufficiently conspicuous by day, and en route LSALTs will provide adequate clearance from the turbines for Night VFR operations.

It would be prudent to confirm whether Airservices Australia has any concerns about the impact of the proposed wind farm upon radar and radio performance in the region as outlined in Section 7.2.3 although investigation undertaken by REHBEIN Airport Consulting suggests the impact, if any, will not be of operational significance.

It is also advisable to provide an opportunity for the Department of Defence to comment formally during the planning permit application process as outlined in Section 7.3.3. Early consultation is recommended to provide an opportunity for any objections to be addressed before the planning permit application process begins.

Analysis suggests that there will be no adverse impact upon aerial agricultural operations in the vicinity of the wind farm. Hang gliding activities near Collector are unlikely to be adversely affected because these operations are conducted during daylight hours when the turbines are clearly visible and the prevailing winds in the area are from the north west which are unsuitable for hang gliding.

CASA currently allows fixed structures up to 110m AGL without marking, lighting or advice to the aviation industry. These structures could be located anywhere and be any shape, size, colour or number. In this instance RATCH Australia proposes structures that are substantially higher at 150m above ground level, concentrated in a defined area, conspicuous because of their shape and colour and unlikely, on the basis of this preliminary investigation, to pose a hazard to aviation.

In this case all the safeguards imposed by CASA to ensure tall structures, including wind turbines, do not constitute a hazard to the safety of civil aircraft operations in Australia are satisfied; and the risk to civil aviation activities, if any, that this wind farm may pose is trivial.

CASA has foreshadowed an increase in the height allowance of objects from 110m to 150m above ground level pending rulemaking action concerning man-made objects located away from aerodromes. Turbines of 150m or more above ground level will require obstacle lighting unless an aeronautical study can show that an object will not be an obstacle. Turbines not exceeding 150m in height will not be obstacles to aircraft operating at night. Nevertheless, subject to the results of a risk assessment to be undertaken by RATCH-Australia hazard may need to be installed on

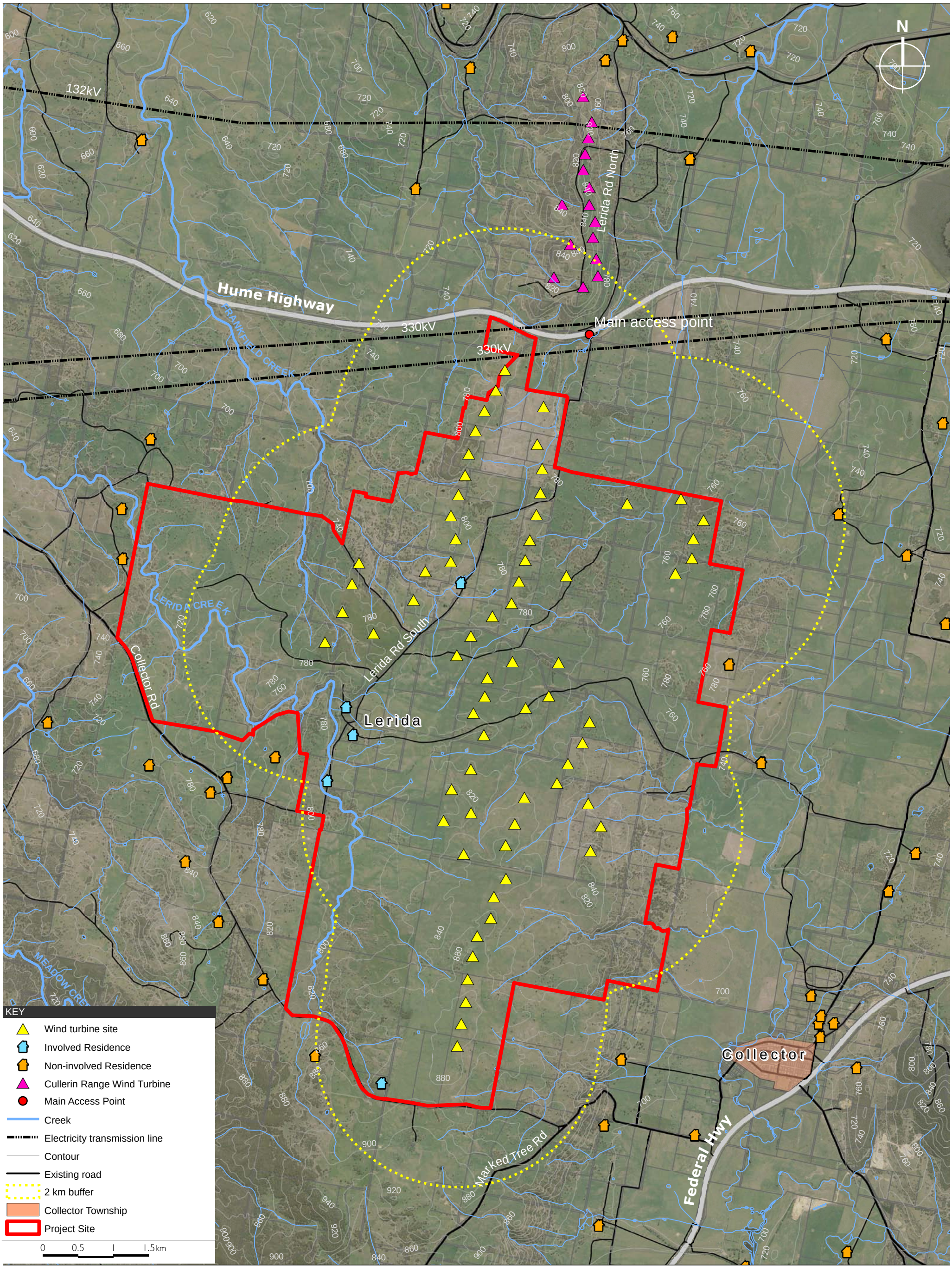
sufficient turbines in the Collector wind farm to define the extremities of the site to discharge duty of care obligations to aviation operators

Lighting should be in accordance with MOS 139, Chapter 9, Section 9.4 and be operated in a manner consistent with a general duty of care towards aviation, such as during the period 30 minutes before and after sunrise and sunset, and during conditions of reduced visibility caused by smoke, dust or haze.

Revisions to associated guidance material are likely to include reissue of CASA Advisory Circular AC139-18(0), *Obstacle Marking and Lighting of Wind Farms* updated to incorporate advice on providing obstacle lighting for structures 150m or more above ground level.

# APPENDIX A

SITE LAYOUT


N
132kV
330kV
330kV
Hume Highway
Main access point
Lerida Rd North
Lerida Rd South
Collector Rd
Lerida
Collector
Federal Hwy
Marked Tree Rd
FRANKFIELD CREEK
LERIDA CREEK
MEADOW CREEK
KEY
Wind turbine site
Involved Residence
Non-involved Residence
Cullerin Range Wind Turbine
Main Access Point
Creek
Electricity transmission line
Contour
Existing road
2 km buffer
Collector Township
Project Site
0 0.5 1 1.5 km
F:\GIS\APP\Collector Windfarm\December 2011 Focus GIS

REHBEIN Airport Consulting

# APPENDIX B

## WIND TURBINE SITE ELEVATIONS

| WIND TURBINE | EASTING | NORTHING | HEIGHT AHD (m) |
|---|---|---|---|
| 1 | 718433 | 6143522 | 800.0 |
| 2 | 718303 | 6143229 | 789.2 |
| 3 | 718143 | 6142944 | 800.0 |
| 4 | 718016 | 6142661 | 800.0 |
| 5 | 717920 | 6142333 | 800.0 |
| 6 | 717869 | 6142028 | 790.5 |
| 7 | 717778 | 6141753 | 780.0 |
| 8 | 717667 | 6141456 | 800.0 |
| 9 | 717737 | 6141127 | 800.0 |
| 10 | 717665 | 6140808 | 786.4 |
| 11 | 717307 | 6140667 | 778.8 |
| 12 | 717140 | 6140259 | 780.0 |
| 13 | 716368 | 6140791 | 760.0 |
| 14 | 716269 | 6140490 | 760.0 |
| 15 | 716134 | 6140091 | 778.4 |
| 16 | 715885 | 6139665 | 780.0 |
| 17 | 716574 | 6139788 | 780.0 |
| 18 | 718978 | 6143004 | 780.0 |
| 19 | 718891 | 6142467 | 770.5 |
| 20 | 718960 | 6142121 | 777.1 |
| 21 | 718935 | 6141776 | 780.0 |
| 22 | 720164 | 6141628 | 760.0 |
| 23 | 718878 | 6141471 | 780.0 |
| 24 | 718785 | 6141111 | 780.0 |
| 25 | 718721 | 6140828 | 780.0 |
| 26 | 719303 | 6140601 | 779.7 |
| 27 | 718632 | 6140529 | 780.0 |
| 28 | 718527 | 6140218 | 780.0 |
| 29 | 718256 | 6140030 | 780.0 |
| 30 | 717952 | 6139751 | 780.0 |
| 31 | 717751 | 6139480 | 780.0 |
| 32 | 718184 | 6139157 | 782.7 |
| 33 | 718539 | 6139389 | 780.0 |
| 34 | 719192 | 6139375 | 777.2 |
| 35 | 718149 | 6138894 | 790.5 |
| 36 | 717986 | 6138660 | 800.0 |
| 37 | 718135 | 6138349 | 800.0 |
| 38 | 718725 | 6138734 | 780.0 |
| 39 | 719054 | 6138902 | 773.5 |
| 40 | 717678 | 6137581 | 820.0 |
| 41 | 717952 | 6137867 | 800.0 |
| 42 | 717564 | 6137136 | 820.0 |
| 43 | 717954 | 6137251 | 820.0 |
| 44 | 717848 | 6136663 | 840.0 |
| 45 | 719633 | 6138534 | 764.1 |
| 46 | 719531 | 6138241 | 780.0 |

| WIND TURBINE | EASTING | NORTHING | HEIGHT AHD (m) |
|---|---|---|---|
| 47 | 719325 | 6137942 | 786.8 |
| 48 | 719170 | 6137671 | 798.9 |
| 49 | 718708 | 6137467 | 800.0 |
| 50 | 718574 | 6137092 | 820.0 |
| 51 | 718443 | 6136785 | 840.0 |
| 52 | 718448 | 6136312 | 860.0 |
| 53 | 718277 | 6136058 | 843.3 |
| 54 | 718233 | 6135757 | 860.0 |
| 55 | 718042 | 6135504 | 864.6 |
| 56 | 717976 | 6135216 | 880.0 |
| 57 | 717905 | 6134890 | 877.8 |
| 58 | 717877 | 6134568 | 880.0 |
| 59 | 717815 | 6134260 | 880.0 |
| 60 | 717758 | 6133946 | 880.0 |
| 61 | 719646 | 6136708 | 800.4 |
| 62 | 719793 | 6137054 | 782.3 |
| 63 | 719612 | 6137380 | 776.3 |
| 64 | 720847 | 6140638 | 760.0 |
| 65 | 721081 | 6140856 | 760.0 |
| 66 | 721100 | 6141132 | 775.7 |
| 67 | 721245 | 6141392 | 760.8 |
| 68 | 720925 | 6141697 | 740.3 |