REHBEIN AIRPORT CONSULTING

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Liverpool Range Wind Farm Aviation Impact Assessment

For Epuron Pty Ltd

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1.0 EXECUTIVE SUMMARY

Epuron Pty Ltd is proposing to develop a wind farm consisting of up to 282 wind turbine generators (WTG) at Liverpool Range in New South Wales between Mudgee and Tamworth. The closest local aerodromes to the proposed wind farm development are Coolah and Quirindi. Coolah is located 17km east of the proposed wind farm and Quirindi is 51km west of the proposed wind farm development. The largest turbine being considered has a maximum height of 1,245m Australian Height Datum (AHD).

The blade tips of the largest turbine are 165m Above Ground Level (AGL). As the proposed wind turbines will be greater than 110m in height (AGL), they must be reported to the Civil Aviation Safety Authority (CASA). The Australian Defence Force (ADF) (Defence) 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 Defence will be sought.

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 registered or certified aerodromes from Mudgee to Tamworth airports. Nor is the wind farm considered likely to 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 500ft above ground level outside populous areas and will therefore be well 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.

Low level flying operations, such as aerial agricultural operations, will be affected within the wind farm site and in the immediate vicinity (1km) of the wind turbine locations.

The wind farm development is unlikely to adversely affect hang gliding operations within the vicinity of Tamworth, as hang gliding is conducted during daylight hours when turbines are clearly visible and are not conducted when winds in the area are from the north east, as these conditions are unsuitable for hang gliding.

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 the wind farm may pose, is considered to be

negligible. However, as with any reported tall structure that may pose a risk, regardless of its likelihood, the position of the proposed wind farm should be shown on appropriate air navigation charts to assist pilots operating in the region. Additionally, CASA may direct or the proponent may identify a need to illuminate the proposed structures in order to highlight the development to the flying community.

2.0 INTRODUCTION

Epuron Pty Ltd is proposing to develop a wind farm consisting of up to 282 wind turbine generators at Liverpool Range in New South Wales between the regional centres of Mudgee and Tamworth. The approximated geographic centre of the proposed site is located 91 kilometres North, North East of Mudgee and approximately 103 kilometres South, South West of the township of Tamworth NSW. Ground level survey heights for the proposed wind turbines within the area range from 570m to 1080m (1870ft to 3,540ft AMSL). The site location is shown in Appendix A. The closest local aerodromes to the proposed wind farm development are Coolah and Quirindi. Coolah is located 17km east of the proposed wind farm and Quirindi is 50km west of the proposed wind farm development. The largest turbine being considered has a maximum height of 1,245m AHD. The turbine generators to be implemented 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 CASA. Defence also has an interest in assessing tall structures and it can be expected that CASA will consider the impact upon military flying operations and if required, advice from Defence will be sought.

This report outlines the assessment of the rules and regulations associated with the development of wind farms, as well as identify the potential risks to aviation activities within the vicinity of the Liverpool Range.

3.0 LEGISLATIVE BACKGROUND

Under the provisions of the *Civil Aviation Act 1998,* the *Civil Aviation Regulations* (CAR) and the *Civil Aviation Safety Regulations* (CASR), CASA has limited power to approve or oppose the erection of structures outside the vicinity of an aerodrome. If deemed necessary, CASA has restricted 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,* however, this has subsequently been 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 regulations 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 may declare the area encompassing the activity as a danger area.

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 CASA MOS Part 139.

The legislative instruments protecting civil aircraft safety can be assumed to replicate the interests of Defence aircraft operations and as such input from Defence could be expected if the proposed activity has a potential impact on military flying operations. CASA may liaise with Defence

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. A desktop analysis has been undertaken to assess the impact the proposed wind farm may have on Surveillance Sensors.

4.0 METHODOLOGY

This study has been carried out in accordance with the requirements of Guideline D of the National Airports Safeguarding Framework issued by the Australian Government Department of Infrastructure and Transport and the Airservices Australia guidelines for Aviation Impact Assessments. Consultation was carried out by Epuron and REHBEIN Airport Consulting with key aviation stakeholders including CASA, Airservices Australia, Department of Defence, Aerial Agriculture Association of Australia and the owners of uncertified private airstrips. 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); and
  - any existing aircraft instrument procedures published in the Aeronautical Information Publication – Departure and Approach Procedures (AIP-DAP);
- 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 has differing concerns regarding the 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 conducting instrument approaches to nearby Airports. This consideration has addressed both 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 unregistered aerodromes which are in close proximity to the proposed wind farm. Eighteen (18) unregistered aerodromes were identified by Epuron and 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 potential 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 a number of private airstrips, 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 operation being undertaken.

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 may 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 15km. 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 10km - 20km 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 en route navigation aids (navaids) and radar used for air traffic control at an aerodrome and/or en route surveillance.

Two types of radar are used for Air Traffic Control (ATC) and surveillance – Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR).

PSR 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 so as to avoid identifying them as moving targets and thus preventing radar clutter. PSR 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 on board an aircraft. The transponder reports the aircraft identification and altitude.

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. Further coverage is augmented by radar data from 6 military radar sites.

PSR can detect aircraft up to 60NM from the radar sensor while TAR, SSR, and RSR can detect aircraft up to 250NM. 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.

Vertical coverage depends on the line of sight of each radar which may be interrupted by terrain or tall structures.

The blades of a wind turbine may be detected if within the coverage and line of sight of the radar.

6.3 RADIO NAVIGATION AIDS

Ground based radio navigation aids could suffer from reflection and deflection effects similar to 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 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 165m high wind turbine could be safely located at around 9.5 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 1,000ft.

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 500ft - odd thousands plus 500ft 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 500ft 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 10NM 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 5,000ft 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 5NM laterally and 4,000ft 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 Defence 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 persist for distances of at least six times the rotor diameter. For a 130m rotor the distance could be 780m 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. 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 worldwide with very few instances of EMI being recorded.

[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)

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 17km to the east of Coolah Airport, 51km west of Quirindi Airport, and 70km northeast of Mudgee Airport. Registered and certified aerodromes shown on the World Aeronautical Chart (WAC) and within 120km of the proposed wind farm site are included in Table 1. An assessment undertaken by Epuron Pty Ltd located 18 unregistered aerodromes within 5 km of the proposed wind farm development as seen in Table 2.

Table 1: CASA Registered and Certified Aerodromes Surrounding the Proposed Site

Aerodrome	Certification and Registration Number	Operator Name	Distance from site (km)
Coolah	R035	Coolah Shire Council	17.3
Quirindi	R150	Liverpool Plains Shire Council	51.0
Coonabarabran	R115	Warrumbungle Shire Council	66.4
Mudgee	1-15S3M	Mudgee Shire Council	70.0
Scone	R131	Upper Hunter Shire Council	76.9
Gunnedah	R139	Gunnedah Shire Council	80.7
Tamworth	1-6FXI	Tamworth Regional Council	102.8
Dubbo	1-6EDH	Dubbo City Council	120.0

7.1.1 REGISTERED AND CERTIFIED AERODROMES

Analysis of the OLS surfaces associated with the nearest aerodromes to the proposed wind farm was undertaken. The closest aerodrome of this classification is Coolah aerodrome and is located approximately 9.2Nm (17km) from the nearest turbine location. Since the obstacle limitation surface (OLS) associated with Coolah Aerodrome extends for a distance of 15km, the proposed wind farm will not affect the OLS at Coolah Aerodrome.

A desktop assessment of the PANSOPs surfaces associated with instrument approach procedures of aerodromes in the vicinity of the proposed development has been undertaken. As a general rule, the primary PANSOPs surfaces will be contained within an area of approximately 35Nm (65km) from the applicable aerodrome. Mudgee is the closest aerodrome with published instrument approach procedures at 37Nm (68.5km) to the proposed development site and therefore the development will not impact on the PANSOPs surfaces. Other aerodromes with published procedures and associated PANSOPs surface are laterally displaced from the proposed site by a sufficient distance as not to be of concern. It should be noted that Airservices are the custodians of the instrument approach procedures and will undertake additional assessment of the PANSOPs surfaces prior to the wind farm being approved.

7.1.2 UNCERTIFIED AERODROMES

Epuron Pty Ltd has established that 18 uncertified aerodromes exist on private properties within 5 km of the proposed development site (Table 2). Fourteen out of the eighteen identified uncertified aerodrome landowners are involved with the development of the wind farm. Epuron Pty Ltd has advised all landowners of uncertified aerodromes in (Table 2) on the potential impacts the wind farm development may have on aviation.

It is not possible to publish instrument approach procedures for uncertified aerodrome as the safety regulator, CASA, cannot be assured that the obstacle environment is both monitored and reported accordingly to the design organisation that would produce instrument approach procedures. Therefore no PANSOPS surfaces are prescribed for this type of aerodrome.

Uncertified aerodromes are unregulated; hence there is no requirement to implement an OLS. It is the responsibility of the pilot in command (PIC) to assess the suitability of an uncertified aerodrome for the operation intended to be undertaken.

Table 2: Uncertified Aerodromes Surrounding the Proposed Site

Reference	Distance from the nearest wind Turbine	Uncertified Aerodrome Owners Involved/Non-involved in development
1	3,240	Non involved
2	160	Involved
3	760	Involved
4	1,656	Involved
5	150	Involved
6	1,190	Involved
7	2,610	Non-involved

Reference	Distance from the nearest wind Turbine	Uncertified Aerodrome Owners Involved/Non-involved in development
8	150	Involved
9	660	Involved
10	950	Involved
11	1,241	Involved
12	790	Involved
13	240	Involved
14	100	Involved
15	970	Non-involved
16	110	Involved
17	2,420	Non-involved
18	2,700	Involved

7.2 RADAR & RADIO NAVIGATION AIDS

7.2.1 RADAR

The impact the proposed wind farm will have on radar facilities has been assessed with consideration to the Eurocontrol Guidelines on *How to Assess the Potential Impact of Wind Turbines on Surveillance Sensors* as required by Airservices Australia for its review of Aviation Impact Assessments.

The closest radar facilities to the proposed wind farm are the Enroute Radars located at Mount Boyce, approximately 200km north east and Round Mountain, 265km south east of the proposed Liverpool Range wind farm. These sensors comprise of a PSR and a SSR. The antenna height of the radar facilities are 1118.6m AHD at Mount Boyce and 1592.7m AHD at Round Mountain, NSW. There is also military radar located at RAAF base Williamtown. The Williamtown radar is approximately 180km from the development site.

The Eurocontrol guidelines divide the area between the PSR or SSR radar antennae and the maximum instrumented range of the radar (60NM for PSR and 250NM for SSR) into zones based on distance from the antennae. Assessment requirements are less complex as distance from the radar antennae increases or the amount of the WTG structure in line of sight of the antennae reduces.

The assessment criteria for PSR outlined in the Eurocontrol guidelines are described in Table 3.

Table 3: PSR Assessment Criteria for Wind Farms

Zone	Zone 1	Zone 2	Zone 3	Zone 4
Description	0 – 500m	500m – 15km and in radar line of sight	Further than 15km 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

The assessment criteria for SSR outlined in the Eurocontrol guidelines are described in Table 4.

Table 4: SSR Assessment Criteria for Wind Farms

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

The Primary Surveillance Radars located at Mount Boyce, Round Mountain and Williamtown have a maximum instrument range of 111km (60Nm). Since the proposed development site is beyond 111kms no further assessment is required under the Eurocontrol guidelines.

In the case of the Secondary Surveillance Radars the development site is situated within the maximum instrument range of the facilities however, is beyond 16km. Based on the Eurocontrol assessment criteria this would position the site in Zone 4. In this case no further assessment is required.

7.2.2 RADIO NAVIGATION AIDS

The closest radio navigation aid to the proposed wind farm site is the Quirindi non-directional beacon (NDB), approximately 51km to the north east. At this distance the wind farm will not have any impact on the performance of the NDB.

7.2.3 AIRSERVICES AUSTRALIA

Investigation undertaken by REHBEIN Airport Consulting suggests the impacts, if any, will not be of operational significance.

Airservices Australia will undertake its own assessment of potential impacts the proposed wind farm may have on radar and radio performance in the region. Airservices Australia will require the following information in order to complete a technical and operational assessment:

- Site plans.
- 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.

7.3 TRANSITING AIR ROUTES

7.3.1 IFR AIR ROUTES

IFR routes W619, W326, V316, H66, W359 and W627 pass near the site of the Liverpool Range wind farm. The relevant route segments have published lowest safe altitudes (LSALTs) of 5,500ft, 5,300ft, 5,600ft, 5,500ft, 5,500ft and 4,200ft respectively. LSALTs are determined by the underlying obstacle environment along the route. The highest obstacle assessed is factored by a clearance buffer of 1000ft. The 'worst case' route lower safe is 4200ft therefore; the highest permissible obstacle must be 3,200ft. Information provided by Epuron Pty Ltd indicates a maximum turbine tip elevation of 1,245m (4,084ft) within the proposed wind farm, which is above the obstacle height used to determine the route LSALT however; the obstacle inspection corridor associated with the W627 route does not extend laterally far enough to the east to warrant consideration.

All other published route LSALTs have been determined based on an obstacle height greater than the highest turbine proposed.

Airservices also determine and publish a Grid Lower Safe altitude for each minute of Latitude and Longitude. The grid LSALT is calculated in the same manner as route LSALTs and allows for a clearance of obstacles by 1000ft. The applicable Grid Lower Safe for the area surrounding the proposed development site is 5400ft.Since the maximum turbine height within the wind farm is 4,084ft AHD there will be no impact on currently published Grid Lower safe altitudes as the highest turbine is less than 4400ft.

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 Liverpool Range 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 5,000m. There are no published VFR routes for aircraft operating in the Liverpool Range region. 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 Night 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 the same manner to those for IFR flights described in Section 7.3.1. The position and heights of the turbines will be shown on Enroute Chart Low Sydney (ERC-L), enabling pilots to consider the obstacle when planning Night VFR flights over or near the wind farm. The maximum turbine height of 4,084ft will dictate a Night VFR route LSALT of 5,100ft in the vicinity of the wind farm. The currently published grid LSALT is 5,400ft therefore, the development of the proposed wind farm will not impact on existing published LSALTs.

REHBEIN Airport Consulting's assessment based on the remoteness of the wind farm from aerodromes likely to be used for Night VFR operations that aviation obstacle lighting on the wind turbines is not required. However as the structures exceed 150m in height; CASA may still identify a need to illuminate the proposed structures in order to highlight the development to the flying community.

7.3.3 MILITARY LOW FLYING OPERATIONS

The Department of Defence (Defence) has been informed of the wind farm proposal and current wind monitoring towers.

Defence has assessed the proposal for any possible impact on its operations including the safety of military aircraft, the effect on Defence communications and the operation of Airfield Surveillance radars.

The wind farm and power line will be located within Danger Area airspace which is used by low flying military aircraft and will also be situated in proximity to a deployable Defence radar located at Mt Coolah. However, Defence has accepted that the deployable radar site will be unusable once the wind farm is constructed.

Defence has requested that the colour used for the wind turbines be conspicuous to aircraft during daylight hours and that power lines be marked with aviation markers where the power lines span valleys or lower terrain areas which may be overflown by low flying military aircraft.

RAAF Aeronautical Information Services (RAAF AIS) should be informed of any structure taller than 30m 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.

7.4 RESTRICTED AREAS

Danger Area D538B overlies the proposed development site. D538B is classified as military flying training and activated periodically through a Notice to Airman (NOTAM). The vertical dimensions of the danger area extend from ground level to 10,000ft AMSL. Flight operations through a danger area are conducted at the operator's discretion. Currently, pilots consider the existing danger area in the flight planning stages in order to determine if transit is practical to their operation. Should the Liverpool Wind Farm development proceed, it is suggested that an additional danger area be promulgated to alert pilots to the existence of the wind farm. The publishing of this additional danger area serves to mitigate the identified risk that potentially the development may have on aviation activities.

A restricted area (R559B) also exists above the published Danger Area however; its vertical limit are not of concern in relationship to this development as they commence at 10,000ft thru to 25,000ft AMSL. There are no Prohibited (P) areas in the region.

7.5 OTHER AVIATION ACTIVITY

7.5.1 AERIAL AGRICULTURAL OPERATIONS

Aerial agricultural operations are normally conducted during daylight hours, at low levels, and often requiring calm or very light wind conditions. (less than 8 knots (15km/h)). At these wind speeds it is reasonable to assume that the presence of wake turbulence could extend for a distance of up to 6 rotor diameters downwind of the nearest turbine. Based on a proposed rotor diameter of approximately 130m there is potential for the existence of an area of disturbed air approximately 780m downwind of the turbine.

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. As a general rule aerial agriculture operators will not conduct spraying operations within a 1km buffer area of established wind farms.

Aerial agricultural operations in the immediate vicinity (approximately 1km) of the wind turbine locations will also not be possible once the wind farm has been built.

7.5.2 SPORT AVIATION

Symbols on ERC-L Sydney indicate that hang gliding is conducted along the north western edge of Tamworth, approximately 30km north of the proposed wind farm site. The wind farm development is not likely to adversely affect hang gliding operations within the vicinity of Tamworth, as hang gliding is conducted during daylight hours when turbines are clearly visible and are not conducted when winds in the area are from the north east, as these conditions are unsuitable for hang gliding.

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 worldwide with very few instances recorded of EMI affecting aircraft radio systems.

8.0 CONCLUSIONS AND RECOMMENDATIONS

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 Epuron Pty Ltd proposes structures that are substantially higher at 165m 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. REHBEIN Airport Consulting have assessed that aviation obstacle lighting on the wind turbines is unlikely to be required however CASA will ultimately make a determination in relation to lighting requirements.

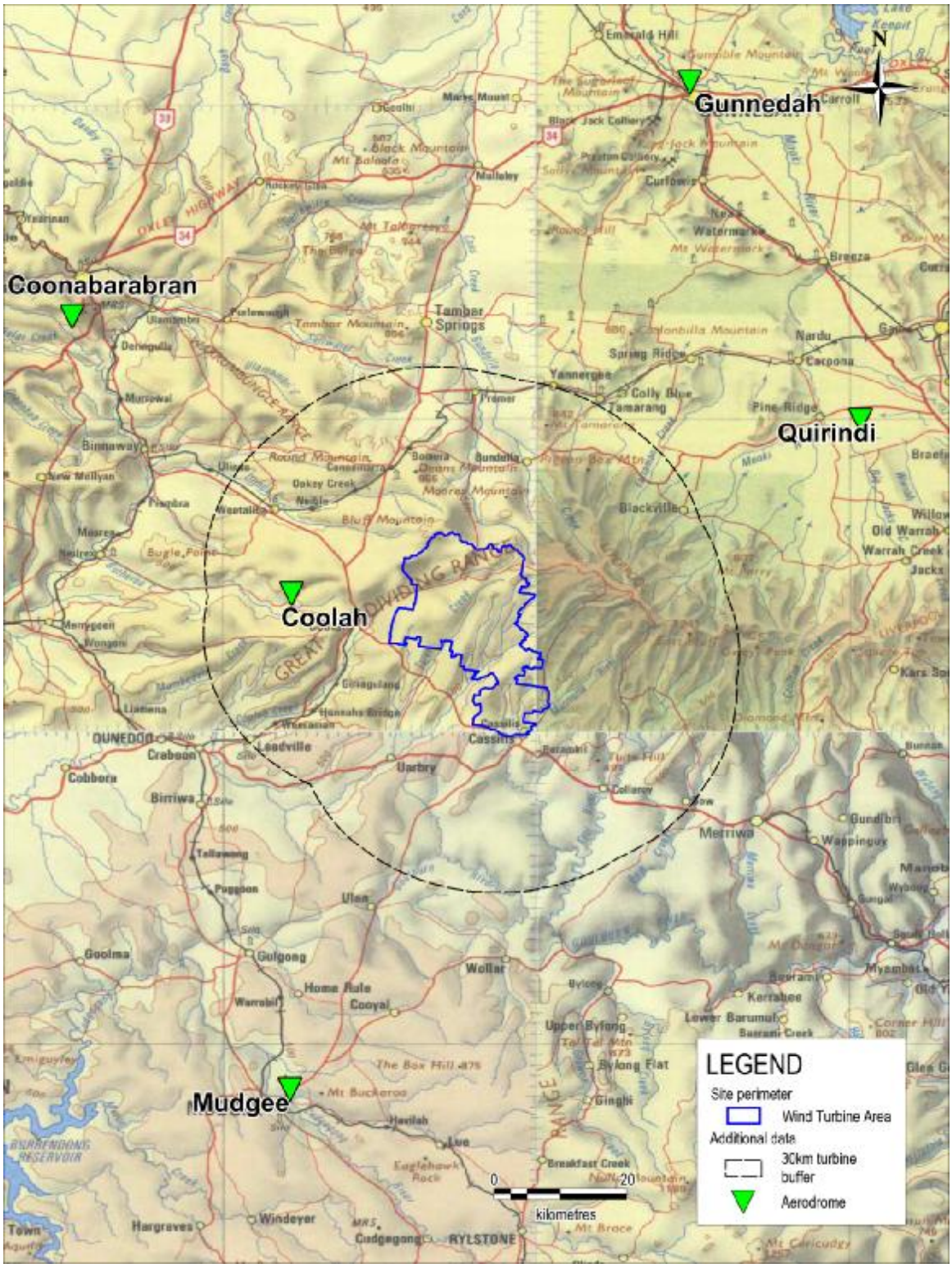
The proposed wind farm will not impact upon aircraft operations to and from nearby registered and certified aerodromes such as Coolah, Mudgee, Quirindi or Tamworth airports. Nor will it interfere with airborne radio, Radar or navigation aid performance.

Analysis undertaken by REHBEIN Airport Consulting indicates that there will be no impact upon IFR traffic transiting the area on routes W619, W326, V316, H66, W359 and W627. 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.

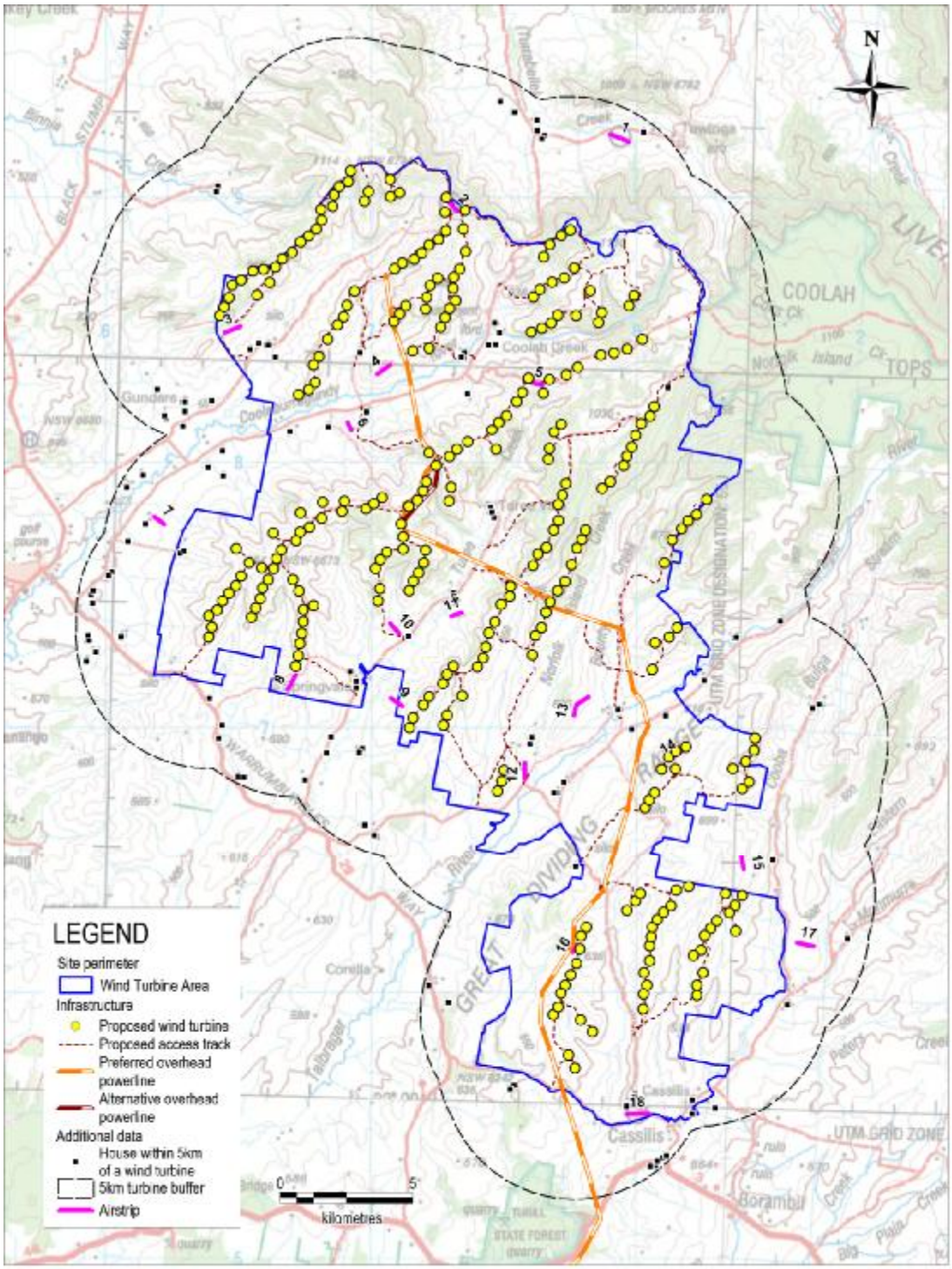
Investigation undertaken by REHBEIN Airport Consulting suggests the impact of the proposed wind farm upon radar and radio performance in the region, if any, will not be of operational significance.

Analysis suggests that there will be no adverse impact upon aerial agricultural operations further than 1km from any wind turbines. The wind farm development is not likely to adversely affect hang gliding operations within the vicinity of Tamworth, as hang gliding is conducted during daylight hours when turbines are clearly visible and are not conducted when winds in the area are from the north east, as these conditions are unsuitable for hang gliding.

APPENDIX A



LOCATION MAP



WIND TURBINE LAYOUT