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Our ref: 100201-01

Dear Shaq

**Re: Crookwell 3 Wind Farm – Addendum Aviation Impacts**

Please find in this correspondence a summary of the net aviation impacts of the addendum to the Crookwell 3 Wind Farm (the Project) proposal.

**1.1. Situation**

Crookwell Development Pty Ltd (the Proponent) is part of an international energy group proposing to develop a new wind farm in the NSW southern tablelands, approximately 17 km south east of Crookwell township, and 25 km north west of Goulburn.

The Crookwell 3 Wind Farm (the Project) site consists of approximately 1500 hectares in two separate parcels, east and south of the approved Crookwell 2 Wind Farm. These two parcels are referred to as Crookwell 3 East and Crookwell 3 South.

The Proponent has proposed an amendment to the Project proposal, which is an addendum to the preferred project report and response to submissions. The proposed addendum is the removal of five more turbines, and increase rotor diameter to 130 m. The change in rotor size will increase the overall blade tip height from 152 m to 157 m above ground level (AGL).

A previous report produced by Aviation Projects, titled *Crookwell 3 Wind Farm Aeronautical Impact and Night Lighting Assessment v1.1 110830*, dated 30 August 2011, only considered a maximum blade tip height of 152 m AGL. Therefore, an addendum report is required that assesses the aeronautical impact of the reduced number of turbines and increased wind turbine rotor size and overall blade tip heights.

An illustration of the Project amendment is provided at Figure 1.

The Proponent engaged Aviation Projects to produce the addendum report.

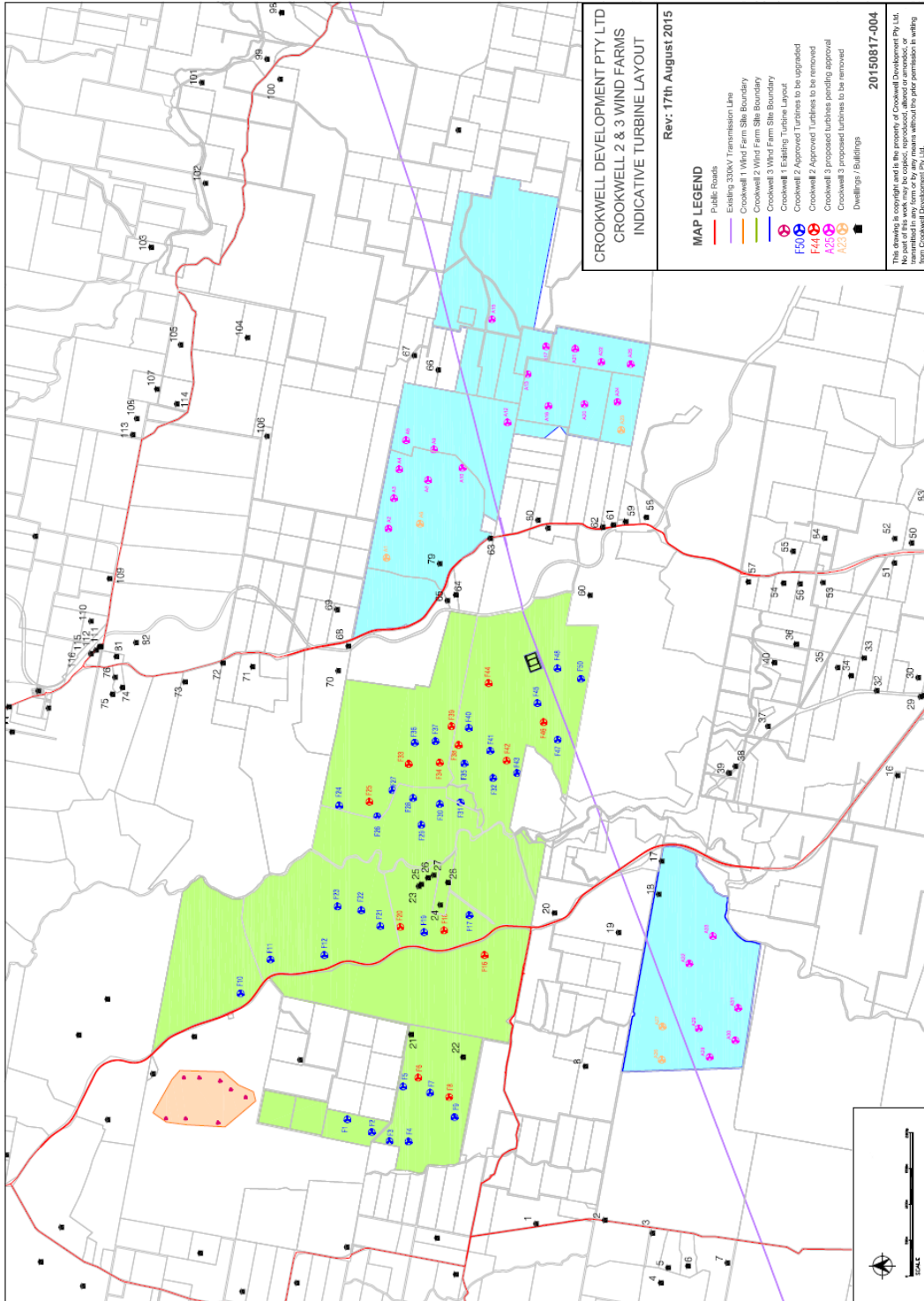


Figure 1 Project layout, showing Crookwell 1, 2 and 3 Wind Farms

## 1.2. References

The following information sources were referenced during the preparation of this report:

- Airservices Australia; Aeronautical Information Package (AIP) including En Route Supplement Australia (ERSA) and Departure and Approach Procedures (DAP), dated 20 August 2015;
- Aviation Projects, *Crookwell 3 Wind Farm Aeronautical Impact and Night Lighting Assessment v1.1 110830*, dated 30 August 2011;
- Civil Aviation Safety Authority, *Civil Aviation Regulations 1988 (CAR)*, as amended;
- Civil Aviation Safety Authority, *Civil Aviation Safety Regulations 1998 (CASR)*, Statutory Rules No. 237, 1998 as amended, dated 10 September 2015;
- Civil Aviation Safety Authority, *Manual of Standards Part 139 – Aerodromes, version 1.12*, dated November 2014;
- Civil Aviation Safety Authority, *Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design, version 1.4*, dated 15 April 2015;
- International Civil Aviation Organization (ICAO) Doc 8168 *Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS)*;
- ICAO Standards and Recommended Practices, *Annex 14—Aerodromes*; and
- OzRunways, aeronautical navigation charts (WAC and ERC) extracts, sourced 22 October 2015.

## 1.3. Client and project related material

The Client provided the following materials for the purposes of this analysis:

- Crookwell Development Pty Ltd, *Crookwell 2 & 3 Wind Farms Indicative Turbine Layout*, dated 17 August 2015;
- Crookwell Development Pty Ltd, *20150925 - C3WF, Turbine Coordinates v4 (SQ)*, dated 25 September 2015; and
- Email sent from Crookwell Development Pty Ltd, subject: *Crookwell 3 WF – Addendum*, dated 19 October 2015.

#### 1.4. Context changes

On 30 August 2011, Aviation Projects produced a report titled *Crookwell 3 Wind Farm Aeronautical Impact and Night Lighting Assessment v1.1 110830*. This report was undertaken on the basis of previous wind turbine data that was yet to be subject to the amendments that are proposed.

For the purposes of defining a baseline for this assessment, a summary of the assessment context used in the report dated 30 August 2011 with any subsequent changes is provided in Table 1. Any changes that have been noted are examined in greater detail in subsequent sections of this letter report.

Table 1 Context baseline

<i>Ref</i>	<i>Heading</i>	<i>Remark</i>
2.	Background Information and Purpose of Report	Changes noted.
3.	Methodology	No notable change.
4.	Stakeholder Consultation	No notable change.
5.	Aeronautical Impacts	Changes noted.
6.	Obstacle Marking and Lighting	Changes noted.

#### 1.5. Background Information and Purpose of Report

The addendum will result in changes to the following elements of the Project when compared with the previous Aeronautical Impact Assessment:

- The maximum blade tip height of the wind turbines will increase by 5 m (16 ft), from 152 m (499 ft) to 157 m (515 ft) above ground level (AGL);
- The wind turbine identified as A25 has not moved and remains located on the base with the highest elevation of 933 m AHD. The previous maximum blade tip height of wind turbine A25 was 1085 m AHD (3560 ft above mean sea level (AMSL)). The proposed increase in turbine height will result in a maximum blade tip height of 1090 m AHD (3576 ft AMSL) for this wind turbine;
- The number of wind turbines will decrease by 7 wind turbines, from 30 to 23 wind turbines; and
- The wind turbine identified as A24 will be relocated approximately 191 m to the north west. The base elevation at A24 will decrease by 3 m from 872 m AHD to 869 m AHD. This change will not expand the perimeter of the Crookwell 3 East and the location of A24 will be on a base with a reduced elevation. In addition, the stakeholder consultation process revealed no turbine specific issues. It can be concluded that this change will not result in additional aeronautical impact and no further assessment of this change is required.

## 1.6. Aeronautical Impacts

### 1.6.1. PANS-OPS surfaces

Annexure 3 of the previous report by Aviation Projects dated 30 August 2011 consists of a report titled *Aeronautical Impact Assessment (PANS-OPS & OLS): Crookwell 3 Wind Farm, Doc v1.0 Final Report*, dated 3 June 2010. The aeronautical impact assessment (AIA) referenced Airservices Australia AIP DAP Amendment 123 Effective 3 June 2010 to 25 August 2010.

The AIA noted the following minimum sector altitudes (MSA) and associated maximum permissible obstacle levels (or minimum obstacle clearance altitudes (MOCA) at Goulburn Airport:

- 10 nm MSA – 4600 ft AMSL with a MOCA of 3616 ft AMSL; and
- 25 nm MSA northern sector – 4700 ft AMSL with a MOCA of 3715 ft AMSL.

These values are still applicable at Goulburn Airport. Since the proposed height change will result in a maximum blade tip height of 1090 m AHD (3576 ft AMSL) at the site of wind turbine A25, the critical obstacle (wind turbine A25) remains clear of the associated MOCAs and therefore will not impact on the 10 nm or 25 nm MSAs at Goulburn Airport.

The AIA also noted the following instrument procedures at Goulburn Airport:

- NDB-A;
- RNAV (GNSS) RWY 04; and
- GPS Arrival.

A check on the Airservices Australia website revealed the following instrument procedures at Goulburn Airport, noting that an additional procedure exists (RNAV-Z (GNSS) RWY 22):

- NDB-A, effective 6 March 2014 (Am 138);
- RNAV-Z (GNSS) RWY 04, effective 30 May 2013 (Am 135);
- RNAV-Z (GNSS) RWY 22, effective 6 March 2014 (Am 138); and
- GNSS Arrival, effective 21 August 2014 (Am 140).

With respect to instrument procedures, the only notable change is the new RNAV-Z (GNSS) RWY 22 terminal instrument procedure, shown by the instrument procedure chart at Figure 2. This new procedure was not contemplated in any assessments conducted by Aviation Projects, and may not have been assessed by any other agency.

The instrument procedure chart at Figure 2 shows that wind turbine A25 at a height of 3576 ft AMSL will be higher than the highest obstacle that is noted on the chart in the vicinity of the Project site (3055 ft AMSL). However, using Google Earth measuring tools, it is estimated that the closest (and highest) wind turbine is A25, which is located approximately 9 nm to the west of the GLBND IAF.

In consideration of the distance between wind turbine A25 and the GLBND IAF, it is unlikely that the PANS-OPS surfaces associated with the new instrument procedure will be impacted, noting that not

all wind turbines will not be shown within the extent of the instrument procedure chart shown in Figure 2.

In any case, it is recommended that the designer of the new procedure (Airservices Australia) be further consulted with respect to potential impacts of the Project when the final turbine model and tip height are selected.

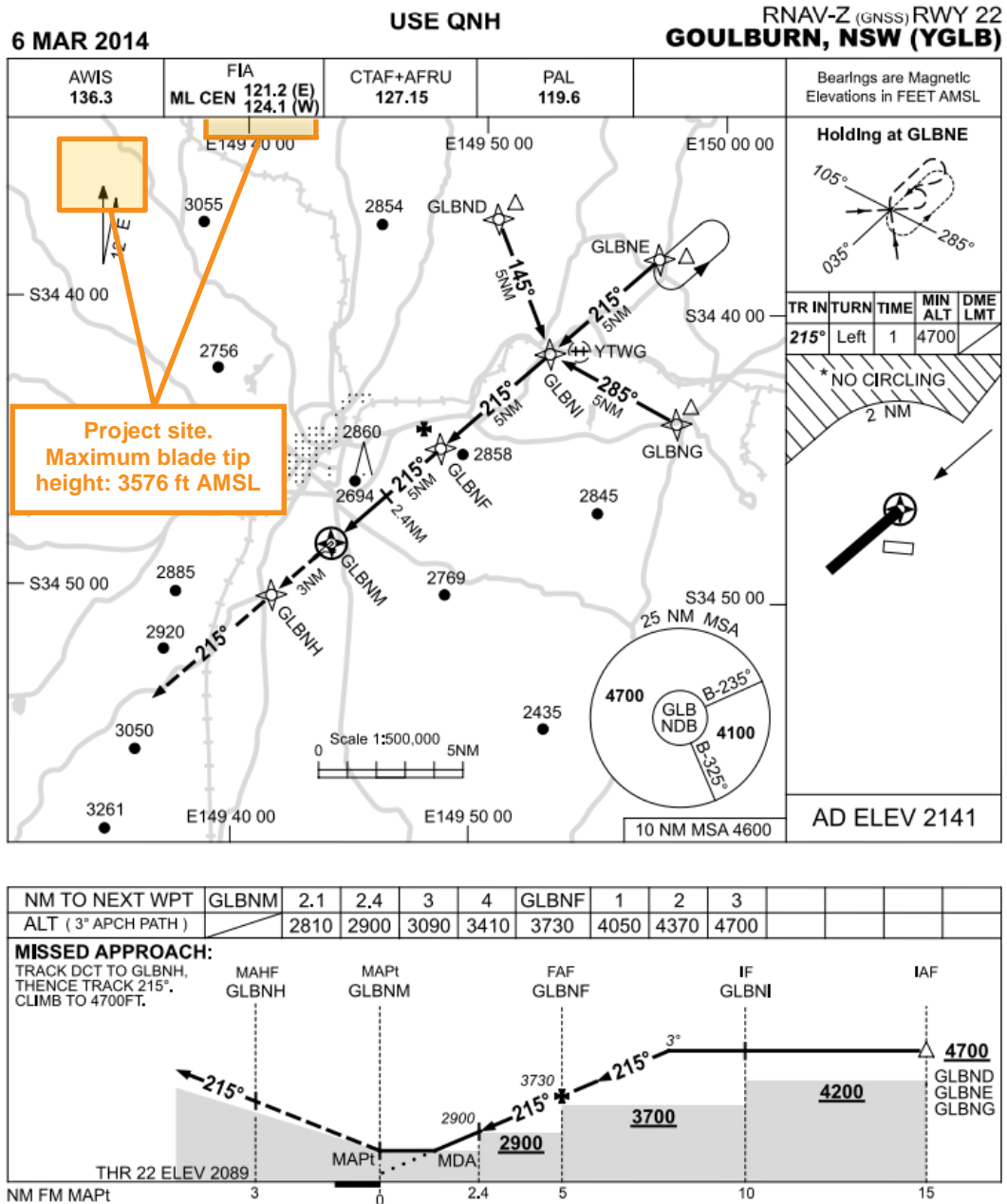


Figure 2 RNAV (GNSS) RWY 22

## 1.6.2. Air traffic routes

The previous report dated 30 August 2011 made the following conclusion:

*Airservices Australia found that at a maximum height of 1085 m (3560 ft) AHD, the proposed wind farm will affect the W10 air route to the north of Goulburn. Lowest Safe Altitude procedures are penetrated by 60 ft and will need be adjusted accordingly (minor adjustment).*

The report noted that the W10 lowest safe altitude (LSALT) was 4500 ft AMSL.

A check on the OzRunways Canberra Terminal Area Chart (TAC), accessed on 22 October 2015, found that the W10 LSALT is still 4500 ft AMSL adjacent to the Project site.

A minimum obstacle clearance of 1000 ft below the published LSALT must be maintained along each air route (source ref MOS 173 8.2.1.1). Based on the previous findings, due to the 60 ft LSALT minimum obstacle clearance penetration, the LSALT would needed to have been raised by 100 ft from 4500 ft to 4600 ft AMSL. With respect to the proposed addendum, the 16 ft increase in the maximum blade tip height to 3576 ft AMSL will result in a penetration of 76 ft, requiring the LSALT to be raised by 100 ft. Therefore, because the required increase in the LSALT has not changed, the addendum does not contribute additional impact on the W10 air route.

## 1.7. Obstacle Marking and Lighting

With respect to the obstacle lighting design of the Project, the previous assessment dated 30 August 2011 stated the following:

*126. In light of the foregoing discussion and since the turbines under consideration for the project range in height from 125 m to 152 m, the wind farm will need obstacle lighting regardless of which turbine is selected.*

...

*134. It is proposed to not light turbines A28 and A30 because:*

- a) the offset distances are small within the aviation context (159 m to 351 m);*
- b) each of those turbines are within the 900m radius from an existing lit turbine;*
- c) the apparent distance between lit turbines (from any approach angle) is no more than approximately 1400 m (0.75 nm); and*
- d) each of these turbines is lower than the lit turbines.*

*135. Under the Annex 14 guidelines one could potentially construe that turbine A21 should be lit. However, because this turbine is set back from the line (along the south-east side of the site) between the two tallest turbines (on the site), A18 and A25 — and because it 34-27m (100+ feet) lower — it is proposed that this turbine NOT be lit.*

Based on the findings of the previous assessment and considering the maximum wind turbine height has increased by 5 m, the Project will need obstacle lighting regardless of which turbine is selected.

The reasoning applied in paragraph 134 from the previous assessment no longer applies due to the removal of wind turbines A26 and A27. In addition, the reasoning applied in paragraph 135 from the previous assessment no longer applies due to the removal of wind turbines A18 and A19.

In light of the reasoning followed in the previous assessment and the proposed changes in the height, number and location of wind turbines, a revised obstacle lighting design has been prepared.

If obstacle lighting is required (for example by CASA), the following 12 wind turbines are recommended to be lit (without the A prefix in the wind turbine identification): 2, 5, 10, 12, 15, 16, 21, 24, 25, 28, 31 and 33.

A map of the Project showing the recommended obstacle lighting design is enclosed.

## **1.8. Summary**

Following a high level evaluation of aviation impacts as a result of the proposed changes to the Project, it was found that the increase in rotor diameter and tip height, and the relocation of wind turbines will not give rise to increased aviation impacts when compared with the proposed locations as assessed at the time of application.

The designer (Airservices Australia) of the new terminal instrument flight procedure RNAV-Z (GNSS) RWY 22 should be further consulted, when the final turbine model and tip height is selected, in order to determine what, if any, impacts arise from the Project.

If you wish to clarify or discuss of the contents of this correspondence, please contact me on 0417 631 681.

Kind regards



Keith Tonkin

Managing Director

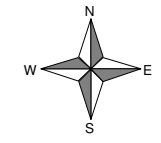
30 October 2015

**Enclosure:** Revised obstacle lighting design



# Crookwell 3 Wind Farm Obstacle Lighting Design

**NOTE: Not for operational use**



The grid at the western edge of the map is 1° 25' 20.52" due west of true north

The grid at the eastern edge of the map is 1° 30' 13.06" due west of true north

- Lit Turbine
- Unlit Turbine
- Wind Monitoring Tower
- Project Application Area

100201-01 Crookwell 3 Wind Farm Obstacle Lighting Design v1.2 151030

Scale 1: 407,000@A3

Centred on 739,870m, 6,172,239m UTM Zone 55 (34°33'49" S, 149°36'52" E WGS84)

