EPS

Glen Innes Wind Farm

Response to Submissions

Modification 4: Turbine Design Changes

Prepared for Glen Innes Windpower Pty Ltd
Prepared by Environmental Property Services

ENVIRONMENTAL PROPERTY SERVICES
11262
June 2018

Contact Information and Declaration	
Declaration:	The opinions and declarations in this document are ascribed to Environmental Property Services (EPS) and are made in good faith and trust that such statements are neither false nor misleading. In preparing this document, EPS has considered and relied upon information obtained from the public domain, supplemented by discussions between key EPS staff, representatives from Glen Innes Windpower Pty Ltd and other consultants.
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Quality Assurance & Version Control Table				
Project: Glen Innes Wind Farm				
Client:	Glen Innes Windpower Pty Ltd			
Rev No.	**Date**	**Our Reference**	**Author**	**Reviewer**
V01	06.12.17	20171206_11262_Glen Innes Wind Farm_RTS_V01	M. Shelly	S. McCall
V02	07.06.18	20180607_11262_Glen Innes Wind Farm_RTS_V02	M. Shelly	S. McCall
Checked by	08.06.2018		A. Tipper	
Approved by	08.06.2018		S. McCall	

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1 INTRODUCTION

1.1 Existing Approval

The construction and operation of the Glen Innes Wind Farm (GIWF) is authorised under Project Approval 07_0036 (Project Approval), granted by the Minister for Planning on 2 October 2009 under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Figure 1-1 shows the location of the project in relation to northern New South Wales. The Project Approval was modified by the Land and Environment Court on 18 August 2010. Since that time, a number of modifications have been approved:

1. Modification 1 for an extension of lapsing date contained in Condition 1.5 of the Project Approval by one year. Approval was granted on 16 August 2013.
2. Modification 2 for the installation of larger and more efficient wind turbines and micro-siting within the approved layout to accommodate the larger dimension wind turbines. Approval was granted on 19 January 2016.
3. Modification 3 for an extension of lapsing date contained in Condition 1.5 of the Project Approval by one year. Approval was granted on 19 January 2016.

The 2009 Environmental Assessment that supported the original application and the 2014 Environmental Assessment for Modification 2 both used example turbine specifications to realistically predict social and environmental impacts. As wind turbine technology was, and is, progressing quickly, both documents noted that the installed turbines would be selected from designs current during the pre-construction phase. The now proposed turbines are more efficient, with high levels of reliability and their selection will maximise electricity production, maximise greenhouse gas savings, and minimise maintenance costs. This flexibility in design selection is in keeping with the initial application and the Project Approval (07_0036).

As the selected Senvion turbine specifications differ to those referred to in the Project Approval, a modification under S75W of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) is required.

Author:	B. Ellis
Reviewer:	A. Tipper
Job Ref:	11262
A3 Scale:	1:450,000

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kilometres

Map Projection GDA 1994 MGA Zone 56

Figure:1-1

Glen Innes Wind Farm
Site Location - MOD 4

Glen Innes Wind Farm
Glen Innes, NSW

14 March 2017

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1.2 Proposed Project Modification

The proposed modification application requests approval to modify and/or clarify the dimensions and locations of the following items:

1. Refined turbine dimensions as per Table 1-1.
2. Refined turbine locations as per Table 1-2, subject to 100m micro-siting allowance due to potential site requirements including ecological constraints or shallow rock.
3. Increased nominal annual generation capacity to up to approximately 90 MW, subject to incremental changes due to installation and local conditions.
4. Increased construction track disturbance footprint from the approved 8m to approximately 12m to account for indirect impacts from track construction (the 12m impact width accords to OEH requested impact areas for biodiversity offset calculations and has been used in approved management plans such as the Construction Environmental Management Plan (EPS, 2016) and the Compensatory Habitat Plan (EPS, 2016).
5. Refined substation location to avoid the Travelling Stock Route, Crown Road and unfavourable topography.
6. Refined concrete batch plant location.

The Project Approval refers to the original Environmental Assessment (Aurecon 2008) and the subsequent assessments supporting the listed modifications, most relevantly the Section 75W Modification 2 Environmental Assessment, prepared by Aurecon in March 2014 (Aurecon 2014). Aurecon 2014 assessed an indicative turbine (Alstom ECO 122) and noted that the actual installed turbines would be selected from those available at the time of construction. Glen Innes Windpower Pty Ltd has now selected a turbine design, the Senvion 3.6M140 EBC, which has longer blades than Alstom ECO 122 and correspondingly taller towers.

The Project Approval does not specify the turbine dimensions, but Condition 1.1 requires the project to be carried out generally in accordance with the EA (which is defined in the approval as including the original EA, the submissions report, the revised layout report and the S75W Assessment Report. As the Modification 2 application specified smaller turbine dimensions, the larger turbines now proposed require approval. Table 1-1 provides a summary of approved and proposed turbine specifications.

Table 1-1: Approved Versus Proposed Turbine Specifications.

Aspect	Approved Specifications	Proposed Specifications	Difference
Turbine numbers	25	25	Nil
Hub height (m)	89	110	24% taller
Blade length (m)	60	68.5	14% longer
Rotor diameter (m)[1]	122	140	15% larger
Rotor swept area (m^2)	11,690	15,394	32% larger
Rotor tip height (m)	150	180	20% taller
Blades per turbine	3	3	Nil
Paint colour	Light grey	Light grey	Nil
Nominal tip speed (m/s)	78	70	-10%
Nominal power per turbine (MW)	2.7	3.6	33%
Total generation capacity (MW)	67.5	90	33%

Note: [1] Because the turbine blades are curved, rotor diameter is the diameter of the outer swept path of the blade tips, not simply twice the blade length.

Figure 1-2 (a to i) show the approved and proposed locations of the wind turbines. Table 1-2 provides the location coordinates, a calculation of distance from the approved locations, the movement bearing and a brief justification. All turbine adjustments are less than 100m. Figure 1-2 (a to i) also show the refined locations of ancillary facilities.

Table 1-2: Refined Turbine Locations (UTM).

Label	Proposed Eastings	Proposed Northings	Blade Tip Elevation mAHD	Distance Moved (m)	Bearing
WTG01	364902.3	6710276.5	1,361	42	SW
WTG02	364985	6709936	1,363	13	NE
WTG03	364925.9	6709583	1,363	0	N/A
WTG04	365131	6709251	1,360	0	N/A
WTG05	365343	6708692	1,352	0	N/A
WTG06	365850	6708179	1,375	0	N/A
WTG07	366170.2	6707771.3	1,414	38	NE
WTG08	366146	6707375	1,385	92	N
WTG09	366063	6707025	1,400	0	N/A
WTG10B	365939.9	6706230.	1,354	22	SW
WTG11	365258.4	6705850.5	1,352	68	NW
WTG11B	365675	6705575	1,365	0	N/A
WTG12B	365980	6705375	1,379	0	N/A
WTG12C	366301.9	6704947	1,374	70	NE
WTG13	365933.2	6704425.1	1,386	94	SW
WTG13B	365792.7	6704174	1,380	20	NE
WTG14B	366071.3	6704670.8	1,384	29	SW
WTG15	366579.8	6703727.6	1,390	98	N
WTG16B	366605.2	6703206.2	1,436	5	SW
WTG16C	366618.7	6703415.8	1,434	21	NE
WTG17	366686	6702920.3	1,392	43	NW
WTG19	367318.4	6702281.3	1,446	40	SW
WTG20B	367521	6705469	1,404	10	NW
WTG22B	367651	6704952	1,415	0	N/A
WTG21B	367774	6705217	1,413	0	N/A

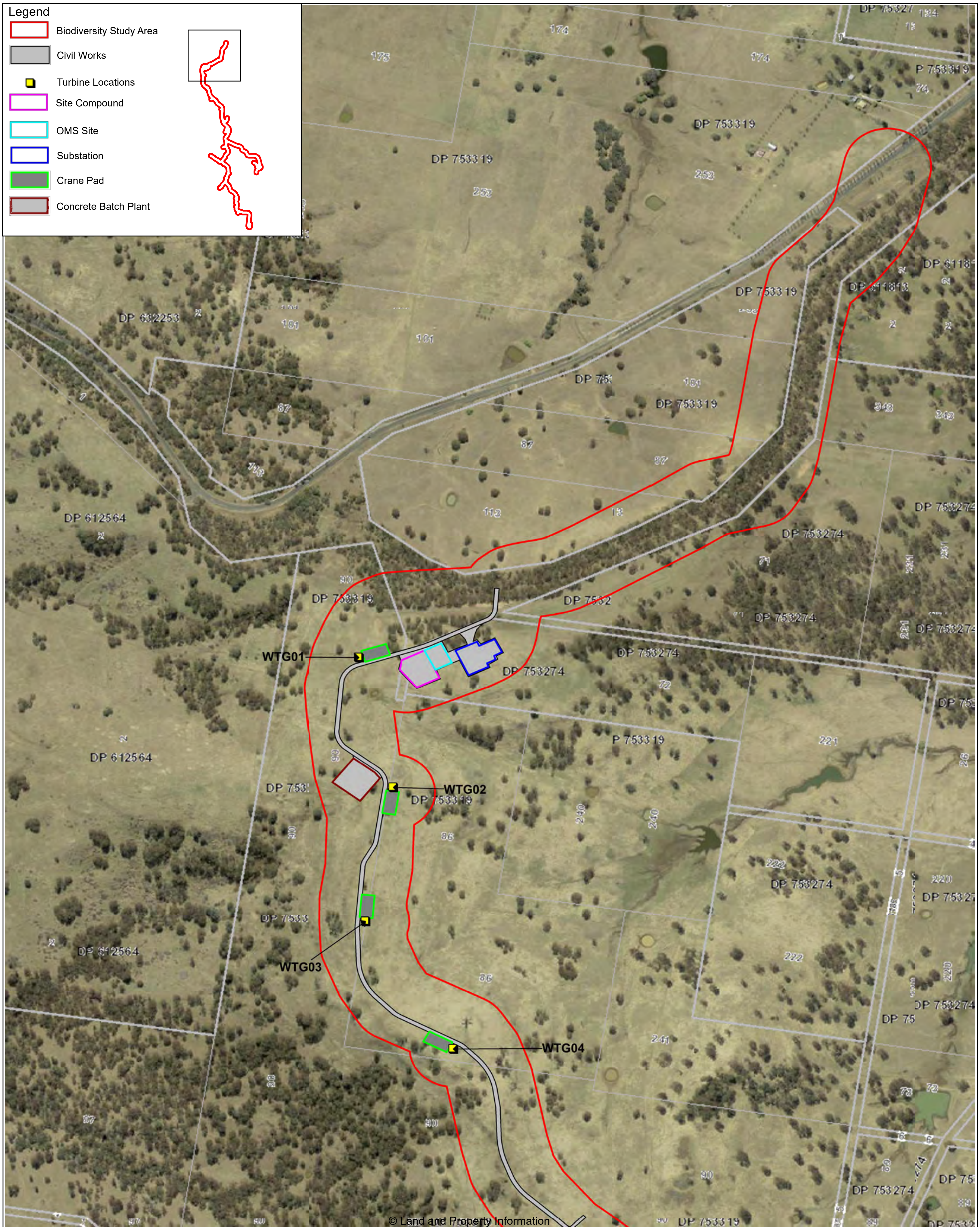
Justification for micro-siting the turbines is to accommodate the revised turbine design, to avoid boundary over-sail, to avoid Wind Sector Management (WSM) loss and to accommodate other layout reconfigurations.

Table 1-3 provides the approximate disturbance footprints of proposed individual windfarm components. A slight increase in temporary disturbance footprint is proposed, from 1.6 ha to 1.7 ha. A larger increase is proposed for the long-term disturbance footprint, going from 18.7 ha to 23.6 ha. This increase is mainly due to the proposed increase in access track footprint. The original Environmental Assessment (Connell Wagner 2008) proposed an 8m wide access track footprint, but in recent consultation with Office of Environment and Heritage, a more realistic, wider footprint was selected. Associated documents such as the approved Construction Environmental Management Plan (EPS 2017) and approved Biodiversity Offset Plan (EPS 2017) have both allowed for the wider disturbance footprint.

Table 1-3 Approximate Disturbance Footprint.

	Approved				Proposed			
Project Component	**Length (m)**	**Width (m)**	**Number[1]**	**Total area for Project (m, unless otherwise stated)**	**Length (m)**	**Width (m)**	**Total area for Project (m, unless otherwise stated)**	**Area Change**
Temporary								
Batching plant	60	50	1	3,000	82	82	6,724	124% increase
Construction office	100	40	1	4,000	100	40	4,000	nil
Main laydown site	150	60	1	9,000	82	82	6,724	25% reduction
Total area				**1.6ha**			**1.7ha**	**9% increase**
Long Term								
Substation and permanent office	80	50	1	4,000	82	82	6,724	68% increase
Access tracks	14,000	8	1	112,000	14,000	12	168,000	50% increase
Turbine footings and transformer pad	18	18	25	8,100	22	22	12,100	49% increase
Turbine construction pads	50	50	25	62,500	62	32	49,600	21% decrease
Total area				**18.7ha**			**23.6ha**	**27% increase**

Note: 1 The number of project components is identical for approved and proposed.



Author:	B. Ellis	N	Figure:1-2a
Reviewer:	A. Tipper	0 300 metres	**Glenn Innes Wind Farm Site Layout - MOD 4**
A3 Scale:	1:8,000	Map Projection GDA 1994 MGA Zone 56	**Glenn Innes Wind Farm Glen Innes, NSW**
Job Ref:	11262		08 March 2017

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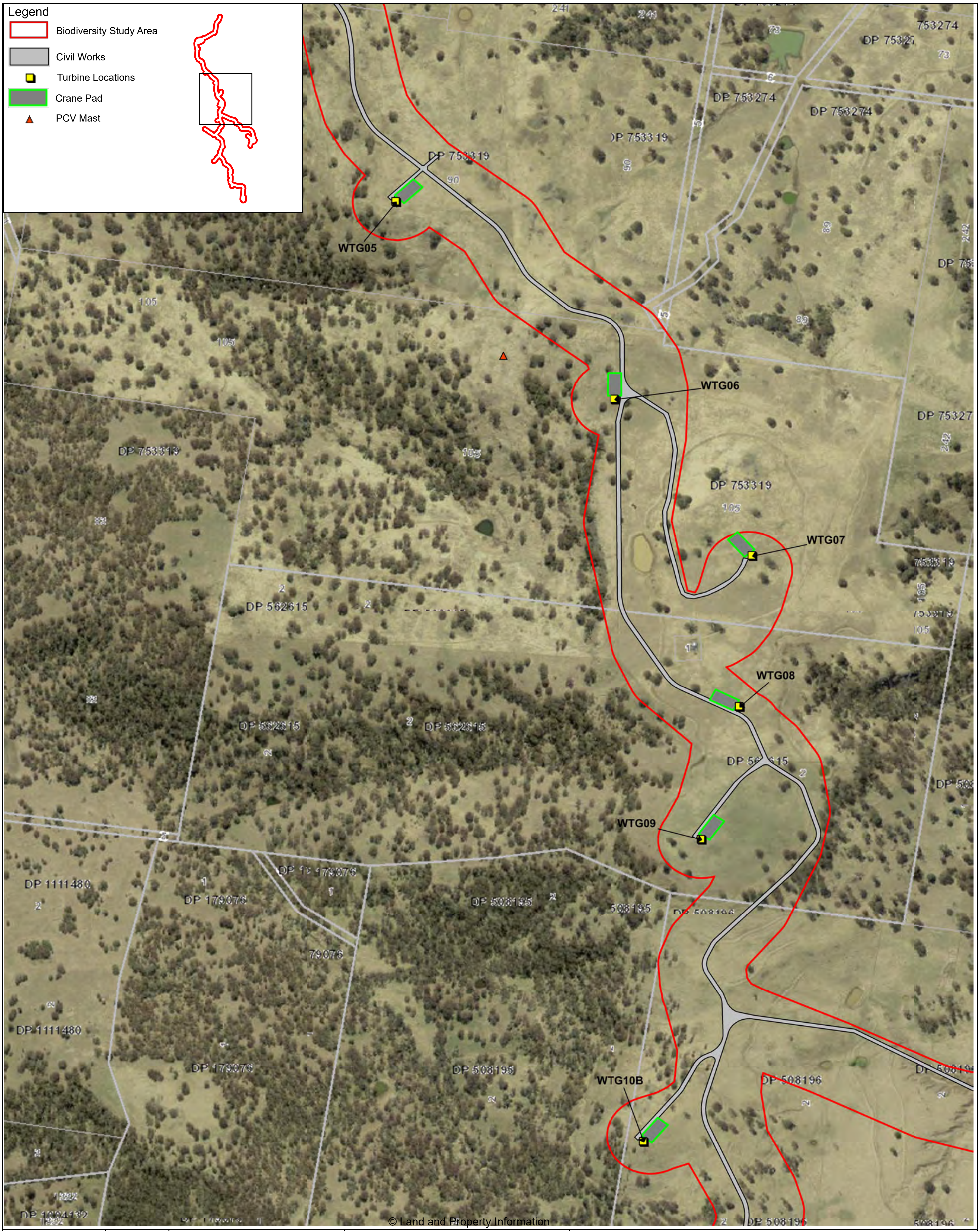

Author:	B. Ellis
Reviewer:	A. Tipper
A3 Scale:	1:8,000
Job Ref:	11262

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Map Projection GDA 1994 MGA Zone 56

Figure:1-2b

Glenn Innes Wind Farm Site Layout - MOD 4

Glenn Innes Wind Farm
Glen Innes, NSW

08 March 2017

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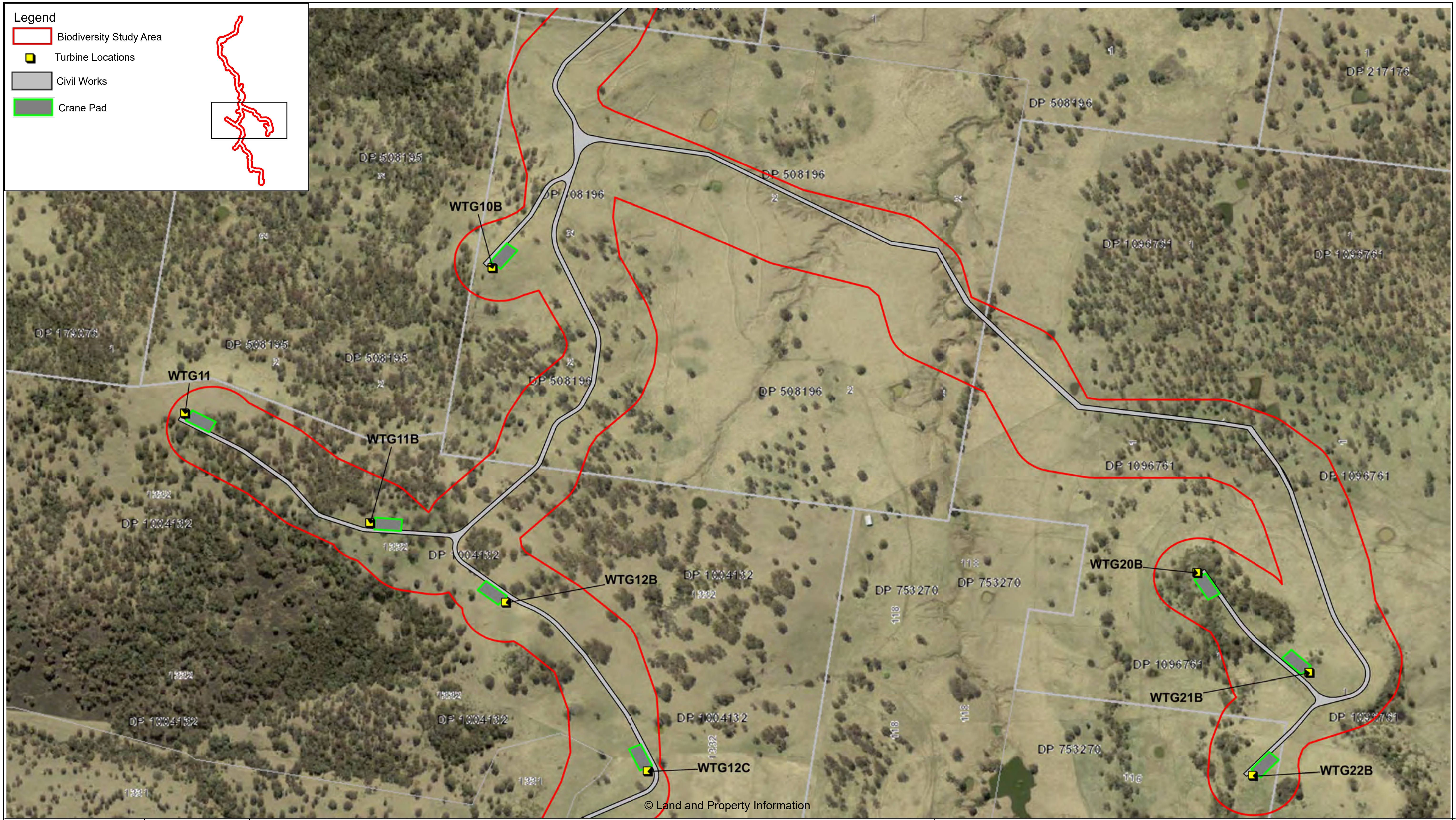

Author:	B. Ellis
Reviewer:	A. Tipper
Job Ref:	1:8,000
A3 Scale:	11262

Figure: 1-2c reduced

Glen Innes Wind Farm
Site Layout - MOD 4

Glen Innes Wind Farm
Glen Innes, NSW

March 11 2017

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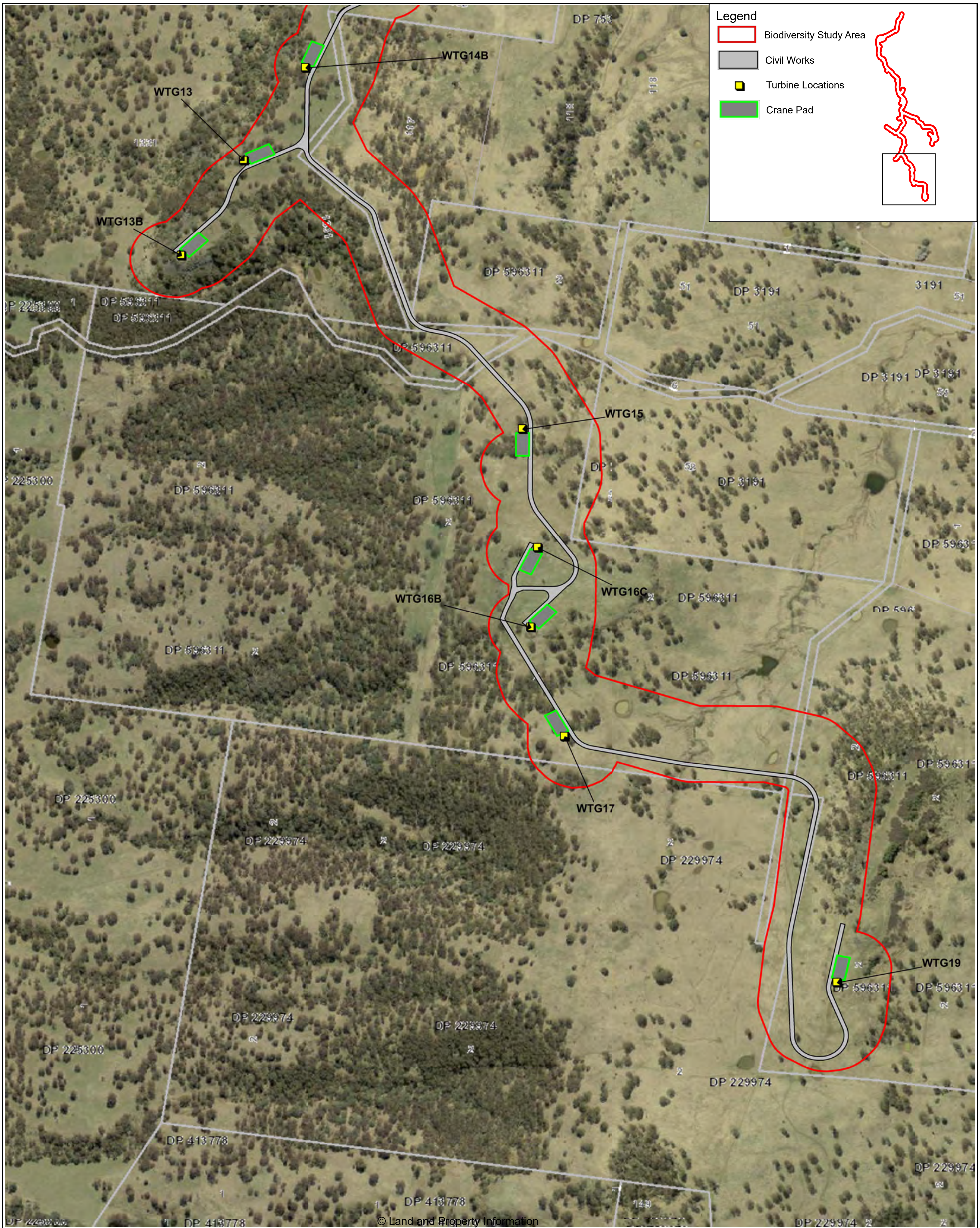

Author:	B. Ellis
Reviewer:	A. Tipper
A3 Scale:	1:8,000
Job Ref:	11262

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Figure: 1-2d

Glenn Innes Wind Farm Site Layout - MOD 4

Glenn Innes Wind Farm
Glen Innes, NSW

08 March 2017

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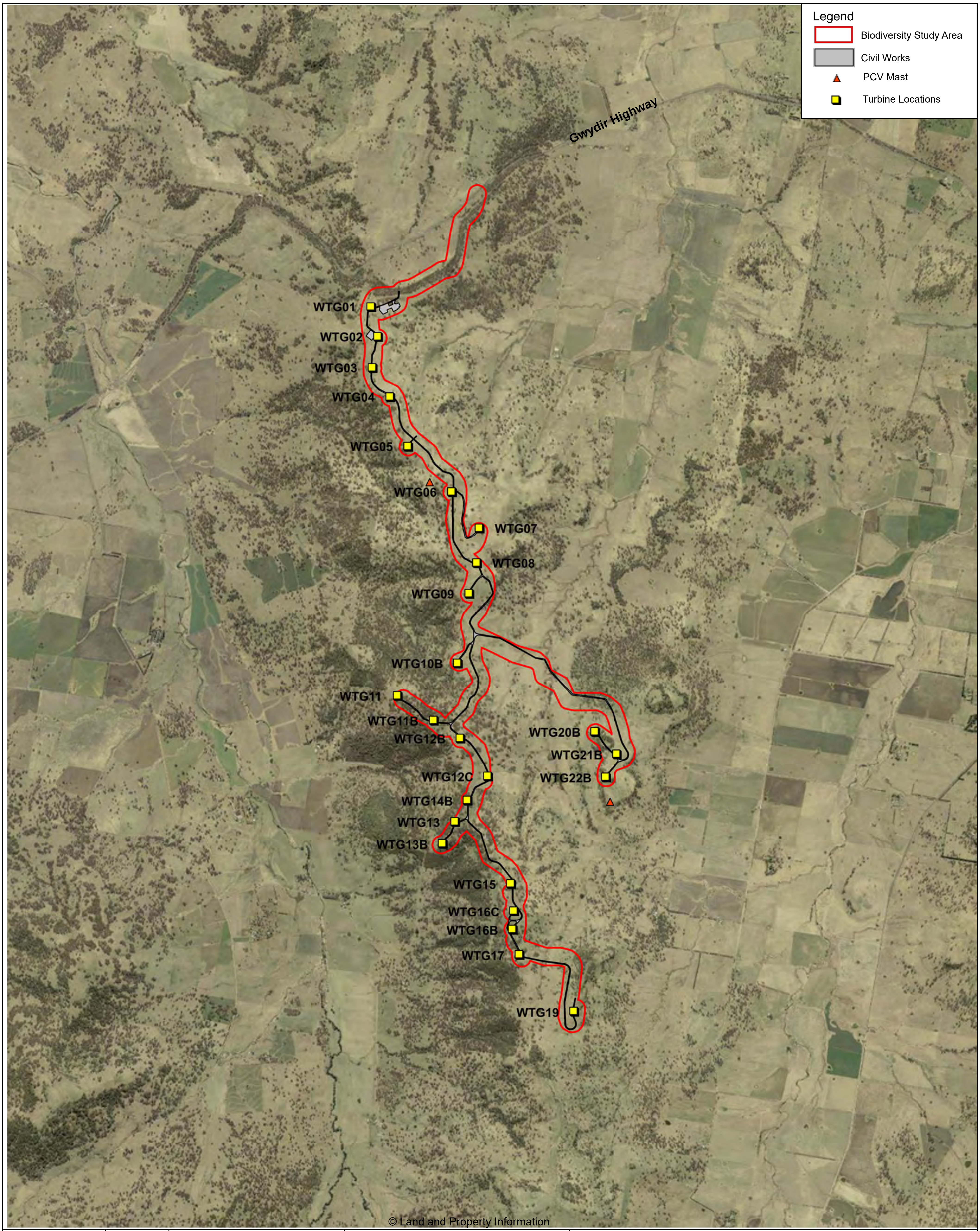

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Reviewer:	A. Tipper
A3 Scale:	1:40,000
Job Ref:	11262

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Map Projection GDA 1994 MGA Zone 56

Figure: 1-2e

Glenn Innes Wind Farm
Site Layout - MOD 4

Glenn Innes Wind Farm
Glen Innes, NSW

08 March 2017

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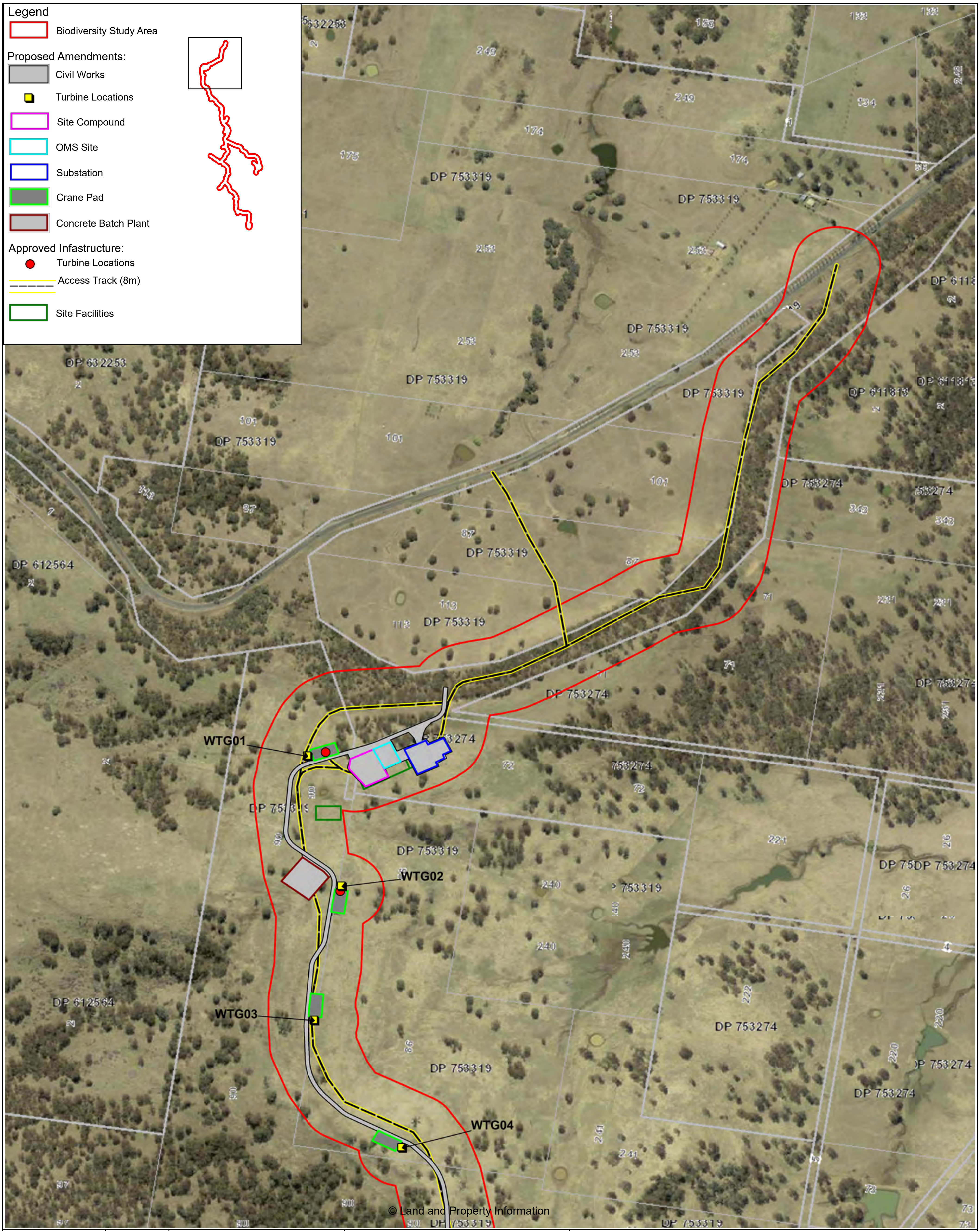

Author:	B. Ellis
Reviewer:	A. Tipper
A3 Scale:	1:8,000
Job Ref:	11262

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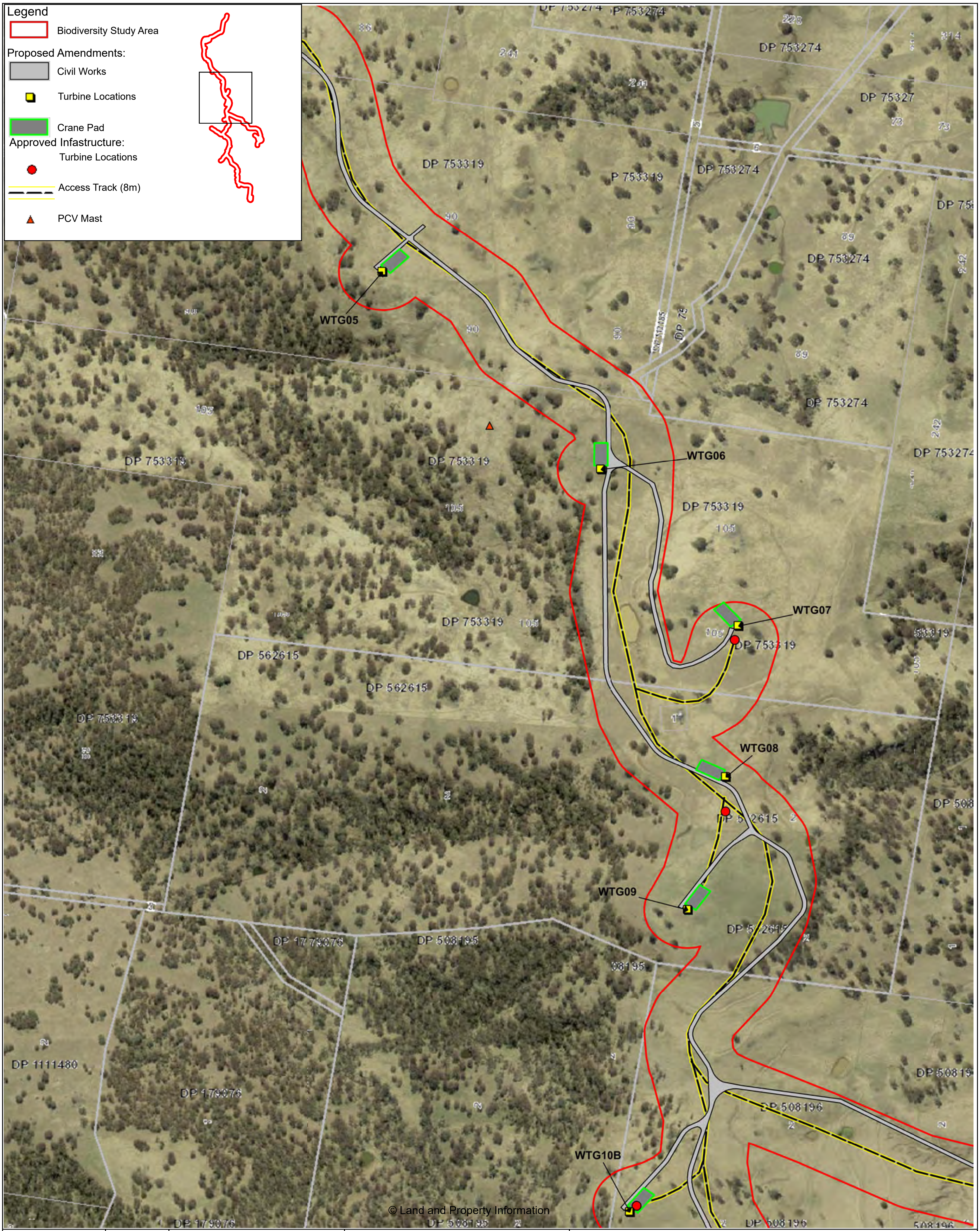
Map Projection GDA 1994 MGA Zone 56

Figure: 1-2f

Glenn Innes Wind Farm
Site Layout - MOD 4

Glenn Innes Wind Farm
Glen Innes, NSW

08 March 2017



Author:	B. Ellis
Reviewer:	A. Tipper
A3 Scale:	1:8,000
Job Ref:	11262

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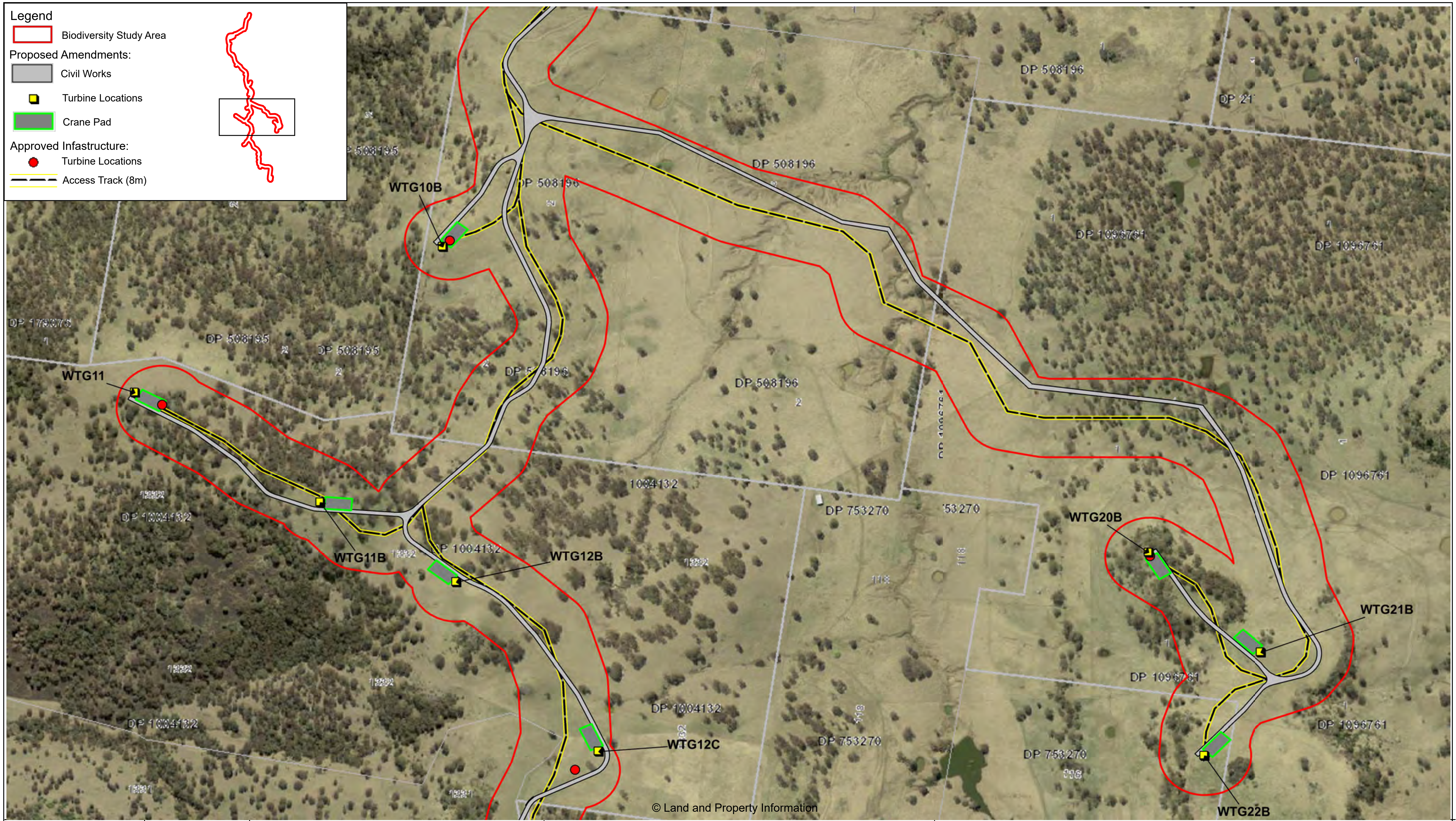
Map Projection GDA 1994 MGA Zone 56

Figure: 1-2g

Glenn Innes Wind Farm
Site Layout - MOD 4

Glenn Innes Wind Farm
Glen Innes, NSW

08 March 2017



Author:	B. Ellis
Reviewer:	A. Tipper
Job Ref:	1:8,000
A3 Scale:	11262

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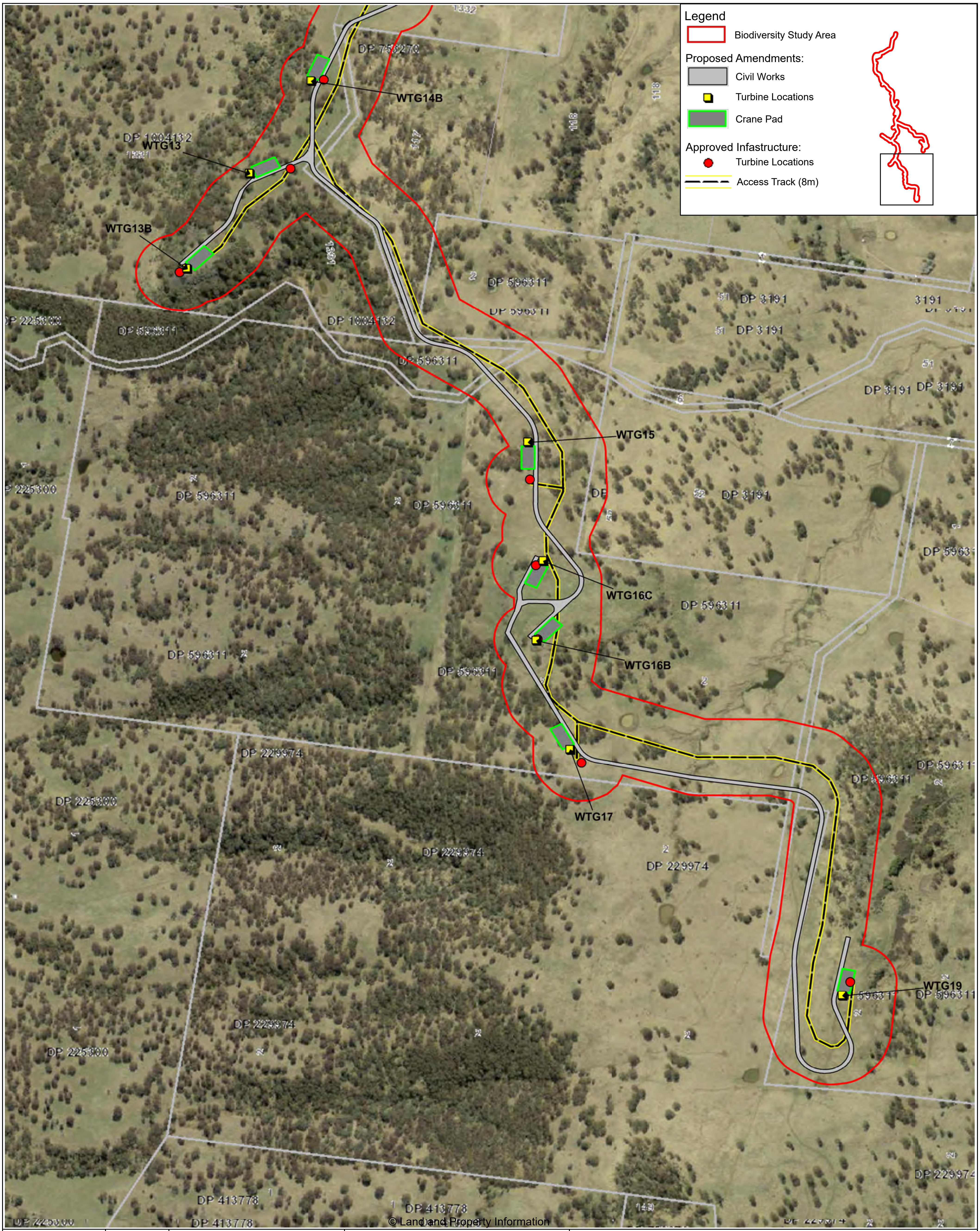
Map Projection GDA 1994 MGA Zone 56

Figure: 1-2h

Glen Innes Wind Farm
Site Layout - MOD 4

Glen Innes Wind Farm
Glen Innes, NSW

March 11 2017



Author:	B. Ellis	N	Figure: 1-2i
Reviewer:	A. Tipper	0 300 metres	**Glenn Innes Wind Farm Site Layout - MOD 4**
A3 Scale:	1:8,000	Map Projection GDA 1994 MGA Zone 56	Glenn Innes Wind Farm Glen Innes, NSW
Job Ref:	11262		08 March 2017

2 Analysis of Submissions

2.1 Submission Matrix

A number of submissions were lodged via the Department of Planning and Environment (DP&E) major projects website during the exhibition period. Table A-1 in Appendix A provides a matrix of the types of submissions and the key issues raised. The matrix separately considers submissions from:

- Agencies (10 submissions);
- Companies and organisations (6 submissions);
- Public submissions from local residents (12);
- Public submissions from other NSW locations (6);
- Public submissions from interstate (15); and
- Public submissions from overseas locations (3).

The matrix notes which submissions are simply comments and which are objections. The DP&E major projects website allows the submitter to choose between "comment" or "objection", and in two cases, local residents have selected "comment", when their submissions appear to be objections. Both have been treated as objections in this Response to Submissions (RTS). Including these, 25 objections were received by NSW based individuals, companies and organisations.

Form letters (identified as Nos. 1, 2 and 3) were used by 18 local, interstate and overseas objectors. Mr Putland lodged, or co-lodged, six submissions in total in the format of Form Letter 2. Mr Putland's submissions have been considered separately in this RTS.

One objector (Mr Gardner of Braidwood) lodged three separate submissions (220673, 220598 and 220675), two if which were identical. His submissions have been considered together in this RTS.

Another objector, the owner of Minnamurra Stud issued a letter with supporting letters from others, all of which have one identifying number (220917) and have been considered together in this RTS.

2.2 Submission Themes

The submissions matrix included as Table A-1 in Appendix A summarises the issues raised in the 51 submissions.

These submission themes are outlined as follows:

1. **Questions approval process**: 12 submissions. In several cases, public submissions questions whether the modification as proposed constituted a new development. At least one submission raised an issue of author certification as required should an EIS have been prepared.
2. **Considers consent lapsed**: 19 submissions considered that the consent has lapsed due to non-commencement.
3. **Noise**: 24 submissions raised noise impacts as an issue, or were concerned about the noise impact assessment. Several also raised concerns about noise from other local windfarms.
4. **Visual**: 38 submissions, mostly around the impact of the wind farm on residents or the methodology used in predictions.
5. **Heritage**: 4 submissions were concerned about the impact on heritage, particularly with respect to Waterloo Station and associated buildings.
6. **Biodiversity**: 13 submissions were concerned about biodiversity impacts, including bird strike with the rotors and the plan to widen the access tracks.
7. **Consultation adequacy**: 12 submissions considered consultation to date to have been inadequate.
8. **Project need**: 12 submissions questioned the need for the Project at all, particularly given the construction of other wind farms in the region.
9. **Property values**: 12 submissions were concerned about how the wind farm would affect property values.
10. **Project viability**: 11 submissions questioned the financial viability of the Project.
11. **Disruption to farm management**: 1 submission raised concerns about the effect of the Project on farm management practices, particularly lambing.
12. **Limits farm subdivision**: 1 submission raised the concern that the Project would limit the potential for farm subdivision.
13. **Shadow flicker effects**: 1 submission raised the issue of the effect of shadow flicker on livestock.
14. **Shadow flicker COI**: 12 submissions considered that having Senvion prepare the shadow flicker assessment was a conflict of interest.
15. **Aviation issues**: 4 submissions raised issues around aviation. One of these submissions was from a local landholder concerned about the effect of the turbines on aerial agricultural operations, while 2 submissions were from agencies outlining the process to manage air operations at Glenn Innes aerodrome. A final submission from Glenn Innes Airport provided a copy of a recent relevant Airspace Report for Sapphire Windfarm and raised concerns about the adequacy of consultation on the airspace issue.
16. **Waste planning**: 1 submission (Council) requested more detail on waste planning by way of a post-approval Waste Management Plan.
17. **Traffic planning**: 1 submission (RMS) requested updates to the Traffic Management Plan and outlined the need for a Works Authorisation Deed.

18. **Water supply**: 1 submission (DPI) requested additional information on the proposed construction water supply.
19. **Crown Land**: 1 submission (DPI) requested additional information on works on Crown Land and the TSR.

Agency submissions are generally addressed individually in Section 5.1, although civil aviation matters are dealt with together in Section 5.1.9. The company, organisation and public submission themes are addressed in Section 5.2 under the following headings:

1. Approval process validity;
2. Lapsing of consent;
3. Noise;
4. Visual;
5. Heritage;
6. Biodiversity;
7. Consultation adequacy;
8. Project need;
9. Property values;
10. Project viability;
11. Farm disruption;
12. Farm subdivision;
13. Shadow flicker; and
14. Aviation issues.

3 COMMUNITY ENGAGEMENT

3.1 Engagement during EA Process

Glen Innes Windpower Pty Ltd notified the Community Consultative Committee (CCC) of the selected turbine design during a meeting on 26 April 2017. The CCC carried a motion to support the approval of the proposed taller towers with longer blades – see Appendix F.

In addition, various phone conversations and face to face meetings had been held with some owners of non-associated residences.

3.2 Ongoing Engagement

Ongoing discussions with neighbouring properties is occurring. Neighbouring agreements have been discussed in face to face meetings with owners of 25 separate residences. These meetings confirmed that many landowners were generally supportive of renewable energy production, although they expressed some concern over specific impacts. No neighbour agreements have yet been executed.

4 Project Changes Due to Submissions

An initial modification application was lodged earlier in 2017 to request planning approval for larger turbine blades, similar to those in the final Modification 4 application. Critically though, this initial application did not involve increased tower height and the Department of Environment and Heritage was concerned that the ground proximity of the lower turbine tips would have unacceptable biodiversity impacts. Accordingly, GIWF redesigned the facility with taller turbines to reduce this potential impact. These taller towers are the subject of the current application.

5 Submission Responses

5.1 Agencies

5.1.1 Glen Innes Severn Council

The Glen Innes Severn Council submission raised concerns about the impact of the modified wind farm on the operation of Glen Innes Airport (addressed in Section 5.1.9) and construction waste management. Council also noted that a road opening permit would be required for access, and that a noise compliance report be prepared.

Council notes concerns about existing construction waste from wind farms having a significant deleterious effect on the local landfill capacity and requests that a Waste Management Plan be prepared. GIWF notes that such a plan has been prepared as part of the Construction Environmental Management Plan approved by DP&E.

In accordance with existing consent Condition 2.22, GIWF will measure operational noise from GIWF within six months of operational commencement in accordance with the NSW Industrial Noise Policy and forward the results to the DP&E, and the Environment Protection Authority.

5.1.2 NSW Rural Fire Service

The Rural Fire Service (RFS) response noted that RFS has no objection to the proposed modification if existing relevant consent conditions 2.35, 2.36 and 2.37 remain unchanged.

GIWF supports the retention of these consent conditions.

5.1.3 Hunter New England Local Health District

The Hunter New England Local Health District submission refers to the National Health and Medical Research Council guidance that wind farms do not cause public health issues if installed and operated according to appropriate planning guidelines and controls.

5.1.4 Office of Environment and Heritage (OEH)

GIWF's initial application for this Modification was for longer blades on towers with the currently approved heights. During consultation with OEH, the Office raised serious concerns about the impact that lower turbine tip sweep would have on fauna. GIWF accordingly modified the application to raise the turbines. The current OEH submission notes the Office's support for this decision.

OEH also provides the following comments:

1. The approved Bird and Bat Adaptive Management Plan requires minor amendments to reflect the turbine dimension changes proposed, although the monitoring methods outlined in the plan are relevant and do not require amendment at this time;
2. As the approved Construction Environmental Management Plan and the Compensatory Habitat Plan were based on 12m wide access tracks, no further assessment is required on this matter;
3. As micro-siting is proposed to avoid native vegetation impacts, no further assessment of this aspect is required; and
4. That the Office is supportive of the proposal to locate the batch plant and substation outside the TSR and Crown Road and that no further assessment of this aspect is required. OEH also recommends that clearing of native vegetation is minimised at these locations.

5.1.5 Roads and Maritime Services (RMS)

RMS noted the following items for consideration:

- The Traffic Management Plan should be updated for longer loads required for longer turbine blades;
- The Works Authorisation Deed process for the agreed improvements to the Gwydir Highway to allow access to the windfarm;
- The Traffic Management Plan considers traffic from the Wattle Vale Quarry; and
- All works on classified roads need to be designed and built according to Austroads Guidelines, Australian Standards, Roads and Maritime Supplements and traffic control undertaken in accordance with the current version of the "*Traffic Control at Worksites Manual*".

Should the Modification Application be approved, the Traffic Management Plan will be updated to account for the longer turbine blades and the interaction with Wattle Vale Quarry. A Works Authorisation Deed (WAD) has been approved by RMS for the project.

5.1.6 Division of Resources and Geoscience

The Division's response notes that it has no objection to the Modification application and that the proposal is aligned with the "*Government's NSW Renewable Energy Action Plan, and would deliver positive social aspects, driving investment and growth in regional NSW and provide alternate income streams*….. and….. *will help the Government meet its commitment to support the national Renewable Energy Target of 33,000 gigawatt hours by 2020*".

5.1.7 Department of Primary Industry (DPI)

Following the exhibition of Modification 4, the Department of Primary Industries (DPI), the key NSW Government Agency responsible for water management responded via DPI OUT17/32687 with the following statement:

> *"The following recommendations are provided for consideration in assessment of the proposal:*
> *Prior to Project Approval*
> - *The proponent is requested to confirm the water supply demands and water sources for the proposed activities. Where additional works are proposed to access water or where existing works are not authorised for the proposed use, an assessment of impacts is requested. Where additional entitlement is required, confirmation is requested on the ability to access sufficient entitlement in the relevant water source."*

The Environmental Assessment (2008) and subsequent documentation notes that water will be required for a range of construction purposes such as dust control, wetting fill for better compaction, concrete production, domestic purposes and fire-fighting reserves. The quantity of water required will vary depending on the timing of the works, weather conditions and site practices. Where construction corresponds with drier conditions this may necessitate more water for dust control. If a concrete batching plant is used on site, then additional water will be required.

Recent analysis of water supply options has identified the following:

1. Licensed surface water extraction via Water Access Licence granted pursuant to Section 61 of the *Water Management Act 2000;*
2. Licensed groundwater extraction via Water Access Licence granted pursuant to Section 61 of the *Water Management Act 2000*;
3. Use of so called Basic Rights water extraction pursuant to Section 53 of the *Water Management Act 2000;* and
4. Purchase of bulk water from Glen Innes Severn Council.

Based on the four potential supply sources listed above, the proponent favours purchase of water from Glen Innes Severn Council. This would guarantee supply to the project and supply would not be constrained by adverse climatic conditions.

Glen Innes sources its water from the Beardy Waters (river) that has a current capacity of 488ML with a backup water supply located on the Mann River, just east of Glen Innes. Glen Innes has a modern water filtration plant with a capacity of 15ML per day has previously supplied bulk water to the White Rock and Sapphire Windfarms for use on road construction and for the mixing of concrete.

DPI also requested additional information on Crown Land issues and details of the Travelling Stock Route. GIWF have been in contact with NSW Department of Industry – Lands in relation to approval to undertake works on Crown Land (23/03/2017). On the 24/03/17 GIWF received Grant of Licence Number RI 578991 executed on behalf of the Minster for Lands and Forestry.

The proponent will maintain contact with the Department of Industry Lands and Forestry and continue to review the need for additional authorisations and approvals. A copy of the final modified layout will be supplied in GIS format to the Department of Industry Lands and Forestry upon approval of the Modification.

5.1.8 Environment Protection Authority (EPA)

The EPA submission notes that the Agency has reviewed the Noise Impact Assessment and that the current consent conditions remain appropriate.

5.1.9 Civil Aviation

Civil aviation issues are addressed in the following sections, firstly with a summary of the issues raised by each agency, followed by an integrated response to the various aspects of civil aviation. A full copy of an Aviation Assessment Report by Landrum and Brown on the civil aviation issues, is attached as Appendix B and informs this section. Also attached as Appendices C and D are the most recent Aviation Impact Statement and Aviation Risk Assessment prepared for the Glen Innes Windfarm.

Submissions

The Civil Aviation Safety Authority (CASA) submission noted:

- That the proposal would require an increase in the minimum sector altitudes at Glen Innes Aerodrome;
- WTG07 would affect RNAV (GNSS) RWY14 instrument approaches;
- Some turbines would affect the minimum sector altitude; and
- That windfarms should be provided with hazard lighting that complies with S9.4 of Civil Aviation Safety Manual.

Glen Innes Council noted that the proposal would have the following:

- The proposal may affect the instrument approaches to the airport;
- WTG07 would affect runway 14 instrument approaches;
- Some turbines would affect the minimum sector altitude; and
- Obstacle collision lighting should be provided.

In a separate submission Glen Innes Regional Airport provided a copy of a recent relevant Airspace Report for Sapphire Windfarm and raised concerns about the adequacy of consultation on the airspace issue.

AirServices Australia's updated submission noted that:

1. *"Steps are being taken to amend procedures at Glenn Innes Airport that will result in the Glenn Innes Wind Farm not impacting Glenn Innes Airport. These changes will become effective in the Departure and Approach Procedures (DAP) issued on 24 May 2018. After this date the proposed Glenn Innes Wind Farm will have no impact on procedure at Glenn Innes Airport. Note that AirServices has co-ordinated this change process with The Airport Group and their procedures at Glenn Innes Airport, and it is our understanding that they have already provided advice to Glenn Innes Airport that their procedures will be unaffected."*
2. *"With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1414m (4640ft) AHD, the Glenn Innes Wind Farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Glen Innes or Inverell Airports*."
3. *"The Glenn Innes Wind Farm will not adversely impact the performance of Precision/Non-Precision Nav Aids, HF/VHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links - unchanged."*

Response

The detailed response document (Landrum and Brown, 2017) in Appendix B notes that the evaluation of aviation issues has been in accordance with the requirements of CASA, Airservices Australia, Defence and the findings are detailed in the Aviation Impact Assessment and Aviation Risk Assessment (attached in Appendix C and D). The proposed airspace amendments (minimum sector altitude) will be implemented by Airservices Australia on determination of the Modification 4 application.

The Aviation Risk Assessment previously noted that aviation hazard lighting should be consistent across the region's windfarms and should have minimal downward light spill and should meet both CASA and Defence requirements.

Landrum and Brown (2017) also note that in accordance with standard procedure, draft versions of the Aviation Risk Assessment were circulated to CASA, Airservices Australia and Defence for review. Copies were also sent to Glen Innes Severn Council and Glen Innes Regional Airport. Further, several discussions were held with the Director of Glen Innes Regional Airport to consider the outcomes of the Aviation Impact Assessment and Aviation Risk Assessment.

Airservices Australia have advised that: they will adjust Departure and Approach Procedures near Glen Innes Regional Airport, so that procedures there will remain unaffected; the proposal will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Glen Innes or Inverell Airports; and the proposal will not affect any aviation navigation aids.

5.2 Company, organisations and public submissions

5.2.1 Approval process validity

Twelve submissions question the validity of the approval process, for the following reasons:

- That the consent had lapsed (see Section 5.2.2);
- That no Transmission Connection Agreement or Electricity Supply and Purchase Agreements are in place;
- That the application does not comply NSW Planning Guidelines Wind Farms 2km setback and community consultation Wind Energy Assessment - Visual Assessment Bulletin (December 2016);
- The Department does not have the power to amend the turbine sites from those approved by the Court;
- That the scale of the modification entails a new application; and

- That a declaration in accordance with Section 6(f) of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 is missing.

These items are discussed in order as follows.

Transmission Connection Agreement

A Transmission Connection Agreement is not a prerequisite for approval and is a separate process to the modification application.

Electricity Supply and Purchase Agreements

An Electricity Supply and Purchase Agreement is not a prerequisite for approval and is a separate process to the modification application.

Court Approved Consent Modifications

Section 96AA of the EP&A Act allows that a *"consent authority may, on application being made by the applicant or any other person entitled to act on a consent granted by the Court and subject to and in accordance with the regulations, modify the development consent… "*

The Minister for Planning was the correct consent authority for this Modification Application, however, the number of objections now requires that the Independent Planning Commission (formerly the Planning and Assessment Commission) be directed to that role.

Scale of Proposed Modification

Section 96AA of the EP&A Act provides conditions under which a consent authority can approve modifications to a Court granted consent, specifically if:

(a) it is satisfied that the development to which the consent as modified relates is substantially the same development as the development for which the consent was originally granted and before that consent as originally granted was modified (if at all), and

(b) it has notified the application in accordance with:

  (i) the regulations, if the regulations so require, and

  (ii) a development control plan, if the consent authority is a council that has made a development control plan that requires the notification or advertising of applications for modification of a development consent, and

(c) it has notified, or made reasonable attempts to notify, each person who made a submission in respect of the relevant development application of the proposed modification by sending written notice to the last address known to the consent authority of the objector or other person, and
(d) it has considered any submissions made concerning the proposed modification within any period prescribed by the regulations or provided by the development control plan, as the case may be.

It is the role of the consent authority to judge if the scale of the proposed modifications meets the listed criteria.

Declaration

Section 6(f) of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 notes the following with respect to the preparation of Environmental Impact Statement:

(a) a declaration by the person by whom the statement is prepared to the effect that:
  (i) the statement has been prepared in accordance with this Schedule, and
  (ii) the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and
  (iii) that the information contained in the statement is neither false nor misleading.

This declaration is relevant only to Environmental Impact Statements, not Environmental Assessments, such as the document that supported the Modification Application.

5.2.2 Lapsing of consent

Nineteen submissions stated that the current approval had lapsed prior to the Modification Application. In most cases, submissions considered that as construction had not commenced, that the consent had lapsed.

Clause 1.5 of the Consolidated Consent (07_0036) notes the following:

"The approval shall lapse on 31 January 2017 unless the Proponent has physically commenced the project."

Section 95(4) of the *Environment Planning and Assessment Act, 1979* (EP&A Act) details consent commencement and notes:

(4) Development consent for:

(a) the erection of a building, or

(b) the subdivision of land, or

(c) the carrying out of a work,

does not lapse if building, engineering or construction work relating to the building, subdivision or work is physically commenced on the land to which the consent applies before the date on which the consent would otherwise lapse under this section.

Section 95(4) allows for "*building, engineering or construction work*" to constitute physical commencement. There is no requirement for "construction" to be commenced.

Engineering work in the form of physical geotechnical investigations on site occurred in January 2017 and so physical commencement occurred in accordance with Section 95(4) of the EP&A Act prior to the consent lapsing date.

5.2.3 Noise

25 submissions raised issues around cumulative noise and the additional noise that would be generated by the taller, larger turbines.

The Council submission reiterates that should post-commissioning noise monitoring identify exceedances, that mitigation measures would need to be examined.

Appendix G provides advice from Sonus, experts in windfarm noise assessments. Sonus makes it clear that the "NSW "*Wind Energy: Noise Assessment Bulletin for State significant wind energy development*" adopts the methodology of the 2009 South Australian document "Wind farms – environmental noise guidelines" (SA 2009) for assessing wind farm noise. The SA 2009 Guidelines state that the noise criteria are set at a level which accounts for the potential cumulative effect from more than one wind farm. That is, the noise criteria apply to each wind farm, not from the combination of all wind farms. Therefore, an assessment of cumulative noise from more than one wind farm is not required in NSW."

The Modification 4 Environmental Assessment includes Appendix 2, which is a supplementary noise assessment prepared by Sonus for the proposed new turbine design and layout. The report quantifies the predicted noise levels and shows that with appropriate mitigation measures (primarily sector downrating of turbines in particular wind conditions) that the currently approved noise criteria can be met.

In accordance with Condition 2.22, Glen Innes Windpower Pty Ltd will measure operational noise from GIWF within six months of operational commencement in accordance with the NSW Industrial Noise Policy and forward the results to the DP&E, and the Environment Protection

Authority. Should any exceedance be measured at non-associated residences the required WTG will be run in a lower noise mode and re-tested to ensure the noise does not exceed requirements.

5.2.4 Visual

38 submissions (of which 12 were from local residents) raised a variety of objections around visual impact and the assessment methodology. Specific objections were:

- The report does not consider the Wind Energy - Visual Assessment Bulletin (Dec 2016);
- The report does not consider the increase in turbine dimensions from those originally approved;
- The visual assessment report was desktop only;
- The report does not adequately consider cumulative impacts of other windfarms;
- Several viewpoints were not considered, including several houses and the Matheson Church and no wireframe modelling was provided for Waterloo Station; and
- No conclusive mitigation measures are provided for viewpoints with high visual impact.

These specific objections are discussed as follows.

Wind Energy - Visual Assessment Bulletin

The Modification EA provided a detailed Visual Impact Assessment (Green Bean 2017), prepared with regards to the visual assessment process outlined in the New South Wales State Government Wind Energy: Visual Assessment Bulletin December 2016 (the Guidelines) as applicable to the assessment of a Modification application.

Consideration of Turbine Dimensions

The Visual Impact Assessment concentrated on the changing visual impacts due to the proposed modification for residences up to 3.6 km away from the nearest turbine, although the Wind Energy Visual Assessment Bulletin suggests that for 180 m tip heights, houses up to 2.4 km away should be given detailed consideration. Several submissions have not fully understood that the VIA assessed and determined *modified impacts*, as the project as approved already has a visual impact that varies by location. The 'as approved' impacts include the previous Glen Innes Wind Farm Mod-2 turbine dimension changes.

Desktop Assessment

The Visual Impact Assessment was a desktop assessment, but with conclusions drawn from previous field work by Green Bean Design. Green Bean Design has undertaken previous site work within and surrounding the Glen Innes Wind Farm site including multiple site inspections for the White Rock Wind Farm, Sapphire Wind Farm and White Rock Solar Farm. Green Bean Design has an understanding of the landscape and receiver locations surrounding the Glen Innes Wind Farm site and demonstrated this in numerous Visual Impact Assessment reports prepared for the DP&E.

Cumulative Assessment

The Visual Impact Assessment considered the cumulative effect of other windfarms by use of cumulative wireframe modelling and reference to the White Rock Cumulative Assessment (Green Bean Design, 2011). The key to wind farm cumulative impact is the extent of visibility between separate project's turbines. Visibility is dependent on turbine location, height, local topography, intervening vegetation and distance to the viewpoint. Of the four wind farms considered in Green Bean Design (2011), Glen Innes and White Rock wind farms are by far the closest together. The report notes that while there is a low direct cumulative impact between the two farms from all residences, there would be some indirect cumulative impacts, where turbines from both projects could be seen from individual residence, albeit not from the same field of view and at some distance. Green Bean Design (2011) notes a similar situation for the cumulative impacts of the White Rock and Sapphire wind farms and concludes that the wind farms together, are unlikely to cause any significant direct to indirect visual impact. The White Rock cumulative assessment (Green Bean Design, 2011) equally applies to GIWF as it considered all the local wind farms, and as the current GIWF modification visual impact assessment shows that the proposed modification would not result in change that would significantly increase the "approved" visual impacts, no change in the magnitude of cumulative impacts will result.

Additional viewpoints

Figure 5-1 shows the various viewpoints around the Glen Innes Windfarm, including the residences within 3.6 km in accordance with the New South Wales State Government Wind Energy: Visual Assessment Bulletin December 2016. Figure 5 of this Bulletin provides a visual magnitude threshold for visual assessment based on turbine height and distance from dwellings. For the proposed 180 m tip height, the threshold distance is 3.6 km.

Figure 5-1 includes the 6 additional residential dwellings identified in submission including those described as being occupied full time, as well as the Matheson Church.

Residential dwellings Waterloo A, Waterloo B, Waterloo D and the Lynn residence have not been assessed as they are beyond the 3.6 km Bulletin threshold distance. Matheson Church has not been assessed as the Church is not occupied and religious services are no longer held there (Rev Richard Clementson, pers.comm., 30 November 2017). In any event, occasional visitors to the Church would not experience any significant additional visual effects as a result of the Modification.

Waterloo Station main house, which is approximately 3.5 km from the nearest approved (or proposed) turbine and is indicated at this distance in Figure 5-1. Figures 2 and 3 of the Visual Impact Assessment compared the zones of visual influence as approved and as proposed and showed that Waterloo Station remains within the same zone of visual influence. The Visual Impact Assessment classified Waterloo Station with a Level 1 sensitivity rating based on its local heritage listing. Figure 5-2 is a new wireframe model for Waterloo Station main house and shows that views south east toward the approved GIWF Mod-2 (and proposed Mod-4) wind turbines are generally open and extend to wind turbines around 7 kilometres from the dwelling. The house has a high visual impact rating for both the approved and proposed turbine designs. The Mod 4 wind turbines would not result in any significant increase in visual effect associated with the approved wind turbines.

Residence Waterloo C is approximately 240 metres to the north of the Waterloo main house and adjoins the Waterloo Road corridor. The dwelling is in a north east to south west orientation with mature tree cover to the north and east of the dwelling. Tree cover will provide some degree of filtering of views toward the approved wind turbines. The Mod 4 wind turbines would not result in any significant increase in visual effect associated with the approved wind turbines.

Green Valley B is located around 125 metres to the south-south-east of the Green Valley residential dwelling. Green Valley B would have a similar outlook and view toward the Mod 4 wind turbines as Green Valley resulting in a Moderate level of visual effect, with no significant change in visual impacts due to the proposed modification.

Mitigation Measures

The Visual Impact Assessment has reviewed the consolidated Mod-2 and Mod-3 Glen Innes Wind Farm Conditions of Consent and determined that the mitigations measures included in the Conditions of Consent should be applied to the Mod-4 project without change.

Conclusion

The key findings of the Mod 4 Visual Impact Assessment remain valid:

The Visual Impact Assessment has *"illustrated and compared the approved GIWF Mod-2 project against the proposed GIWF Mod-4 wind turbine design and layout. This VIA concludes that the proposed increase in wind turbine tip height would be discernible from some surrounding and proximate view locations where views toward the approved GIWF Mod-4 wind turbines exist. Additional levels of visibility would be limited to two or three wind turbine hubs and/or blade tips. The GIWF Mod-4 wind turbine is not considered to be of a magnitude that would significantly increase visual effects and visual impact ratings associated with the approved GIWF Mod-2 development'"*

5.2.5 Heritage

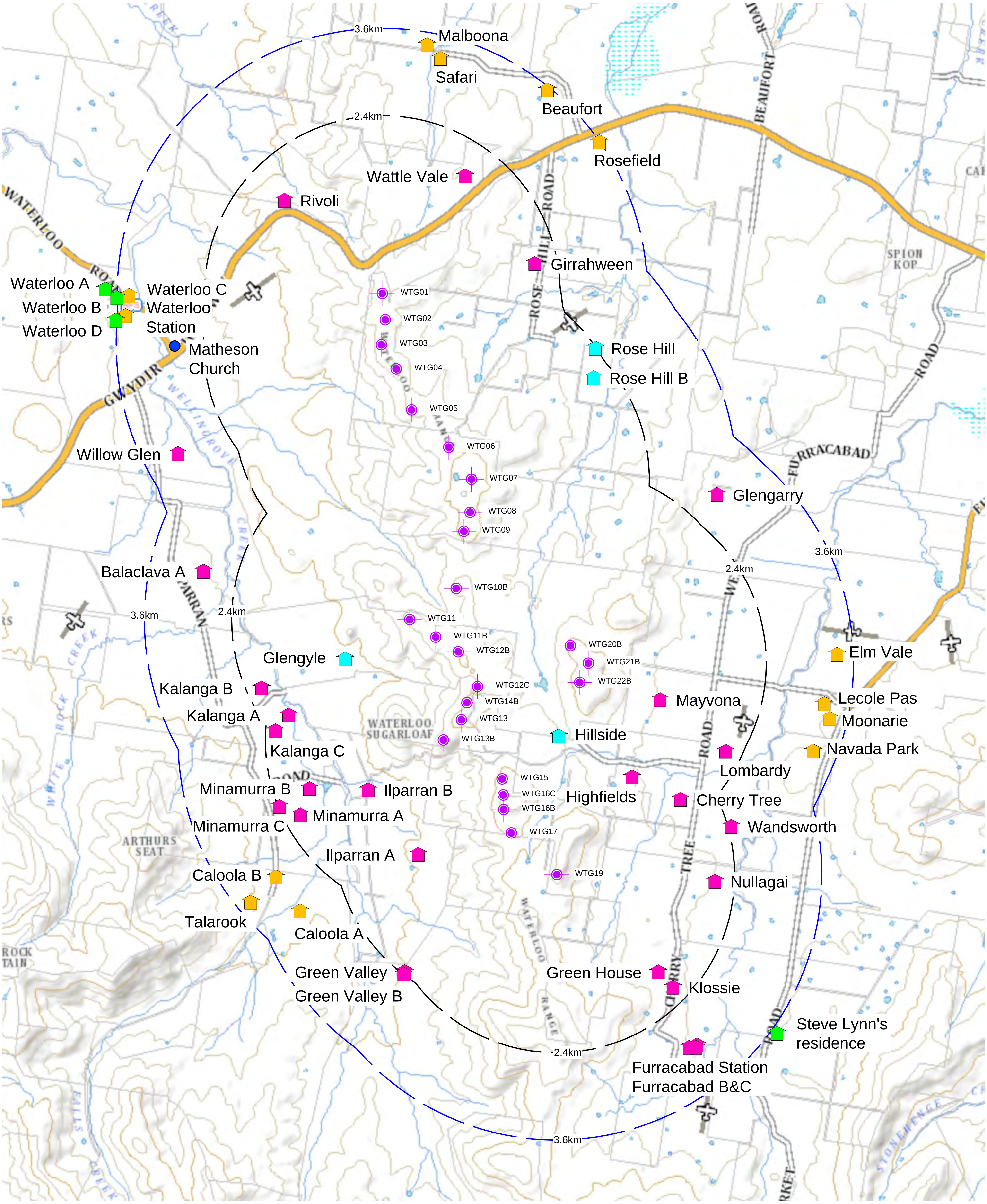
Four submissions, two of which were of local origin, discussed the impact of the Project on the heritage values of Waterloo Station at Matheson.

The Glen Innes Severn Council Local Environmental Plan (LEP) lists 196 items of heritage items, one of which is Waterloo Station, which is listed as having local significance. Waterloo Station is not listed on any State or National heritage registers. Waterloo Station is recorded on the National Trust of Australia Register, although this has no statutory provision.

The Glen Innes Severn Council LEP Clause 5.10 notes that the objectives of a heritage listing are to "to *conserve the heritage significance of heritage items and heritage conservation areas, including associated fabric, settings and views,".* The LEP further notes that development consent is required for demolition, changes to, alterations of heritage items or erection of new buildings or subdivision of land on which heritage items are located. While this clause applies to developments within the listed item, for example any works on the homestead or shearing shed, it does not apply to developments outside the listed item, and so are not relevant to the Modification application.

While Glen Innes Severn Council is not the consent authority for this Modification application and the LEP clauses do not apply, the objectives of the local heritage listing are relevant of consideration. Consent exists for the GIWF Wind Farm, and the question of relevance is whether the proposed changes make further changes to the listed item, associated fabric or views.

The Modification does not affect the listed item directly, nor the associated fabric. With respect to views, the application does not affect views towards Waterloo Station. Views from Waterloo Station are however affected by the current approval. The Wind Energy Visual Assessment Bulletin (Table 3) lists sensitive land use designations, which includes Commonwealth or State listed heritage sites, but not those listed under LEPs or of local significance, or National Trust listings. Table 1 of the Bulletin provides similar significance designations. Nonetheless, the Visual Impact Assessment that formed part of the Modification Application (Green Bean Design, 2017), conservatively gave Waterloo Station a Level 1 viewer sensitivity rating based on its local heritage listing.



Legend

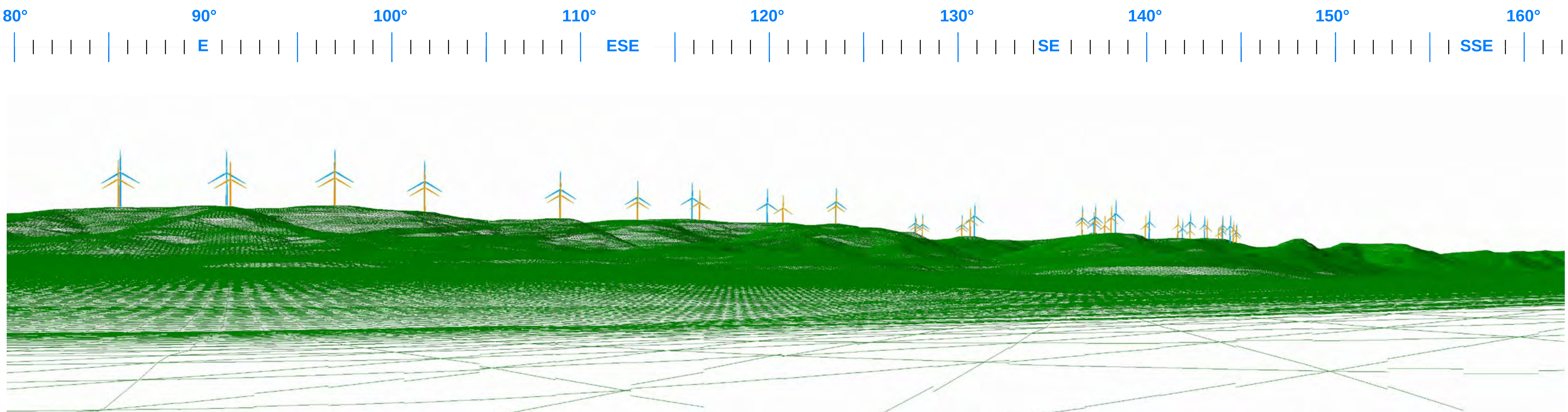
Approved GIWF Mod-2 and proposed Mod-4 wind turbine (indicative location)	Non associated residential dwelling between 2.4 km and 3.6 km of proposed Mod-4 wind turbine not assessed in the approved GIWF Mod-2 Application
Associated residential dwelling within 3km of an approved Mod-2 and proposed Mod-4 wind turbine	Non associated residential dwelling beyond 3.6 km of proposed Mod-4 wind turbine not assessed in the approved GIWF Mod-2 Application
Non associated residential dwelling within 3.6 km of approved Mod-2 and proposed Mod-4 wind turbine	2.4 km wind tubine distance offset in accordance with DPE Visual Bulletin Dec 2016, Figure 5 - 180 m tip height
	3.6 km wind tubine distance offset in accordance with DPE Visual Bulletin Dec 2016, Figure 5 - 180 m tip height

0km 1km

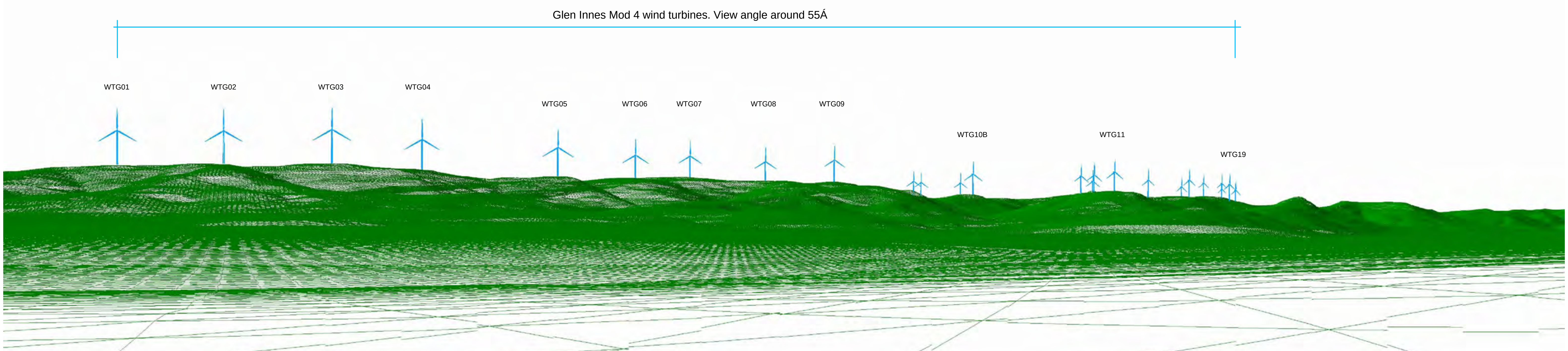
Figure 1 GIWF Approved Mod-2 and proposed Mod-4 layout (amended for Response to Submissions)

Glen Innes Wind Farm Mod 4 Visual Impact Assessment

GREEN BEAN DESIGN
landscape architects



Waterloo: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 3.51 kilometres. Tips visible 25, Hubs visible 25
Distance to closest Glen Innes Mod 4 wind turbine 2.45 kilometres. Tips visible 25, Hubs visible 25



Waterloo: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 49 -
Wireframe 43 Waterloo

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4

5.2.6 Biodiversity

Thirteen submissions mentioned the effect of the Project on biodiversity, mostly with general comments about ecological impacts, but with specific mention of issues such as:

- Bird strike;
- The effect of widening the access tracks from 8m to 12m; and
- Habitat fragmentation and the risk to threatened species.

Consultation with the OEH during preparation of the Modification 4 Environmental Assessment caused a revision in the then proposed turbine design to increase the tower height to reduce the potential for low flying bird and bat strike. This taller design reduces the potential strike impact, even when compared to the approved design.

During consultation with OEH during the preparation of Bird and Bat Adaptive Management Program (BBAMP), Flora and Fauna Management Plan (FFMP) and Compensatory Habitat Package (CHP), a disturbance footprint of approximately 12m was introduced to allow calculation of indirect construction impacts and associated biodiversity offset requirements. The 12m width incorporates impacts associated with drainage channels and batters. The amended track locations remain located within the Biodiversity Study Area used in the original documentation and in the approved CHP.

In terms of the potential total increase in disturbance area that will result from 4m widening of the access track, the area will increase from 11.2ha to 16.8ha. The existing approved CHP already assessed the 12m access track width, so appropriate offsets (via biodiversity credits) is already to be provided for this increased level of impact.

No threatened flora species were identified in initial surveys for the original EIS, although more recent surveys noted the presence of *Thesium australe* outside the direct impact zone. No impacts to threated flora species are predicted. Three threatened animal species were noted during surveys (all bats) and database searches predicted an additional 13 species. Specifically, no threatened birds were recorded on the site, and none of the observed or potentially occurring species require offset credits.

The biodiversity-related post-approval documentation includes the CHP, BBAMP and FFMP. All three documents were approved by DP&E in January 2017. All documents have been prepared in regular consultation with OEH. All documents incorporate consideration of the areas that includes the proposed turbine and specifications, refined ancillary facilities, new track widths and aspects such as carcass search methods in the BBAMP. The CHP incorporates indirect impacts into the BioBanking calculations as recommended by OEH and it is considered that such an approach also addresses the potential impacts of the turbine, including rotor swept area impacts, refined ancillary facilities, and new track widths.

5.2.7 Consultation adequacy

A Community Consultative Committee (CCC) has been established for the project. The CCC has been involved in the Modification process and carried a motion to support the approval of the proposed taller towers and longer blades.

As noted in Section 3, ongoing discussions with neighbouring landowners is occurring. The focus of these discussions is neighbouring agreements, and a number of landowners have expressed interest in entering a neighbouring agreement. Neighbouring agreements have been discussed in face to face meetings with owners of 25 separate residences. These meetings confirmed that many landowners were generally supportive of renewable energy production, although they expressed some concern over specific impacts. No neighbour agreements have yet been executed.

GIWF plans to update the Community Information Plan (2016) with details of specific activities to be undertaken prior to commencement of construction inform the wider community on the final approved layout and design. As identified in Section 3 of the Community Information Plan, specific activities planned to be undertaken include:

- Website updates;
- Publishing newspaper articles and advertisements;
- Community Information Open sessions; and
- Sponsorships of local organisations.

5.2.8 Project need

Changes in global climate conditions have been partially attributed to increased atmospheric greenhouse gas content. Generating renewable power reduces emissions of greenhouse gases, such as carbon dioxide, associated with traditional methods of power generation by offsetting electrical generation required from fossil fuel power stations.

The Glen Innes Wind Farm will increase Australia’s wind energy generating capacity and assist in meeting Australia’s obligations under international conventions and agreements, such as the Kyoto Protocol and the Paris Agreement.

5.2.9 Property values

In 2010, the Land and Environment Court handed down the judgement in *Glen Innes Landscape Guardians Incorporated -v- Minister for Planning & Glen Innes Windpower Pty Limited* [2010] NSWLEC 1281. One of the issues referred to in that case was the potential for the decrease in property values as a result of the windfarm. Justice Moore, who heard the case stated, *"Questions of diminution of value are not matters that I can lawfully take into account in these proceedings (whether or not they would occur, a matter about which I make no comment)."*

In 2016, the NSW Office of Environment and Heritage (OEH) commissioned an investigation into the potential impact of wind farm developments on property prices in NSW. The report was entitled Review of the Impact of Wind Farms on Property Values (Urbis 2016). The key finding of that report was that "*For rural properties used for primary production, there is no direct loss of productivity resulting from wind farms; therefore, they are unlikely to negatively impact the value of such properties.*"

5.2.10 Project viability

The Project as originally applied for would had an electrical generation capacity of 81 MW. The project as currently approved has a generation capacity of 67.5 MW, and the Modification Application would result in an increase to 98.75 MW.

The project as currently approved was based on the installation of Alstom ECO122 turbines each with 60 m long blades and a nominal generation capacity of 2.7 MW. The current Modification Application is for 25 turbines each with 68.5 m long blades and a nominal generation capacity of 3.95 MW. For a 14% increase in blade length, each turbine will increase its nominal generation capacity by 33%, reflecting partially the increased efficiencies of longer blades, and partly the improved generator efficiencies.

The 33% increase in power production that would eventuate from the Modification, would come at very little additional financial cost to the project and so would significantly improve the Project's viability. The reason for this is that as more wind turbines are built around the world, additional research and development has allowed the manufacture of longer blades and larger turbine assemblies at cost-effective prices. These larger turbines produce more electricity and are now more and more commonly installed, meaning that larger assemblies cost relatively less than smaller assemblies.

Relevant analysis, such as Energy Yield Assessments, have been completed to support these understandings.

5.2.11 Farm disruption

Several submissions raised issues around disruption of farm activities, with specific issues such as:

- Disruptions to aerial agriculture (discussed further in Section 5.2.14;
- The effect of shadow flicker on horses;
- Limitations on calving and lambing;
- Noise effects on agisted horses; and
- The effects of noise reducing farm incomes from cottage rental.

A report titled 'Update of UK Shadow Flicker Evidence Base' was prepared for the UK Department of Energy and Climate Change in 2011 in part examined reported behaviour of horse to shadow flicker from wind turbines. The report quoted documents from several countries and noted the following:

1. Canada: Studies indicate that horses quickly acclimatize to shadow flicker, although generally horses should not be ridden in shadow flicker zones until acclimatised; and
2. USA: Experience by an equestrian in North America, was that shadow flicker from an operational wind turbine startled horses but the shadows simply caused the horse to stop briefly until their riders urged them on.

Given that shadow flicker is required to be limited to a maximum of 30 hours per year at non-associated dwellings, the potential shying by un-acclimatised horse is expected to be consistent with Canadian and USA experiences.

The question of the effect of wind turbine noise on agisted horses was raised by one landowner in the Matheson Valley. This issue was analysed by the British Horse Society, whose stated policy is that there a "*minimum separation distance of 200 m or three times the blade tip height (whichever is greater) will be required between a turbine and any routes used by horses or a business with horses."* The policy statement notes though that this separation might not be appropriate in all cases.

For the GIWF Project, three times the tip height would equate to 540m. Applying this British Horse Society recommended offset to the Project turbines, all of which are to be built on top of the Waterloo Range, the offset zone falls wholly within steep partly wooded country, rather than the flatter valley floors where the stud and agisted horses would most usually reside. In the case of the specific objector (M. Ritchie, Minnamurra Stud), whose horse stud is in the Matheson Valley, the nearest turbine to any part of that property is 1580m, or approximately three times the offset distance recommended by the British Horse Society.

One of the ecological management procedures to dissuade raptors from approaching operating turbines is to limit calving and lambing paddocks to areas away from the turbines. While this will affect farm operations of wind farmer properties, no such restrictions on farm operations are possible on non-associated farms. The proposed modification does not change this approved management measure and no additional impacts are expected.

One objector in the Matheson Valley (M. Ritchie, Minnamurra Stud) raised his concern that wind turbine noise would prevent him renting out a farm cottage. Taking into account the cottage in question maybe one of the three dwellings on the property, the noise assessment and the consolidated consent both refer to Minnamurra A, B and C. In accordance with Condition 2.22, Glen Innes Windpower Pty Ltd will measure operational noise from GIWF within six months of operational commencement in accordance with the NSW Industrial Noise Policy and forward the results to the DP&E, and the Environment Protection Authority. Should any exceedance be measured at non-associated residences the required WTG will be run in a lower noise mode and re-tested to ensure the noise does not exceed requirements.

5.2.12 Farm subdivision

Farm subdivision is governed by the Glen Innes Severn LEP 2012, which zones most of the rural area around GIWF as RU1 Primary Production. One of the relevant zone objectives is "*To minimise the fragmentation and alienation of resource lands*."

The LEP limits minimum lot sizes in this region, the minimum lot sizes are generally 150 ha (category AD) or 300 ha (AE). The 150ha limit general extends across the Furracabad Valley, while more elevated areas to the east and west have the larger lot size limit. Observationally, most of the individual lots in the Furracabad Valley are well less than the current minimum, so further widescale sub-division would require planning control changes.

5.2.13 Shadow flicker

Condition 2.6 of the Project Approval relates to shadow flicker and states in part:

"Shadow Flicker arising from the operation of the project shall not exceed 30 hours/annum at any residence not associated with the project."

Table 5-1 provides the predicted maximum theoretical shadow flicker for residences within 2,000 m for the modified turbines.

Table 5-1: Theoretical Maximum Shadow Flicker Predictions

Residence	Description	Nearest turbine (m)	Shadow flicker (hours/annum)
Hillside	Associated residence (vacant)	814	0
Mayvona	Non-associated residence (vacant)	1,060	58.5
Glengyle	Associated residence	1,116	72
Ilparran B	Non-associated residence (vacant)	1,299	48.4
Ilparran A	Non-associated residence	1,383	42.4
Highfields	Non-associated residence	1,420	29.95
Wattle Vale	Non-associated residence	1,821	0
Cherry Tree (Eungai)	Non-associated residence	1,932	0
Rose Hill B	Associated residence	1,932	9.3
Green House	Non-associated residence (vacant)	1,941	0
Rivoli	Non-associated residence	1,982	0

Shadow flicker modelling provides the maximum theoretical hours of flicker per year without a consideration of modifying technical and environmental factors. The most important of these factors is cloud. On cloudy days no shadows are produced, so no flicker can result. Based on the Bureau of Meteorology's Glen Innes weather station cloud data, the area has a mean of 130 cloudy days per year (defined as 6 eighths of the sky showing cloud). Considering cloud cover against the theoretical maximum predictions would significantly reduce the predictions provided in Table 5-1.

Given that flicker modelling provides a theoretical maximum figure and further that cloud cover varies daily, seasonally and even annually, actual prediction of shadow flicker is difficult to accurately predict. To limit received shadow flicker duration to 30 hours per year at all non-associated residences, the turbines can be fitted with shadow management modules that monitor flicker causing conditions and shut down the affected turbines as necessary. Calculations show that such management modules will limit flicker to less than 30 hours per year at all non-associated residences. Alternatively, GIWF will consult with potentially affected landholders and discuss amenity agreements.

In accordance with the current consent conditions, GIWF will prepare an operational shadow flicker report for *Cherry Tree, Highfields, Mayvona,* and *Ilparran B.* This report will clarify the actual received flicker at these residences and to determine if additional flicker management is required.

5.2.14 Agricultural aviation

Aircraft are used routinely in the Glen Innes regional for agricultural purposes (primarily fertiliser application). Landrum and Brown (2017 in Appendix B) note that such operations are undertaken near windfarms and other obstacles throughout the world and that appropriate risk management and pre-flight planning is required by the operator allowing for a consideration of all obstacles such as turbines, weather station masts, powerlines, trees etc.

One submission was from a local landholder concerned about the effect of the turbines on aerial agricultural operations. During the preparation of the Aviation Risk Assessment, Landrum and Brown consulted with David Boundy, the Director of SuperAir, the key aerial application contractor in the area. While Mr Boundy noted his continuing concern with currently approved turbines affecting the viability of aerial application, he was clear that the proposed increase in turbine height and size would make little difference.

6 PROJECT EVALUATION

The proposed modification is requested for installation of more modern and efficient turbines at the approved Glen Innes Wind Farm, and associated refined dimensions and locations of turbines and ancillary infrastructure.

The proposed modification application requests approval to modify and/or clarify the dimensions and locations of the following items:

1. Refined turbine dimensions as per Table 1-1.
2. Refined turbine locations as per Table 1-2, subject to 100m micro-siting allowance due to potential site requirements including ecological constraints or shallow rock.
3. Increased nominal annual generation capacity to up to approximately 90 MW, subject to incremental changes due to installation and local conditions.
4. Increased construction track disturbance footprint from the approved 8m to approximately 12m to account for indirect impacts from track construction (the 12m impact width accords to OEH requested impact areas for biodiversity offset calculations and has been used in approved management plans such as the Construction Environmental Management Plan (EPS, 2016) and the Compensatory Habitat Plan (EPS, 2016).
5. Refined substation location to avoid the Travelling Stock Route, Crown Road and unfavourable topography.
6. Refined concrete batch plant location.

This Environmental Assessment concludes that the proposed modifications will cause no significant change to the environmental and social impacts predicted for the wind farm as currently approved. The modifications will facilitate greater electricity production and consequent additional GHG savings.

Approval of the modification would require only minor changes to the Project Approval conditions and importantly the currently required environmental management, emission limits and monitoring requirements will be maintained.

Appendix A

Submissions Matrix

Submitter	Reference number	Location (Property name)	Stakeholder Type	View	Form letter/ petition	Questions approval process	Considers consent lapsed	Noise	Visual	Heritage	Biodiversity	Consultation adequacy	Project need	Property Values	Project viability	Disruption to farm management	Limits farm subdivision	Shadow Flicker effects	Shadow flicker report COI	Glen Innes Airport	Ag air issues	Waste Planning	Traffic Planning	Water Supply	Crown Land
Agencies																									
NSW Rural Fire Service	223841		Agency	Comments																					
CASA	221238		Agency	Comments																1					
Hunter New England Local Health District	221910		Agency	Comments																					
Glen Innes Severn Council	221368		Agency	Comments				1												1		1			
OEH	224021		Agency	Comments																					
RMS	221365		Agency	Comments																			1		
Division of Resources and Geoscience	221912		Agency	Comments																					
DPI	221915		Agency	Comments																				1	1
EPA	221242		Agency	Comments																					
Airservices Australia	223835		Agency	Comments																					
Companies and organisations																									
Glen Innes Regional Airport	?	Glen Innes	Group	Comments																1					
Glen Innes Landscape Guardians	221661	Glen Innes	Group	Objects	Form letter no.2	1	1	1	1		1	1	1	1					1						
Green Valley	221657	Glen Innes (Green Valley)	Company	Objects	Form letter no.2	1	1	1	1		1	1	1	1					1						
Furracabad Station	221653	Glen Innes (Furracabad Stn)	Company	Objects	Form letter no.2	1	1	1	1		1	1	1	1					1						
Eungai South	221655	Glen Innes	Company	Objects	Form letter no.2	1	1	1	1		1	1	1	1					1						
Waterloo Station Pastoral Company	221684	Glen Innes (Waterloo Stn)	Company	Objects			1	1	1	1					1										
Minamurra Stud	220917	Matheson (Minamurra Stud)	Company	Objects	with two attached support letters			1				1													

Submitter	Reference number	Location (Property name)	Stakeholder Type	View	Form letter/ petition	Questions approval process	Considers consent lapsed	Noise	Visual	Heritage	Biodiversity	Consultation adequacy	Project need	Property Values	Project viability	Disruption to farm management	Limits farm subdivision	Shadow Flicker effects	Shadow flicker report COI	Glen Innes Airport	Ag air issues	Waste Planning	Traffic Planning	Water Supply	Crown Land
Public Submissions																									
Local residents																									
Geoffrey Putland	221622	Glen Innes	Individual	Objects	Form letter no.2	1	1	1	1		1	1	1	1					1						
Phillip Rhodes	221908	Glen Innes	Individual	Objects	Form letter no.2	1	1	1	1		1	1	1	1					1						
John Lynn	220318	Furracabad	Individual	Comments, but appears to be an objection	main submission and one later submission.			1	1					1				1							
Joe Sparks	220279	Glen Innes	Individual	Comments, but appears to be an objection		1			1																
Rolf Sieber	221019	Glen Innes	Individual	Objects		1			1																
Colin James	222235	Matheson	Individual	Objects			1	1	1		1	1			1				1						
Daniel McAlary	222197	Furracabad	Individual	Objects				1	1							1	1	1			1				
David Foran	222079	Glen Innes	Individual	Objects					1																
Deborah Anderson	221802	Matheson	Individual	Objects			1	1	1						1										
Donald Anderson	222081	Matheson	Individual	Objects			1	1	1	1			1		1										
Anonymous	221974	Matheson	Individual	Objects				1	1																
Anonymous	224295	Furracabad	Individual	Objects			1	1	1		1			1											
Other NSW submissions																									
Sam Hobden	221780	Bondi	Individual	Objects	Form letter no. 1				1						1										
Scott Hobden	221669	Nundle	Individual	Objects	Form letter no. 1				1						1										
Anthony Gardner	220673, 220598 and 220675	Braidwood	Individual	Objects	Issued 3 objections, 2 of which are identical. Submissions considered together.		1		1			1							1						

Submitter	Reference number	Location (Property name)	Stakeholder Type	View	Form letter/ petition	Questions approval process	Considers consent lapsed	Noise	Visual	Heritage	Biodiversity	Consultation adequacy	Project need	Property Values	Project viability	Disruption to farm management	Limits farm subdivision	Shadow Flicker effects	Shadow flicker report COI	Glen Innes Airport	Ag air issues	Waste Planning	Traffic Planning	Water Supply	Crown Land
Other NSW submissions																									
Michael Crawford	221780	Boro (Tarago)	Individual	Objects		1	1																		
Peter Spearritt	222135	Brunswick Heads	Individual	Objects					1	1															
Anonymous	221102	NSW	Individual	Objects				1																	
Interstate submissions																									
David Anderson	221782	Chelmer, Qld	Individual	Objects	Form letter no. 1				1						1										
Veronica Rooker	221858	MacKay, Qld	Individual	Objects	Form letter no.2	1	1	1	1		1	1	1	1					1						
Tania Neill	221663	New Farm, Qld	Individual	Objects	Form letter no.2	1	1	1	1		1	1	1	1					1						
Frank Laudari	221879	McDowall, Qld	Individual	Objects	Form letter no.2	1	1	1	1		1	1	1	1					1						
Graham Newell	222096	McDowall, Qld	Individual	Objects	Form letter no.2		1	1	1		1	1	1	1					1						
Ann Wegener	221784	Dakabin, Qld	Individual	Objects	No specific issues raised.																				
Donna Anderson	221638	Toowong, Qld	Individual	Objects				1	1						1										
James Anderson	221632	Toowong, Qld	Individual	Objects			1		1																
Doug Lyon	221686	Yeronga, Qld	Individual	Objects			1	1	1																
Marion Lyon	221692	Yeronga, Qld	Individual	Objects				1	1	1															
Graham Hesse	221786	Kallangur, Qld	Individual	Objects					1																
John Lyon	221837	Ipswich, Qld	Individual	Objects					1				1												
Robert Lyon	222201	Brisbane, Qld	Individual	Objects	Form letter 3				1																
Helen Darch	221961	Brisbane, Qld	Individual	Objects				1	1		1														
Anonymous	222239	Greenslopes, Qld	Individual	Objects	Form letter 3				**1**																
Overseas submissions																									
Joshua Anderson	221634	Belgium	Individual	Objects	Form letter no. 1				1						1										
Anonymous	221644	Belgium	Individual	Objects	Form letter no. 1				1						1										
Amy Anderson	221822	Belgium	Individual	Objects	Form letter no. 1				1						1										

Submitter	Reference number	Location (Property name)	Stakeholder Type	View	Form letter/ petition	Questions approval process	Considers consent lapsed	Noise	Visual	Heritage	Biodiversity	Consultation adequacy	Project need	Property Values	Project viability	Disruption to farm management	Limits farm subdivision	Shadow Flicker effects	Shadow flicker report COI	Glen Innes Airport	Ag air issues	Waste Planning	Traffic Planning	Water Supply	Crown Land
Sub-totals																									
Agencies		10 submissions				0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	1	1
Companies and organisations		5 submissions				4	5	6	5	1	4	5	4	4	1	0	0	0	4	1	0	0	0	0	0
Local residents		12 submissions				4	6	9	12	1	4	3	3	4	3	1	1	2	3	0	1	0	0	0	0
Other NSW submissions		6 submissions				1	2	1	4	1	0	1	0	0	2	0	0	0	1	0	0	0	0	0	0
Interstate submissions		15 submissions				3	6	8	14	1	5	4	5	4	2	0	0	0	4	0	0	0	0	0	0
Overseas submissions		3 submissions				0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Total submissions		**51 submissions**				**12**	**19**	**25**	**38**	**4**	**13**	**13**	**12**	**12**	**11**	**1**	**1**	**2**	**12**	**3**	**1**	**1**	**1**	**1**	**1**

Appendix B

Aviation Assessment Report

Aviation Assessment

Glen Innes Wind Farm

Final Report.V02

16 October 2017

ENVIRONMENTAL PROPERTY SERVICES PTY LTD

EPS

Project	Client	Project No.	Version No.	Author
Glen Innes Wind Farm	Environmental Property Services	**LB00100**	001	Barrie Slingo
			002	Barrie Slingo

VERSION NO.	BASIS OF ISSUE	DATE	REVIEWERS
001	Final report for submission to Client	12 October 2017	BR, HRS
002	Updated inputs	16 October 2017	BR, HRS

Contents

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Executive Summary

The Glen Innes Wind Farm (GIWF) has received Planning authority approval for the installation of 25 turbines with a maximum turbine tip height of 150 m AGL. The wind farm proponent (Nexif Energy Australia Pty Ltd (Nexif) currently propose that the turbine tip height be increased from 150 m AGL to 180 m AGL but intend to retain the approved turbine layout and locations with minor micro-siting allowances up to 100 m.

This Report has been prepared to consider:

- the "aviation" related objections raised during the public exhibition of the project; and
- the comments and inputs received from "aviation" stakeholders.

The findings of these considerations include:

- the recommended airspace changes have been accepted by Airservices Australia and accepted and recommended by Glen Innes Severn Council (the owner of Glen Innes Regional Airport); and
- the recommended aviation hazard lighting has been endorsed by the Civil Aviation Safety Authority (CASA) and accepted and recommended by Glen Innes Severn Council.

1. Introduction

Environmental Property Services Pty Ltd (EPS), consultants on behalf of the wind farm developer Nexif, has tasked Landrum & Brown (LB) to address the aviation matters that have been raised during planning associated with the Glen Innes Wind Farm (GIWF). The current proposal for this wind farm (referred to as Modification 4 – MOD 4) includes increasing the approved turbine tip height from 150 m AGL to 180 m AGL.

In May 2017, Landrum & Brown Worldwide (Australia) Pty Ltd (L&B) was tasked by EPS to undertake:

- an Aviation Impact Statement (AIS); and
- an Aviation Risk Assessment (ARA).

The studies associated with these tasks were undertaken in accordance with relevant Australian aviation authority requirements, specifically:

- Airservices Australia (AsA) – "**Airservices Aviation Assessments for Wind Farm Developments";**
- National Airports Safeguarding Framework (NASF) Guideline D – **"Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers"**; and
- Civil Aviation Safety Authority (CASA) – "**Manual of Standards Part 139 - Aerodromes**"

During the course of these studies, consultation was undertaken with Glen Innes Regional Airport (GIRA), CASA and AsA. At Appendix A is a Summary of the findings of the AIS, and Appendix B provides the Executive Summary of the ARA study.

In brief, the major findings of these studies are:

- The GIWF turbines will infringe on prescribed airspace. The AIS Report recommended an adjustment to the Minimum Safe Altitude to overcome this infringement. (AsA subsequently accepted the recommended airspace changes but has deferred implementation pending State government approval of GIWF – MOD 4); and

- Due to the proximity of the wind farm to GIRA and other wind farms in the area, the ARA Report recommended the provision of hazard lighting of GIWF in accordance with NASF Guideline D. (This recommendation has been endorsed by CASA).

In accordance with the standard procedure for consideration of these aviation assessments, Draft Reports were forwarded to CASA, AsA and Department of Defence for their review and comment. As part of the Planning process, copies of the Report were also forwarded to the NSW Department of Planning and Environment, Glen Innes Severn Council and GIRA. Because of the wide distribution of the Reports, several comments and inputs to the consideration of the aviation aspects associated with GIWF have been raised and this Report is a consolidation of aviation related comments received.

Responses and inputs to the aviation consideration of the GIWF – MOD 4 are addressed in the body of this Report and at the following Appendices:

- Appendix C – CASA letter Ref. GI17/652 of 23 August 2017 to NSW Department of Planning;
- Appendices D and E – AsA – Email advice of 4 September 2017 to NSW Department of Planning and Email advice of 15 September 2017 to Landrum & Brown respectively;
- Appendix F – Glen Innes Severn Council letter of 21 August 2017 to NSW Department of Planning; and
- Appendix G – GIRA – Email advice of 22 September 2017 to NSW Department of Planning.
- Appendix H – Responses to Public Submissions

2. Overview

GIWF is located on the Waterloo Range about 12 kilometres to the west of Glenn Innes as shown in Figure 2.1. The project area spans approximately 8.5 kilometres from north to south and about 3 kilometres from east to west. The topography across the project site generally decreases in height from the south towards the north.

The Aerodrome Reference Points (ARP) for the nearby airports of Glen Innes (YGLI) and Inverell (YIVL) are also shown in Figure 2.1.

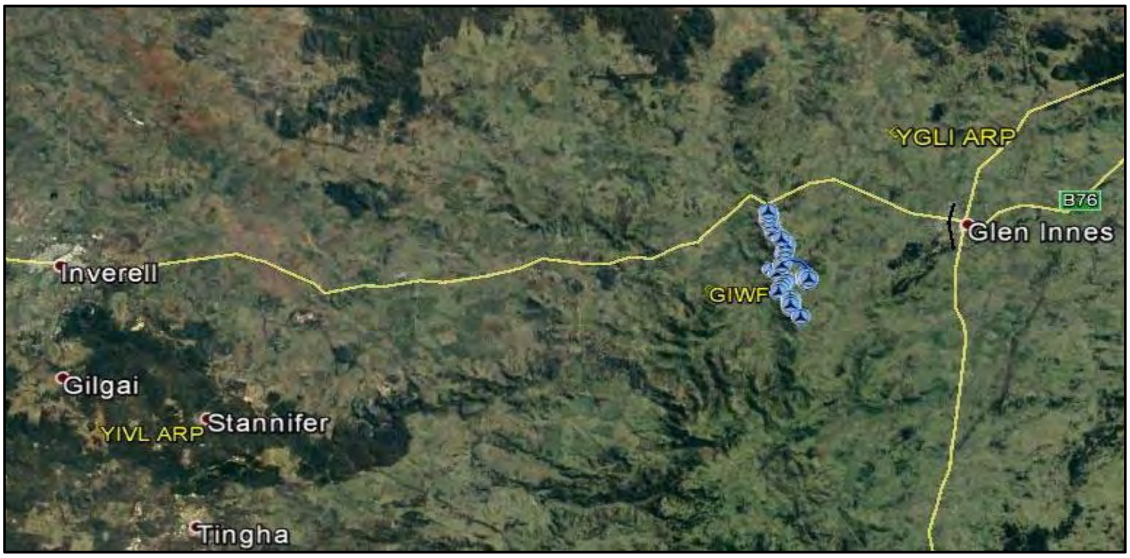


Figure 2.1 General Location of the Proposed GIWF

Planning approval has been received for the GIWF to install and operate a total of 25 turbines with a turbine tip maximum height of 150 m AGL. The current proposal (GIWF MOD – 4) proposes the same number of turbines and essentially same turbine layout, but with a turbine tip height of 180 m AGL.

3. Analysis of submissions

In response to the public exhibition of the GIWF proposal, a number of public objections were raised and submitted to the NSW Department of Planning and Environment. Examination of these submissions reveal that three (3) related specifically to "aviation" related issues. These objections and comments are summarised in Table 3.1 below.

Submission No.	Name	Comment/Objection
222235	Colin James, Matheson	The visual pollution will be far greater blight on the landscape, will aviation lighting be required more detrimental visual impact.
220598, 220673, 220675	Gardiner	"Prior to the commencement of construction, the Proponent shall consult with the Civil Aviation Safety Authority on the need for aviation hazard lighting in relation to the wind turbines." Why would you require this wording when construction had commenced 6 months previously?
222197	Daniel McAlary	The development will adversely affect farming operations on nearby properties, including:- (a) creation of visual and physical barriers hindering aerial agriculture, in wet times air seeding of fertilisers seeds, etc. cannot be done by wheeled vehicles because they can sink in sodden soils.

Table 3.1 Summary of "aviation" related submissions

4. Actions taken

Following consideration of the AIS and the ARA, CASA and AsA have endorsed the findings of those study recommendations. Additionally, AsA addressed the required airspace changes and had arranged for the necessary changes to be implemented by AsA and The Airports Group with effect from 24 May 2018 (Appendix D). However, AsA subsequently advised that as the GIWF project MOD – 4 was not approved, implementation will be deferred pending State government approval (Appendix E).

Discussions were held with GIRA on several occasions to consider the outcomes of the AIS and ARA, outcomes and findings involving recommended airspace changes and aviation hazard lighting that accord with GIRA requirements.

Insofar as the public objections raised in Table 4 above and addressed in Sections 5 and 6 below, it is recommended that:

1. The obstacle lighting used should be of a type that has minimal downward lighting component and meets the requirements of CASA and Department of Defence;
2. The wind farm developer meets the requirements of CASA, AsA and Defence in terms of formal notification regarding "Tall Structures";
3. The location of the wind farm be included on relevant aeronautical charts; and
4. Education of local aerial agricultural operators be undertaken by CASA, the Aerial Agricultural Association of Australia (AAAA), and Recreational Aviation Australia (RAA) regarding hazards associated with flying operations in the vicinity of wind farms.

5. Changes to the project

As indicated above, GIWF – MOD 4 involves an increased turbine tip height to 180 m AGL. The recommended changes to aviation related aspects involve airspace changes have been accepted and endorsed by AsA and will be implemented by AsA and The Airports Group. The wind farm developer should also meet the requirements of CASA, AsA and Department of Defence in terms of notification of "Tall Structures" and the type and characteristics of hazard lighting to be installed.

6. Responses to public submissions

As indicated above, a total of three (3) aviation related public comments/objections were received in response to the public exhibition of the GIWF project. Analysis of the aviation related comments/objections indicates the following issues:

1. Impact on Visual Amenity created by the hazard lighting. Suitable hazard lighting can be obtained to minimise the impact to Visual Amenity.
2. Consultation with CASA. CASA is the Australian aviation safety regulator and should be informed where there is a possible impact to the safety of aircraft and airport operations.
3. Aerial agricultural operations. Aerial agricultural is undertaken in the vicinity of wind farms (and other obstacles) throughout the world. Appropriate risk management and pre-flight planning is required.

Detailed responses to these public comments/objections are included at Appendix G.

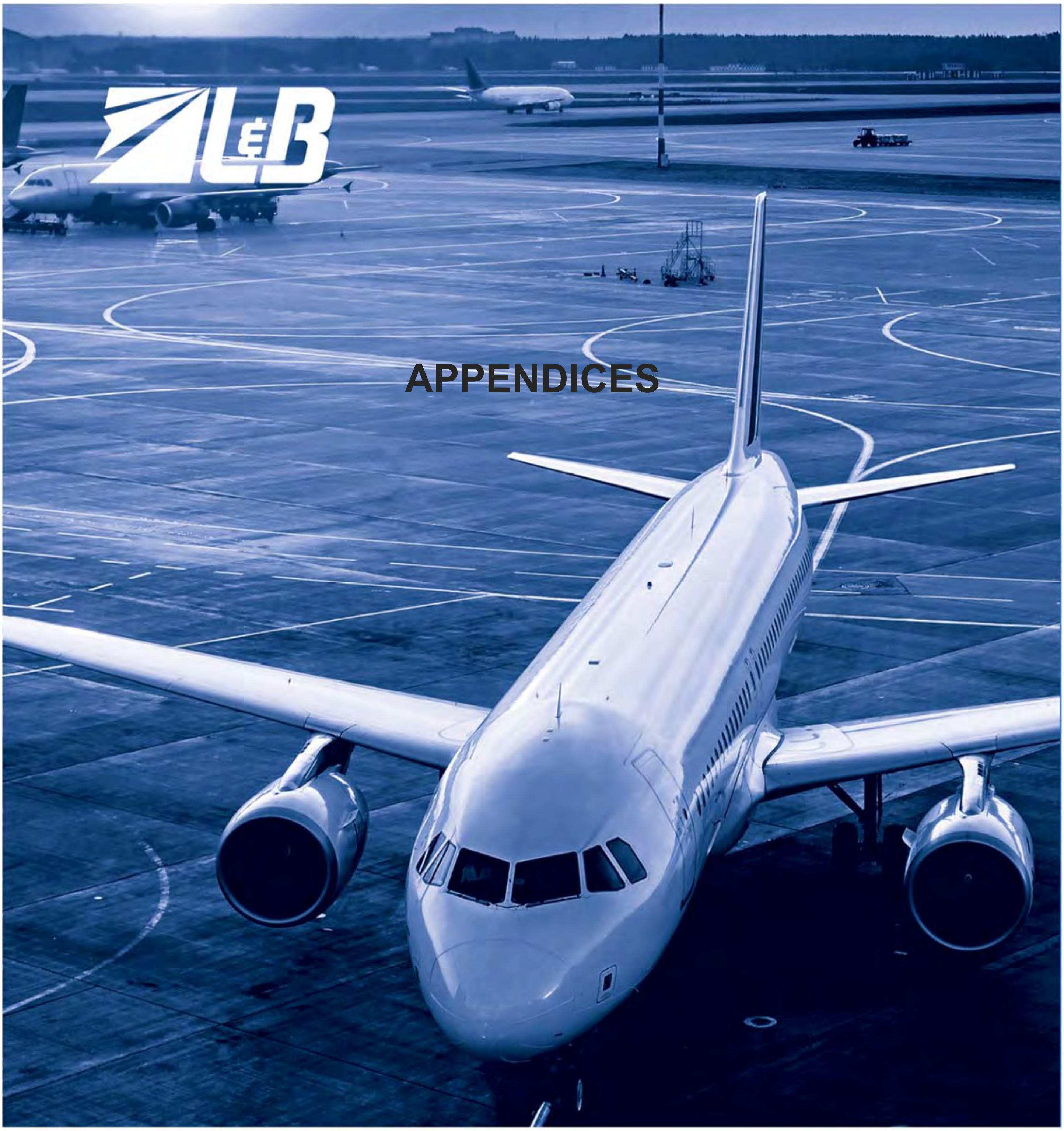
7. Project evaluation

From an aviation related aspect, evaluation of the impact to aviation operations has been undertaken in accordance with the requirements of CASA, AsA and Defence and are represented in the AIS and ARA studies and findings. No further evaluation of the AIS and ARA is considered necessary. The recommendations of those studies have been accepted by CASA, AsA, Department of Defence and Glen Innes Severn Council. AsA will arrange for the required airspace amendments to be implemented when approval of GIWF MOD – 4 has been notified. The recommendations also address the requirements of GIRA.

However, as indicated above, the Visual Amenity issue of aviation hazard lighting and the provision and control of the aviation hazard lighting for the GIWF may require further consideration as indicated in Appendix H.

8. References

1. CASA Manual of Standards Part 139, Aerodromes. Particularly Sections 8.10 "Obstacle Marking" and Section 9.4 "Obstacle Lighting";
2. AsA Document of 19 August 2014 "Airservices Aviation Assessments for Wind Farm Developments";
3. NASF Guideline D "Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers"
4. CASA AC 139.08 "Reporting of Tall Structures"
5. AAAA Windfarm Policy March 2011



APPENDICES

APPENDIX A

Glen Innes Wind Farm

Aviation Impact Statement

Summarised Results

APPENDIX A

Glen Innes Wind Farm – Aviation Impact Statement

The following is an extract of the Final Report of the Aviation Impact Statement as issued to Environmental Property Services on 16 June 2017.

SUMMARISED RESULTS

The Aviation Impact Statement shows that the Glen Innes Wind Farm development will NOT impact upon the following:

- The OLS published for any registered or certified aerodrome;
- The operation of any Navigation Aids and Communication facilities; and
- The operation of any Airspace Surveillance facility.

However the GIWF WILL impact upon the following:

- The 25 nm Minimum Sector Altitude (MSA) for Glen Innes Aerodrome.

Requests to increase the Glen Innes 25 nm MSA from 5500 ft to 5600 ft will need to be considered by Airservices Australia (AsA) and the Civil Aviation Safety Authority (CASA) for approval.

As the 10 nm MSA is 6100 ft, and the altitude at the Initial Approach Fixes (IAF) and holding for the RNAV approaches is 6200 ft, aircraft would be required to be no lower than 6100 ft within 10 nm of the ARP or 6200 ft for the IAF for RNAV approaches. It is considered that the increase in the 25 nm MSA to 5600 ft will have minimal impact on flight operations.

APPENDIX B

Glen Innes Wind Farm

Aviation Risk Assessment

Executive Summary

APPENDIX B

Glen Innes Wind Farm – Qualitative Risk Assessment and Obstacle Lighting Review

The following is an extract of Final Report of the Aviation Risk Assessment as issued to Environmental Property Services on 11 September 2017.

Executive Summary

Glen Innes Wind Farm have commissioned Ambidji to undertake an aviation risk assessment of the potential impact to aviation of the proposed changes to increase the Glen Innes Wind Farm (GIWF) wind turbine tip heights from 150m to 180m Above Ground Level (AGL).

An updated Aviation Impact Statement (AIS) completed in June 2017 found that the GIWF development will not impact the use or operation of:

- Published Obstacle Limitation Surface (OLS);
- Navigation Aids,
- Communication facilities, and
- Airspace Surveillance

The GIWF development will however require the 25 nm Minimum Sector Altitude (MSA) for Glen Innes Aerodrome to be increased by 100ft (from 5500ft to 5600ft) which is considered to have minimal impact on flight operations.

This aviation risk assessment considers the proposed changes to the GIWF in terms of potential risk to aircraft, airport operations and airspace in the vicinity of the proposed wind farm development arising from:

- the intention to increase turbine heights from 150m to 180 m AGL (i.e. increased obstacle height);
- any resultant changes to flight procedures and prescribed airspace in the vicinity of the wind farm; and
- any additional risks or considerations which are apparent since the original aviation risk assessment was undertaken.

For VFR flights, no existing highly trafficked routes transit through the wind farm location and sufficient vertical and lateral separation can easily be achieved within the existing surrounding navigable airspace. For operations compliant with Visual or Instrument Flight Rules (VFR/IFR), the proposed increased height in the turbines has been shown to offer no increase in risk to aviation.

Three threats have been identified and assessed which could lead to a loss of separation event occurring in the vicinity of the wind farm:

- Authorised Low Level Operations;
- VFR flights into Instrument Meteorological Conditions (IMC) conditions; and
- IFR navigational error in IMC.

It is demonstrated that only in the event of Authorised Low Level flights (e.g. aerial application or emergency response) or flights operating outside prescribed rules and conditions (accident / incident conditions) that the increased height of the wind farm turbines offer any potential additional risk to aviation. It is these flights that are the subject of this risk assessment.

Because the outcomes of these events all relate to "severe" outcomes (1 or 2 fatalities), the risk scores cannot be reduced below a Medium on the Civil Aviation Safety Authority (CASA) risk matrix. The inherent risks of aviation activity in the area associated with a loss of separation leading to a collision with terrain (CFIT into the ground) are all assessed as High on the CASA matrix.

Collisions with a turbine or a Loss of Control (LOC) (e.g. due to encountering turbine wake or manoeuvring to avoid a turbine) are also assessed to present a Medium or High risk and therefore do not increase the inherent risk profile for flights in the area. It is therefore concluded that the increased turbine heights do not increase the risk to aviation.

When considering the need for Obstacle Lighting, the accumulative effects of the neighbouring wind farms in close proximity (and the decision to light these) has been taken into account. Assessment of a "non-standard application of aviation obstacle lighting" to these wind farms for night VFR flights concludes that there is potential for confusion if some of the wind turbines (clusters) are lit and others aren't – i.e. a "false negative". It is recommended that the same obstacle lighting regime plan be adopted, (i.e. lighting intensity, type, spacing) to ensure against the "false negative" issue identified in this report.

Other recommendations to further reduce the potential for loss of separation events to occur in the vicinity of the wind farm include:

- Reinforcement with local pilots through consultation with the local flying schools, clubs and companies operating in the area;
- Pilot Education through CASA and RAA regarding the hazards associated with flights in the vicinity of windfarms;
- Pilot Education through CASA and RAA regarding the commonly misunderstood aspect of the aviation regulations with respect to navigable airspace for in VFR flights – i.e. that day VFR flights MUST be conducted with a minimum vertical separation of 500 ft above the ground **and any object on it**; and
- Clearer designation of wind farms on the navigation charts to aid pilot comprehension where multiple wind farms exist.

APPENDIX C

Civil Aviation Safety Authority

Letter of 23 August 2017

to

NSW Department of Planning and Environment

Australian Government
Civil Aviation Safety Authority

STAKEHOLDER ENGAGEMENT GROUP

CASA Ref: GI17/652

23 August 2017

Mr Tim Stuckey
Planning Officer
Resource and Energy Assessments
Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

Email: Tim.Stuckey@planning.nsw.gov.au

Dear Mr Stuckey

I refer to your email of 7 August 2017 requesting comments from the Civil Aviation Safety Authority (CASA) on the proposed modifications to the Glen Innes Wind Farm.

I am advised that the wind farm proposal is outside the obstacle limitation surface for Glen Innes Aerodrome by definition, but is still very closely located to the aerodrome.

The aerodrome itself is experiencing growth with an increase in training operations forecast (highlighted in the risk assessment provided by the proponent). Major development works (funding provided at State and Federal level) are in the planning stages to cater for the expected introduction of a commercial flying college. Runway 10/28 is to be sealed, a parallel taxiway to be constructed and a new hardstand for 40 aircraft is being built. These improvements will see an increase in the number of low experience pilots flying to and from Glen Innes Aerodrome in most weather conditions and at night.

At 180m high Above Ground Level, the proposed turbines and taller blades will infringe the navigable airspace (150m height limit) in close proximity to Glen Innes Aerodrome and will require an increase in minimum sector altitudes (MSA) for Glen Innes Aerodrome.

Airservices Australia advise that turbine WTG07 will affect the RNAV (GNSS) RWY14 instrument procedure at Glen Innes Aerodrome. In addition, turbines WTG07, WTG08 WTG09 and WTG12B will affect the 25nm MSA NE sector at Glen Innes Aerodrome.

The report only refers to Airservices Australia as the procedure design organisation responsible for the published instrument approach procedures, however, The Airport Group is responsible for maintenance of the RWY 32 RNAV approach. It is therefore strongly recommended that both procedure design organisations are consulted for possible impact. To check which organisations are responsible you can view the procedures at http://www.airservicesaustralia.com/aip/aip.asp then 'Departure and Approach Procedures'. The logo on the bottom of each procedure plate indicates the design organisation responsible. The operator of Glen Innes Aerodrome should also be consulted prior to any changes being made to the Aerodrome's Instrument Flight Procedures.

GPO Box 2005 Canberra ACT 2601 Telephone 131 757

2

The report does not discuss any impact on the circling area of the approach procedures. Aerodrome weather is available through an Aerodrome Weather Information Service by phone. If actual aerodrome QNH is used by a pilot, the minimum descent altitude (MDA) may be reduced by 100'. This has not been taken into account in the report. For example, Table 7.1, using an MDA of 4040' for RWY14 RNAV shows that the aircraft height above the turbine #7 is clear by 107'. With an MDA of 3940' using actual QNH, this clearance is minimal.

It is not known what atmospheric assumptions have been used in the report or in the design of the published procedures by Airservices Australia and The Airport Group. This affects, among other things, the turn radius and climb speeds used in the designs. The results provided in Table 7.1 may not correlate with actual design calculations.

CASA recommends that the wind farm should be provided with steady red medium intensity aviation hazard lighting which complies with Section 9.4 of the Civil Aviation Safety Authority Manual of Standards Part 139 – 'Aerodromes', and spaced in accordance with the National Airports Safeguarding Framework (NASF) Guidelines. Further information on the NASF guidelines is available from the following link:
https://infrastructure.gov.au/aviation/environmental/airport_safeguarding/nasf/

Should such lighting be considered a negative impact on visual amenity and result in resident objection, CASA would recommend that an Aircraft Detection Lighting System (as recommended in the United States Federal Aviation Administration Advisory Circular AC 70/7460-1L CHG1 – 'Obstruction Marking and Lighting'), be installed. Such a system would only activate the lights when an aircraft is detected in the near vicinity and deactivate the lighting once the aircraft has passed. This would be a reasonable and feasible alternative to having lights activated from dusk to dawn and in low light levels during the day and would ensure aviation hazard lighting is implemented in a manner that minimises visual intrusion to surrounding residences.

I trust this information is of assistance.

Yours sincerely

Carolyn Hutton
Manager
Government and International Relations Branch

GPO Box 2005 Canberra ACT 2601 Telephone 131 757

APPENDIX D

Airservices Australia

Email Advice of 4 September 2017
to
NSW Department of Planning and Environment

Tim Stuckey

From: Airport Developments <Airport.Developments@AirservicesAustralia.com>
Sent: Monday, 4 September 2017 9:18 AM
To: Tim Stuckey
Cc: 'airspace.protection@casa.gov.au'; 'neil.hansford@bigpond.com'
Subject: UPDATED AIRSERVICES RESPONSE: NSW-WF-063 - Glen Innes Wind Farm [SEC=UNCLASSIFIED]

Good morning Tim,

Due to upcoming flight validation activity by Airservices, steps are being taken to amend procedures at Glenn Innes Airport that will result in the Glenn Innes Wind Farm not impacting Glenn Innes Airport. These changes will become effective in the Departure and Approach Procedures (DAP) issued on 24 May 2018. After this date the proposed Glenn Innes Wind Farm will have no impact on procedure at Glenn Innes Airport.

Note that Airservices has co-ordinated this change process with *The Airport Group* and their procedures at Glenn Innes Airport, and it is our understanding that they have already provided advice to Glenn Innes Airport that their procedures will be unaffected.

Therefore, based on the above amendments proceeding, below is our revised assessment advice:

I refer to your request for an Airservices assessment of the Glen Innes Wind Farm.

Airspace Procedures
With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1414m (4640ft) AHD, the Glenn Innes Wind Farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Glen Innes or Inverell Airports.

Note that procedures not designed by Airservices at Glen Innes and Inverell Airports were not considered in this assessment.

Communications/Navigation/Surveillance (CNS) Facilities
The Glenn Innes Wind Farm will not adversely impact the performance of Precision/Non-Precision Nav Aids, HF/VHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links - unchanged.

Regards,

Tony Aiezza
Operational Standards and Assurance
Airservices

Tower Road, Melbourne Airport
Tullamarine VIC 3043
t 03 9339 2272 | m 0409 143 120

From: Airport Developments
Sent: Friday, 18 August 2017 2:31 PM
To: 'Tim Stuckey' <Tim.Stuckey@planning.nsw.gov.au>
Cc: airspace.protection@casa.gov.au; 'neil.hansford@bigpond.com' <neil.hansford@bigpond.com>
Subject: AIRSERVICES RESPONSE: NSW-WF-063 - Glen Innes Wind Farm [SEC=UNCLASSIFIED]

Hi Tim,

APPENDIX E

Airservices Australia

Email Advice of 15 September 2017
to
Landrum & Brown

Barrie Slingo

From: Airport Developments <Airport.Developments@AirservicesAustralia.com>
Sent: Friday, 15 September 2017 10:41 AM
To: Barrie Slingo
Subject: NSW-WF-063 - Glen Innes Wind Farm [SEC=UNCLASSIFIED]

Good morning Barrie,

At this stage this wind farm is still a proposal and as far as we are aware, state planning approval for construction is not yet granted. Therefore, Airservices is not required to implement any changes yet. In addition, as this change will require co-ordination with another Part 173 Provider, changes in DAP is considered the most appropriate method, rather than NOTAM.

Regards,

Tony Aiezza
Operational Standards and Assurance
Airservices
Tower Road, Melbourne Airport
Tullamarine VIC 3043
t 03 9339 2272 | m 0409 143 120

From: Barrie Slingo [mailto:BSlingo@landrum-brown.com]
Sent: Monday, 11 September 2017 3:49 PM
To: Airport Developments <Airport.Developments@AirservicesAustralia.com>
Subject: Glen Innes Wind Farm

Hi Tony

We have received from the Glen Innes Wind Farm developer (Nexif Energy Pty Ltd) a copy of Airservices advice to the NSW Department of Planning and note the Date of Effect of 24 May 2018 for promulgation of the recommended airspace changes. The wind farm developer has now advised that the tentative programme for installation of the wind turbines could result in being ready for the erection of wind turbines prior to this date, particularly if favourable weather conditions prevail. Consequently, they have queried whether:

a. The date of effect could be advanced at all? (Note: The DAP promulgation interval period is recognised); and
b. If not, could a NOTAM be raised to cover the interim period?

Your advice would be appreciated. I am happy to discuss if you require further information.

Kind regards

Barrie Slingo
Senior Managing Consultant
Landrum & Brown
Global Aviation Planning & Development
Level 5, 114 Flinders Street
Melbourne Victoria 3000 Australia
T +613 9639 7744 M+ 61 427 004 388
F +613 9663 0194
landrum-brown.com

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APPENDIX F

Glen Innes Severn Council

Letter of 21 August 2017

to

NSW Department of Planning and Environment

EMBRACING CHANGE, BUILDING ON HISTORY

GLEN INNES SEVERN COUNCIL

21 August 2017

Mr Tim Stuckey
Planning Officer
Resource and Energy Assessments - Planning Services
Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

Dear Tim

RE: MODIFICATION OF GLEN INNES WIND FARM PROJECT (MP 07_0036)

I refer the application to further modify the Glen Innes Wind Farm Project (MP 07_0036), located 12 km west of Glen Innes in the Glen Innes Severn Local Government Area. Council notes the proposed modification, submitted by Glen Innes Windpower Pty Ltd involving:

- Increasing turbine blade length to 68.5 m and overall rotor tip height 180 m;
- Micro-siting of turbines and ancillary infrastructure; and
- Increasing the width of access tracks.

Council wishes to make the following submission regarding the proposed amendments to Glen Innes Wind Farm Project (MP 07_0036):

1. The proposed increase in the turbines will impact on the Glen Innes Regional Airport in that:

    a. The proposed heights may affect the instrument approaches to Glen Innes Airport principally used by the NSW Ambulance Service contractor, Royal Flying Doctor Service and a proposed 600 student flying academy approved by Council.
    b. Wind turbines WTG07 turbine **will affect** the RNAV (GNSS) RWY 14 instrument procedure at Glen Innes Airport therefore impacting on approaches to runway 14.
    c. The heights of wind turbines WTG07, WTG08, WTG09 and WTG12B **will affect** the 25nm MSA NE Sector at Glen Innes Regional Airport therefore impacting on navigation requirements.
    d. Obstacle collision lighting should be provided to the proposed wind farm so as to ensure itinerant recreational pilots, whom are not licensed to fly at night and are most likely to continue on to try to get to the airport in deteriorating visibility and marginal daylight operations, are adequately protected. The concern also in this respect is that in the event of a collision it would have a detrimental reputational impact on the Glen Inness Airport and proposed flight academy.

2. No details of how waste will be dealt with from the development. In this regard a Waste Management Plan should be prepared prior to construction commencing. Council is concerned regarding the amount of waste being generated from the

Kindly address all correspondence to: The General Manager PO Box 61 Glen Innes NSW 2370
Town Hall Office - 265 Grey St Glen Innes NSW 2370
Phone: (02) 6730 2300 Fax: (02) 6732 3764
Email: council@gisc.nsw.gov.au
Website: www.gisc.nsw.gov.au
ABN: 81 365 002 718

wind farms and the general lack of effort to sort and recycling waste therefore having a significant impact on the Glen Innes Landfill capacity and life span.

3. A road opening permit will be required under the provisions of section 138 of the *Roads Act 1993* for the proposed access road to the Wind Farm.

4. In view of the increase in size it is recommended that the Proponent prepare a Noise Compliance Report which assesses the performance of the project against the operational noise criteria as specified in the environmental assessment.

5. In the event that the Noise Compliance Plan indicates that noise from the wind turbines exceeds the noise limits specified under the environmental assessment, as relevant, the Proponent shall investigate and propose mitigation and management measures to achieve compliance with the noise limits.

For any further information please do not hesitate to contact Council's Director of Development, Planning & Regulatory Services on 6730 2365.

Yours sincerely

Graham Price
DIRECTOR OF DEVELOPMENT, PLANNING & REGULATORY SERVICES

APPENDIX G

Glen Innes Regional Airport

Email advice of 22 September 2017

to

NSW Department of Planning and Environment

Tim Stuckey

From: Neil Hansford <neil.hansford@bigpond.com>
Sent: Friday, 22 September 2017 10:48 AM
To: Tim Stuckey
Cc: 'Graham Price'; 'Peter Sniekers'; 'Peter Sullivan'
Subject: Airspace Report Glen Innes Wind Farms
Attachments: Glen Innes Windfarm Airspace Assessment.doc

Please find Report on Airspace prepared by Aviation Technical Specialist Aerosafe Inspections Issue 1: dated 22nd September 2017.
This report highlights substantial safety hazards which need to be considered under NSW Planning duty of care.
We are happy for this data to be released to the proponents and to the concerned public.
We advise that only White Rocks developers have ever sought to negotiate safe outcomes with Glen Innes Regional Airport Pty Ltd despite us advising their mutual consultants Ambidji of our concerns.
Our understanding of the NSW legislation is that the proponent must consult with affected parties which hasn't happened.

GLEN INNES REGIONAL AIRPORT
Neil Hansford
Director
Glen Innes Regional Airport Py Ltd
Emmaville Road
Glen Innes NSW 2370
Phone: 0249191626
Fax: 0240275063
Mobile: 0422868237

APPENDIX H

Responses to Aviation Related Public Submissions

APPENDIX G

Responses to aviation related public submissions

Submission No.	Name	Comment/Objections	Response
222235	Colin James, Matheson	The visual pollution will be far greater blight on the landscape, will aviation lighting be required more detrimental visual impact.	This is a "Visual Amenity" issue. Hazard lighting can be used that minimises the intensity of the light below the horizontal; i.e. the light beam is focussed upwards. Should the Visual Amenity aspects have negative impact, CASA has recommended installation of an Aircraft Detection Lighting System (ADLS). Due to other wind farms in the proximity of Glen Innes Regional Airport and in terms of consistency, it is recommended that ADLS be installed on the other wind farms and all ADLS are synchronised to switch on and off simultaneously. It will also be necessary to consider the distance from the wind farms at which the aircraft activates the ADSL.
220598, 220673, 220675	Gardiner	"Prior to the commencement of construction, the Proponent shall consult with the Civil Aviation Safety Authority on the need for aviation hazard lighting in relation to the wind turbines." Why would you require this wording when construction had commenced 6 months previously?	The Civil Aviation Safety Authority (CASA) is the Australian aviation safety regulator. This is a standard requirement for all wind farms with turbine heights in excess of 150 m AGL. Notification to CASA, AsA and Defence is also required for any structure exceeding 30 m AGL if within 30 km of an airport or 45 m AGL elsewhere.
222197	Daniel McAlary	The development will adversely affect farming operations on nearby properties, including:- (a) creation of visual and physical barriers hindering aerial agriculture, in wet times air seeding of fertilisers seeds, etc. cannot be done by wheeled vehicles because they can sink in sodden soils.	Aerial agriculture is undertaken in the vicinity of wind farms throughout the world. Appropriate planning must be undertaken, including liaison with the wind farm operator. Aerial agricultural operations planning includes pre-flight risk assessments allowing for consideration of the locations and heights of all obstacles, including wind farm turbines and met. masts. Similar pre-flight risk planning is also undertaken by emergency services operators when deploying aerial operations in the vicinity of any obstacle. Recommend that CASA, AAAA and RAA provide education of local operators on the hazards associated with flying in the vicinity of wind farms.

Appendix C

Aviation Impact Assessment

FINAL REPORT

AVIATION IMPACT STATEMENT

GLEN INNES WIND FARM

LB 00100

Report to:

Environmental Property Services Pty Ltd

16 June 2017

The Ambidji Group

(A Division of Landrum & Brown)

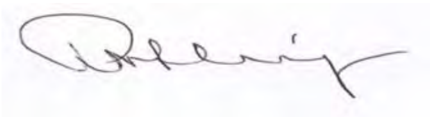
Level 5, 114 Flinders Street, Melbourne

VIC 3000, Australia

THE AMBIDJI GROUP

DOCUMENT RELEASE APPROVAL

Approved for Final Release: Final Report V2.0



Name: Barrie Slingo

Title: Senior Managing Consultant

Date: 16 June 2017

Distribution: Steve McCall
Environmental Property Services Pty Ltd

REV NO	DESCRIPTION	DATE	Prepared	QA
V0.1	Draft AIS	06 June 2017	BR	BWS
V1.0	Final AIS Report	16 June 2017	BWS	BR
V2.0	Revised AIS Final Report	16 June 2017	BR	BWS

TABLE OF CONTENTS

1. INTRODUCTION

Aviation Risk Assessments for the Glen Innes Wind Farm (GIWF) have been prepared by Aurecon in 2013 and 2014. However, since then several changes have occurred including an increase in the turbine tip height from 150 m AGL to 180 m AGL, withdrawal of the Glen Innes (GLI) Non Directional Beacon (NDB), NDB Approach and the GNSS Arrival procedure, and amendments to the air route structure and Lowest Safe Altitudes (LSALTs).

As a result of these changes, The Ambidji Group has been contracted by Environmental Property Services Pty Ltd (EPS) to prepare an updated Aviation Impact Statement (AIS) in accordance with the terms of the Airservices Australia (AsA) letter of 19th August 2014. A copy of this letter is shown at Appendix A.

The proposed GIWF will comprise 25 wind turbines with a tip height of 180 m AGL. The highest turbine tip is WTG19 at 1446 m AHD rounded up to 4745 ft AHD.

The main purposes of the AIS are to determine any infringements or impacts by the proposed Wind Farm:

- on the Obstacle Limitation Surfaces (OLS) and the Procedures for Air Navigation Services Operations (PANS-OPS) surfaces at any registered or certified aerodrome within 30nm of the wind farm boundary;
- on the Lowest Safe Altitudes (LSALT) for Air Routes in the vicinity; and
- on the performance of Navigation Aids and Airspace Surveillance Systems.

Details of Aerodromes, OLS, PANS-OPS procedures, Lowest Safe Altitudes, Navigation and Airspace Surveillance facilities were obtained from the Australian Information Publications (AIP), AsA sources and CASA publications.

2. SUMMARISED RESULTS

The AIS shows that the GIWF development will NOT impact upon the following:

- The OLS published for any registered or certified aerodrome;
- The operation of any Navigation Aids and Communication facilities; and
- The operation of any Airspace Surveillance facility.

However the GIWF WILL impact upon the following:

- The 25 nm Minimum Sector Altitude (MSA) for Glen Innes Aerodrome.

Requests to increase the Glen Innes 25 nm MSA from 5500 ft to 5600 ft will need to be considered by Airservices Australia (AsA) and the Civil Aviation Safety Authority (CASA) for approval.

As the 10 nm MSA is 6100 ft, and the altitude at the Initial Approach Fixes (IAF) and holding for the RNAV approaches is 6200 ft, aircraft would be required to be no lower than 6100 ft within 10 nm of the ARP or 6200 ft for the IAF for RNAV approaches. It is considered that the increase in the 25 nm MSA to 5600 ft will have minimal impact on flight operations.

3. WIND FARM LOCATION

GIWF is located on the Waterloo Range about 12 kilometres to the west of Glenn Innes as shown in Figure 3.1. The project area spans approximately 8.5 kilometres from north to south and about 3 kilometres from east to west. The topography across the project site generally decreases in height from the south towards the north.

The Aerodrome Reference Points (ARP) for Glen Innes (YGLI) and Inverell (YIVL) are also shown in Figure 3.1.

Figure 3.1 General Location of the Proposed GIWF

4. OBSTACLES

A list of the proposed wind turbine locations and heights is shown in Appendix B.

Coordinates are in WGS 84, accurate to 0.1 second of arc and elevations Above Mean Sea Level (AMSL) are accurate to 0.3 metres.

The highest obstacle, turbine WTG 19 at 1446 m or 4745 ft AHD is shown in yellow shading (Appendix B.)

5. DRAWINGS

A basic drawing in a Google Earth image of the proposed wind turbine locations is shown in Figure 5.1 below. The highest turbine tip WTG 19 and height of 4745 ft are shown in yellow.

A detailed drawing showing final turbine locations in electronic format compatible with Microstation version 8i will be forwarded separately.

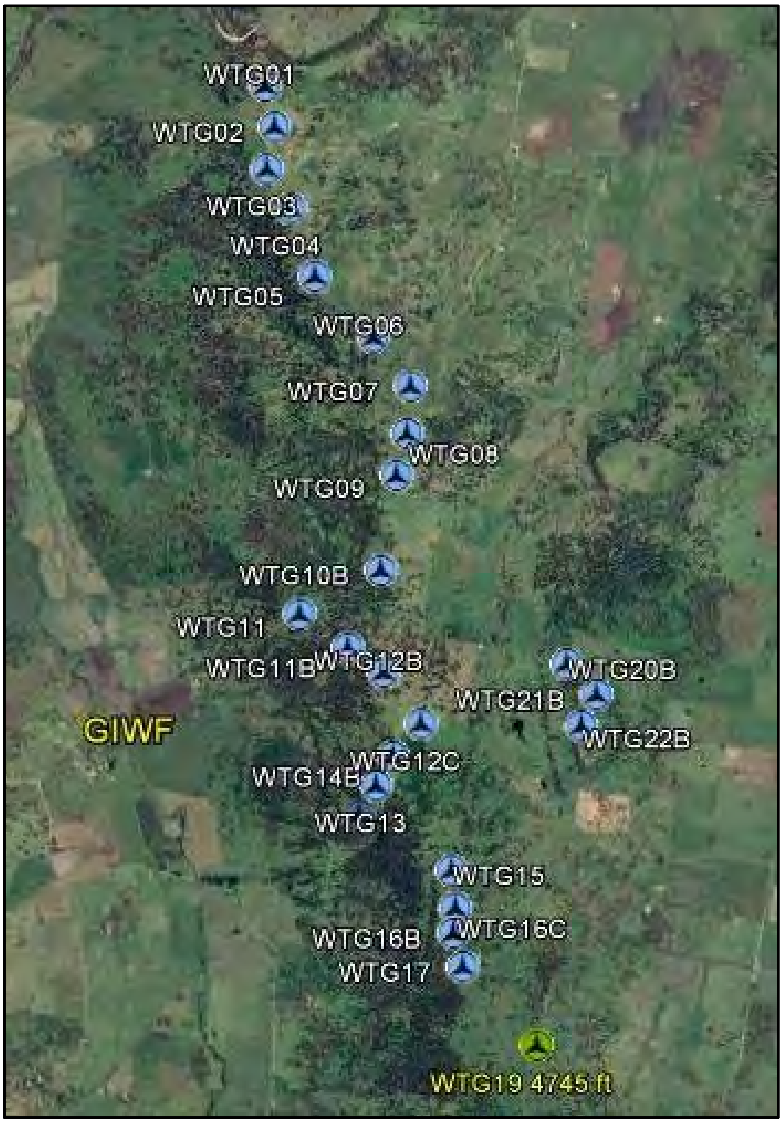


Figure 5.1 Layout of the GIWF showing Wind Turbine Locations

6. AERODROMES WITHIN 30 NAUTICAL MILES – OLS SURFACES

There are two registered or certified aerodromes within 30 nm of the nearest wind farm turbine:

- Glen Innes (YGLI) 5.67 nm (10.5 km) to the North East of the nearest turbine; and
- Inverell (YIVL) 25.15 nm (46.6 km) to the South West of the nearest turbine.

Figure 6.1 shows the locations of the nearest turbines and distances to the YGLI and YIVL Aerodrome Reference Points (ARPs).

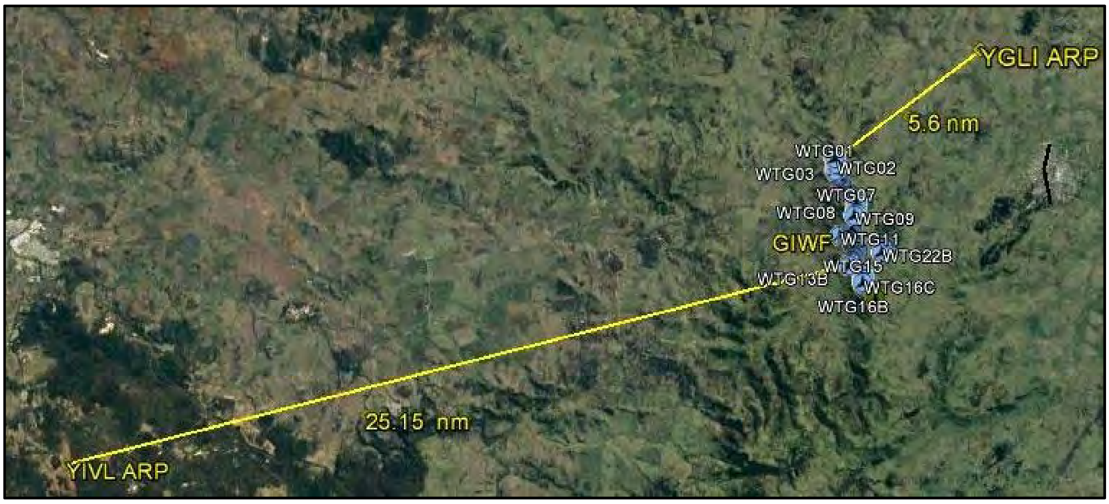


Figure 6.1 Glen Innes and Inverell ARPs in relation to the GIWF

6.1 Glen Innes OLS

OLS surfaces for Glen Innes aerodrome extend to 5.5 km from the runway thresholds. As the nearest runway threshold is 9.7 km from the nearest GLI turbine boundary, the wind farm is clear of the OLS.

6.2 Inverell OLS

OLS surfaces for Inverell aerodrome extend to 5.5 km from the runway thresholds. As this airfield is 46.5 km from the nearest GIWF turbine, the wind farm is clear of the OLS.

The OLS surfaces for Glen Innes and Inverell aerodromes will not be impacted by the GIWF.

7. PANS-OPS SURFACES

All altitudes in PANS-OPS procedures are in feet (ft) AHD, distances are in Nautical Miles (nm) and bearings are in degrees magnetic (M). The magnetic variation in the area is 11° east. Aircraft performance category (CAT) is published in the CASA MOS Part 173.

All PANS-OPS calculations in this report are made in accordance with ICAO doc 8168 PANS-OPS and CASA MOS Part 173.

7.1 Glen Innes

There are two instrument approach procedures published in the AIP DAP for Glen Innes. These are:

RWY 14 RNAV (GNSS); and

RWY 32 RNAV (GNSS).

The proposed GIWF has a possible impact on the RWY 14 RNAV procedure, and a copy of the procedure is shown in Figure 7.1. The approximate boundary of the GIWF is also shown.

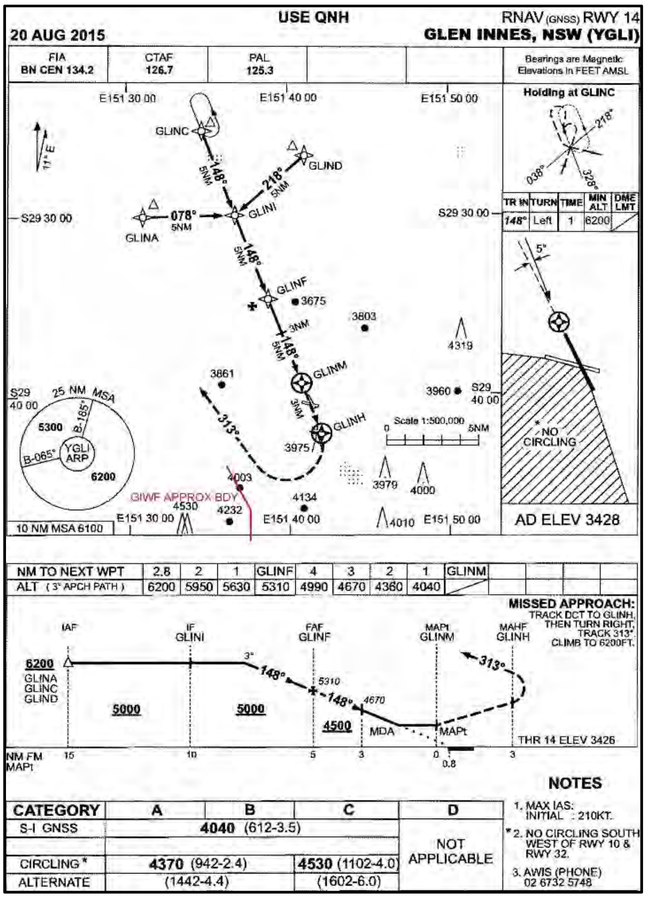


Figure 7.1 YGLI RWY 14 RNAV (GNSS) Approach Procedure

MINIMUM SECTOR ALTITUDE (MSA)

The MSA is shown in Figure 7.1 and is common to both RWY RNAV procedures. As can be seen in Figure 7.1, the 25 nm MSA divided into two sectors with the bearings of 065°(M) and 185° (M) to the ARP being the dividing lines.

To the north and west of the dividing line the MSA is 5500 ft AHD, and 6200 ft from the north east through to south west. Within 10 nm of the ARP the MSA is 6100 ft.

Whilst the GIWF is nominally within the 10 nm MSA of 6100 ft., 5 nm buffers need to be applied to the B-065°(M) line boundary and to the 25 nm sector boundary, which means that the 5500 ft MSA extends over part of the GIWF. This is shown in Figure 7.2.

As can be seen in Figure 7.2 many turbines are within the 5500 ft MSA, and the highest of these is WTG 9 at 4594 ft AHD (yellow text in the figure). When the Minimum Obstacle Clearance of 1000 ft is applied, the result is 5594 ft, which exceeds the 5500 ft MSA by 94 ft. This means that the sector MSA will need to be raised by the nearest 100 ft. to 5600 ft.

It will be recommended that AsA is requested to increase the 25 nm sector MSA to 5600 ft.

As the 10 nm MSA is 6100 ft, and the altitude at the Initial Approach Fixes (IAF) and holding for the RNAV approaches is 6200 ft, aircraft would be required to be no lower than 6100 ft within 10 nm of the ARP, or 6200 ft for RNAV approaches. It is considered that the increase in the 25 nm MSA to 5600 ft will have minimal impact on flight operations.

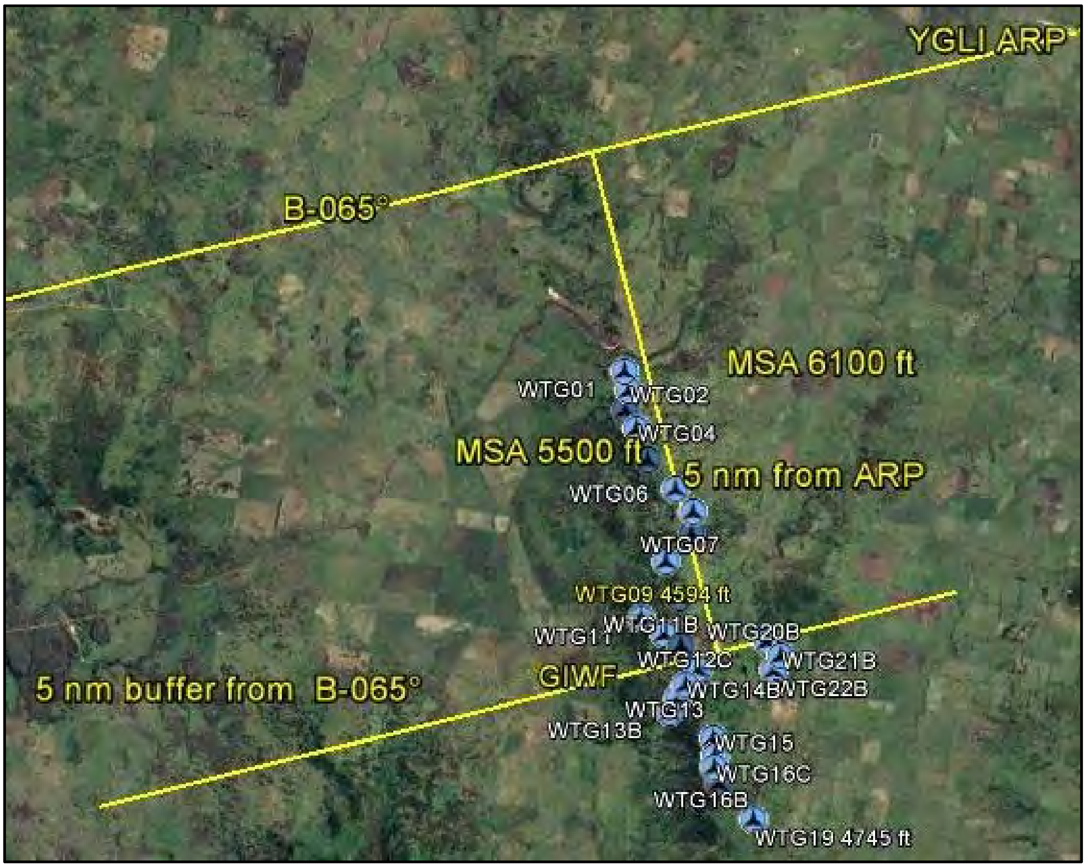


Figure 7.2 MSA BUFFER AREAS AND THE GIWF

INSTRUMENT APPROACH PROCEDURES

RNAV (GNSS) RWY 14 (see Figure 7.1)

Holding and Final Approach

These segments are well clear of the GIWF.

Missed Approach

(Note that all calculations for the missed approach area were made in accordance with ICAO Doc 8168 PANS-OPS Volume 2 Part 1 Section 4 Chapter 6.)

The missed approach commences at GLINM and tracks straight ahead to GLINH, then turns right to track 313º M.

CAT C aircraft conducting this manoeuvre will fly over the GIWF area as far west as 10.32 nm from GLINH (turn diameter 8.23 nm plus waypoint area width of 2 nm).

Figure 7.3 shows the navigation tolerances for the missed approach segment of the approach (in red), the start of climb (SOC) point, and the shortest distances to significant turbines (01, 07, 21B and 19) from GLINH.

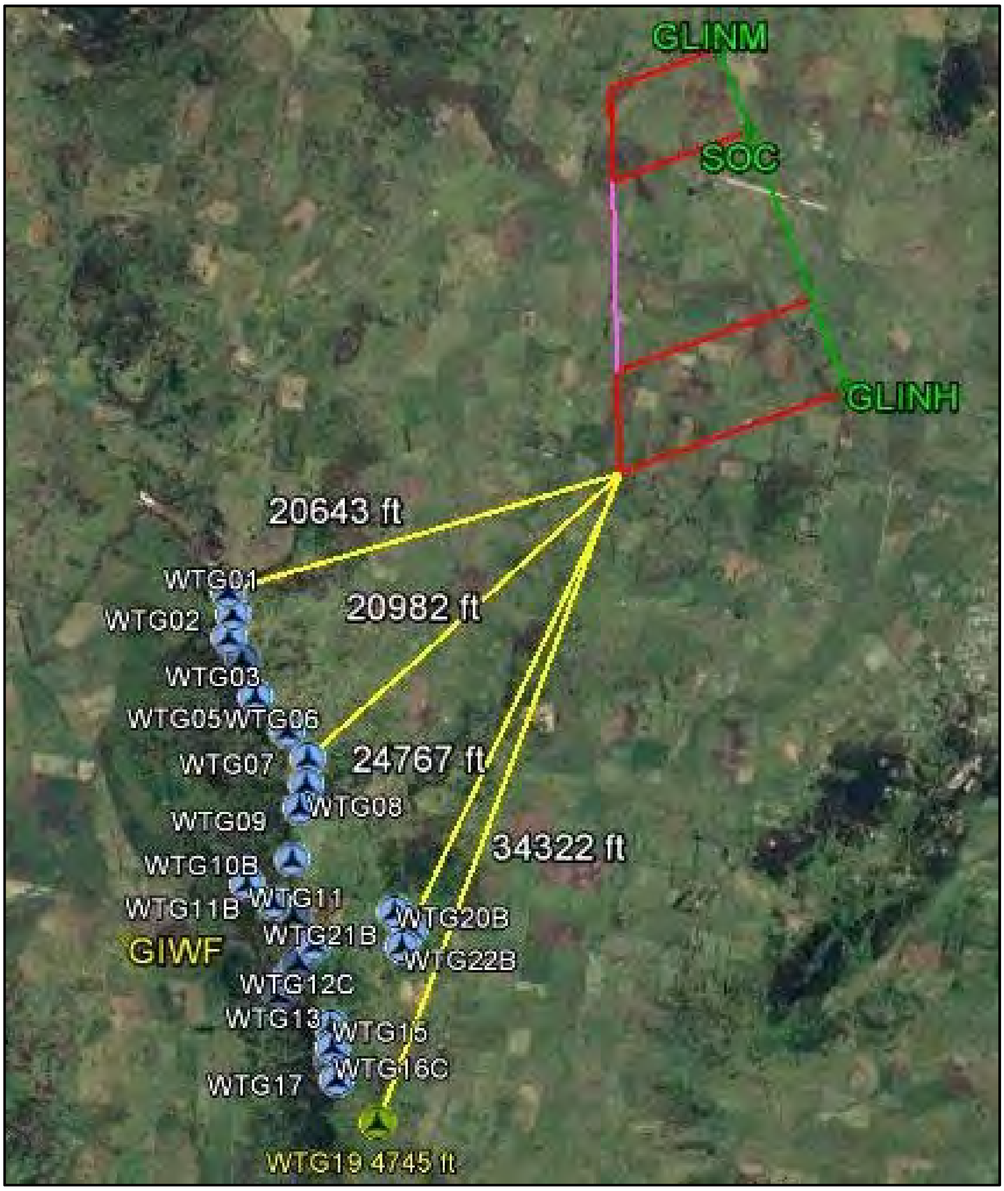


Figure 7.3 RWY 14 RNAV (GNSS) MISSED APPROACH and the GIWF

Table 7.1 below shows the calculations of the aircraft altitude over the turbines minus the MOC of 164 ft which is the PANS-OPS surface at the turbine location. The turbine heights are all below the PANS-OPS surface as shown by negative values in the last column.

Turbine	Turbine AHD ft	Dist from GLINH ft	ACFT Height Gain from GLINH	ACFT Height Gain from SOC to GLINH	MAPt MDA ft	Height AHD at Turbine	164 ft MOC	Penetration?
1	4469	20346	509	346	4040	4895	4731	-262
7	4640	20982	525	346	4040	4911	4747	-107
21B	4636	24767	619	346	4040	5005	4841	-205
19	4745	34322	858	346	4040	5244	5080	-335

Table 7-1 RWY 14 RNAV Missed Approach Calculations

The RWY 14 RNAV (GNSS) approach is not impacted by the GIWF.

RNAV (GNSS) RWY 32

The applicable heights and navigation tolerances for this approach procedure are well clear of the GIWF.

7.2 Inverell

MINIMUM SECTOR ALTITUDE (MSA)

The MSA is 6200 ft within 25 nm of the IVL NDB in the sector over the GIWF (see Figure 7.4).

When the Minimum Obstacle Clearance of 1000 ft is applied to the highest tip AHD of 4745 ft, the result is 5745 ft which is below 25 nm MSA.

The MSA is not impacted by the GIWF.

GNSS ARRIVAL

A copy of this procedure extracted from the AIP DAP is shown in Figure 7.4. All of the GIWF turbines are located more than 25 nm from the IVL NDB which is beyond the start of the procedure.

The GIWF turbines are beyond the Inverell GNSS ARRIVAL PROCEDURE.

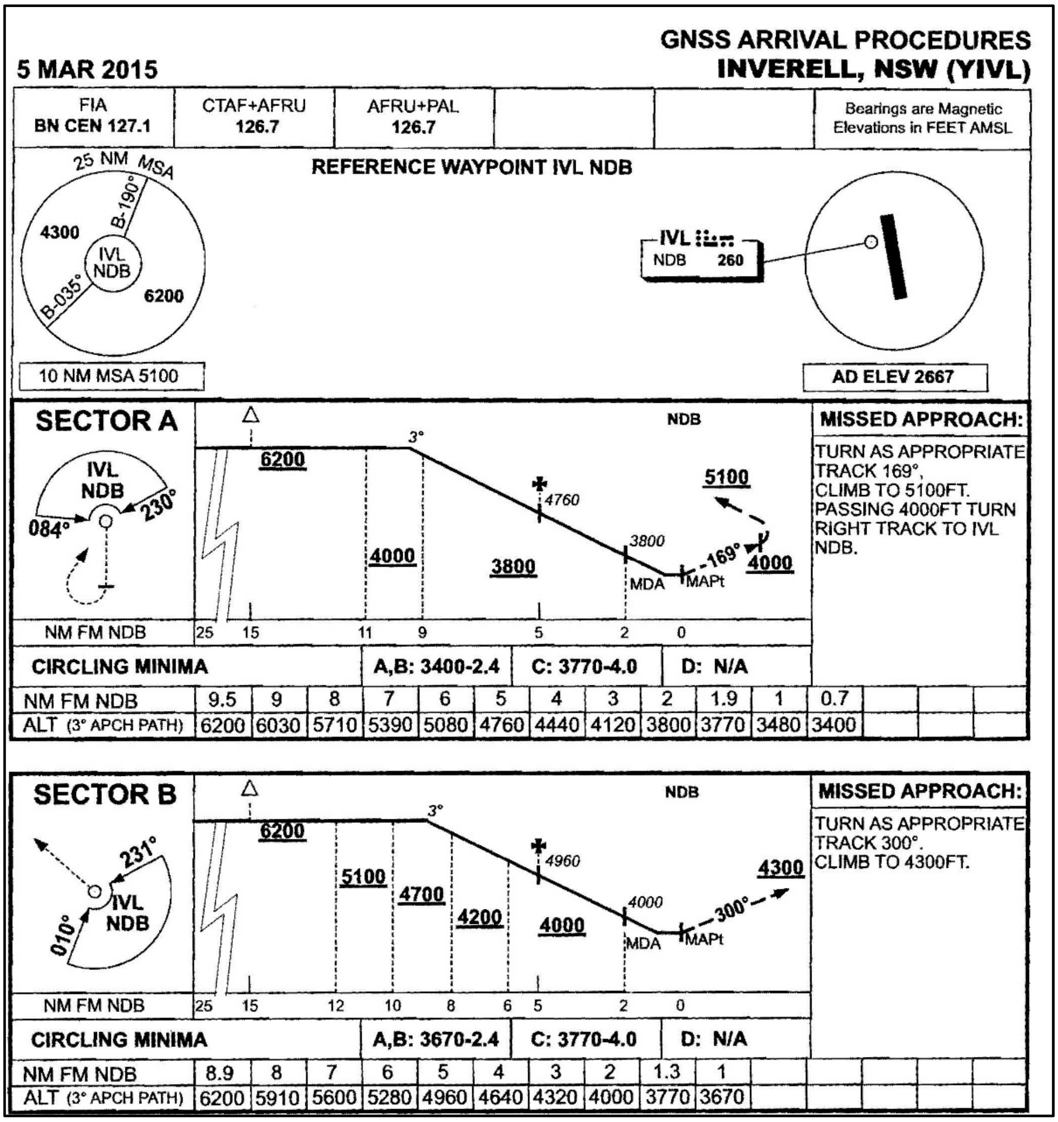


Figure 7.4 YIVL GNSS Arrival Procedure

RNAV (GNSS) RWY 34 and NDB RWY 16

The applicable navigation tolerances for these approach procedures are well clear of the GIWF.

8. AIR ROUTES AND LOWEST SAFE ALTITUDES (LSALTS)

Several published air routes are in the vicinity of the GIWF and are shown in Figure 8.1 below.

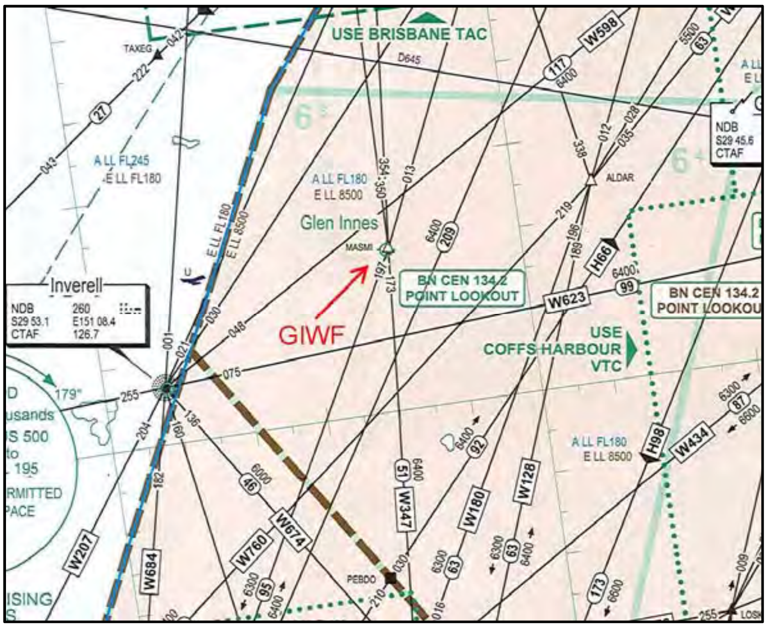


Figure 8.1 Air routes in the vicinity GIWF (approximate location)

The GRID LSALT and significant air routes and LSALTs are shown in Table 8.1.

Route	Section	LSALT ft
GRID		6300
W347	ARM-MASMI-OK	6400
W598	IVL-GAMBL	6400
W623	IVL-GFN	6400
W169	HUUGO-TW	6400
W267	IVL-VILLA	6400
W326	VONDO-MASMI-TW	6400/6300

Table 8.1 LSALTs

The highest turbine tip is 4745 ft, and when the MOC of 1000 ft is applied the result is 5745 ft, which is below the lowest LSALT of 6300 ft on W326 and the grid LSALT.

The GIWF will not impact the LSALTs of the nearby Air Routes.

9. AIRSPACE

The GIWF is situated in Class G airspace, beneath Class E airspace with a lower limit of 8500 ft. There are no Military Restricted airspaces in the vicinity.

10. NAVIGATION AIDS AND COMMUNICATION FACILITIES

NAVIGATION AIDS

CASR Part 139 Manual of Standards – Aerodromes, Chapter 11, sets out the general requirements for navigation aid sites and air traffic control (ATC) facilities, including the clearance planes for planned and existing facilities.

There is one Navigation Aid in the vicinity, the Inverell (IVL) NDB, located 46.7 km to the south west of the nearest wind turbine.

The restricted area applicable to an NDB is 150m (Part 139 MOS, paragraph 11.1.13.1 refers).

As the GIWF is well beyond the above restricted area, it will not impact on the performance of the IVL NDB.

COMMUNICATION FACILITIES

There are no AsA communication facilities located within 30 nm of the wind farm.

The GIWF will not impact on the performance of any communication facilities.

11. RADARS

The nearest AsA Radar installations are an SSR at The Round Mountain, 100 km to the South East, and a combined PSR/SSR at Mt Somerville, 240 km to the north east.

Both of these radars are too far from the GIWF for the wind turbines to have any impact on radar performance.

12. CONCLUSIONS

This Aviation Impact Statement for the GIWF has made the following conclusions:

The GIWF development will NOT impact upon the following:

- The OLS published for any registered or certified aerodrome;
- The operation of any Navigation Aids and Communication facilities; and
- The operation of any Airspace Surveillance facility.

However the GIWF WILL impact upon the following:

- The 25 nm Minimum Sector Altitude (MSA) for Glen Innes Aerodrome;

It will be recommended that AsA is requested to increase the 25 nm MSA to 5600 ft.

As the 10 nm MSA is 6100 ft, and the altitude at the Initial Fix (IF) for the RWY 14 and RWY 32 RNAV approaches is 6200 ft, aircraft would be required to be no lower than 6100 ft within 10 nm of the ARP and no lower than 6200 ft before commencing either of the RNAV approaches.

It is considered that the increase in the 25 nm MSA to 5600 ft will have minimal impact on flight operations.

APPENDIX A

Airservices Australia
Aviation Assessments for Wind Farm Developments
19 August 2014

airservices

Corporate & International Affairs
25 Constitution Avenue
(GPO Box 367)
CANBERRA ACT 2600

t 02 6268 5101
f 02 6268 4233

www.airservicesaustralia.com

ABN 59 698 720 886

To Whom It May Concern

Airservices Aviation Assessments for Wind Farm Developments

Guidelines to manage the risk to aviation safety from wind turbine installations (Wind Farms/Wind Monitoring Towers) are under development by the National Airports Safeguarding Advisory Group (NASAG). NASAG is comprised of high-level Commonwealth, State and Territory transport and planning officials and has been formed to develop a national land use planning regime to apply near airports and under flight paths.

The wind farm guidelines will provide information to proponents and planning authorities to help identify any potential safety risks posed by wind turbine and wind monitoring installations from an aviation perspective.

Potential safety risks include (but are not limited to) impacts on flight procedures and aviation communications, navigation and surveillance (CNS) facilities which require assessment by Airservices.

To facilitate these assessments all wind farm proposals submitted to Airservices must include an Aviation Impact Statement (AIS) prepared by an aeronautical consultant in accordance with the AIS criteria set out below.

AIS must be undertaken by an aeronautical consultant with suitable knowledge and capabilities to provide a reliable and comprehensive report. All data is to be supplied in electronic form. If you are not familiar with any aeronautical consultants, you may wish to view the list on the Civil Aviation Safety Authority (CASA) website:

http://www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_90412

connecting australian aviation

AIS Criteria

The AIS must provide a detailed analysis covering, as a minimum:

Airspace Procedures:

1. Obstacles
    - Co-ordinates in WGS 84 (to 0.1 second of arc or better)
    - Elevations AMSL (to 0.3 metres)
2. Drawings
    - Overlayed on topographical base not less that 1:250,000. Details of datum and level of charting accuracy to be noted.
    - Electronic format compatible with Microstation version 8i.
3. Aerodromes
    - Specify all registered/certified aerodromes that are located within 30nm (55.56km) from any obstacle referred to in (1) above.
    - Nominate all instrument approach and landing procedures at these aerodromes.
    - Confirmation that the obstacles do not penetrate Annex 14 or OLS for any aerodrome. If an obstacle does penetrate, specify the extent.
4. Air Routes
    - Nominate air routes published in ERC-L & ERC-H which are located near/over any obstacle referred to in (1) above.
    - Specify two waypoint names located on the routes which are located before and after the obstacles.
5. Airspace
    - Airspace classification – A, B, C, D, E, G etc where the obstacles are located.

Navigation/Radar:

1. Detect the presence of dead zones
2. False target analysis
3. Target positional accuracy
4. Probability of detection
5. Radar coverage implications
6. We would expect the analysis to follow the guidelines outlined in the EUROCONTROL Guidelines on How to Assess the Potential Impact of Wind Turbines on Surveillance Sensors.

http://www.eurocontrol.int/sites/default/files/field_tabs/content/documents/events/guidelines-to-assess-potential-impact-of-wind-turbines.pdf

NOTE: Within the Eurocontrol Guidelines there are specific assumptions about the type of Wind Turbine for which the Guidelines are applicable (i.e. 3 blades, 30-200 m height, and horizontal rotation axis). For any deviations to the Wind Turbine characteristics listed within the Eurocontrol Guidelines, the proponent should justify to Airservices why the Eurocontrol Guidelines are still applicable.

Airservices Review of AIS

Airservices will review the quality and completeness of an AIS and will undertake limited modelling and analysis to confirm the findings and recommendations of the report.

Provided the AIS is of sound quality and is complete in accordance with the above criteria, there will be no charge for the review or limited modelling and analysis.

If the AIS is not of sound quality or is not complete in accordance with the above criteria, no modelling or analysis will be undertaken. Airservices will advise the proponent that the AIS does not meet the requirements and that the proposal cannot be assessed by Airservices.

If Airservices review of an AIS confirms impacts identified in the report (or identifies additional impacts), Airservices will advise the proponent of the impacts and the required mitigating actions (where mitigation is feasible). The proponent will also be advised that there will be charges for any mitigation actions to be undertaken by Airservices.

These charges may be advised at the time but it is likely that a detailed quote will be needed and this will only be provided on request from the proponent.

Please contact Airport Relations on 02 6268 4725 or airport.developments@airservicesaustralia.com if you have any questions.

Current as at 19 August 2014

APPENDIX B

Glen Innes Wind Farm
Site Identification, Coordinates and Elevations

	MGA Z56 Co-ords (m)		WGS 84 GEO Co-ords		Tower base m AHD (from Nexif data)	Plus 180m tip heigth m AHD	TIP height ft AHD
ID	X	Y	LAT	LON			
WTG01	364902.339	6710276.477	-29.730351	151.603097	1181.3954	1,362	4,469
WTG02	364985.000	6709936.000	-29.733432	151.603909	1182.6178	1,363	4,472
WTG03	364925.999	6709583.000	-29.736611	151.603255	1182.7997	1,363	4,472
WTG04	365131.000	6709251.000	-29.739628	151.605333	1179.6116	1,360	4,462
WTG05	365343.000	6708692.000	-29.744695	151.607455	1172.0839	1,353	4,439
WTG06	365850.000	6708179.000	-29.749378	151.612633	1194.7612	1,375	4,512
WTG07	366170.300	6707771.398	-29.753091	151.615894	1233.8423	1,414	4,640
WTG08	366146.000	6707375.000	-29.756664	151.615594	1204.7406	1,385	4,544
WTG09	366063.000	6707025.000	-29.759813	151.614692	1219.5165	1,400	4,594
WTG10B	365939.915	6706230.070	-29.766972	151.613320	1174.1710	1,355	4,446
WTG11	365258.421	6705850.535	-29.770322	151.606226	1171.5490	1,352	4,436
WTG11B	365675.000	6705575.000	-29.772853	151.610499	1184.7694	1,365	4,479
WTG12B	365980.000	6705375.000	-29.774691	151.613629	1199.0703	1,380	4,528
WTG12C	366301.929	6704947.001	-29.778587	151.616905	1194.0323	1,375	4,512
WTG13	365933.188	6704425.169	-29.783256	151.613026	1206.2001	1,387	4,551
WTG13B	365792.702	6704174.023	-29.785506	151.611542	1199.7919	1,380	4,528
WTG14B	366071.337	6704670.751	-29.781055	151.614486	1203.7742	1,384	4,541
WTG15	366579.833	6703727.169	-29.789623	151.619628	1209.7784	1,390	4,561
WTG16B	366605.155	6703206.227	-29.794326	151.619826	1256.0276	1,437	4,715
WTG16C	366618.681	6703415.791	-29.792437	151.619991	1254.3728	1,435	4,708
WTG17	366686.034	6702920.347	-29.796914	151.620627	1211.5657	1,392	4,567
WTG19	367318.371	6702281.338	-29.802747	151.627089	1265.6647	1,446	4,745
WTG20B	367521.000	6705469.000	-29.774009	151.629577	1223.9825	1,404	4,607
WTG22B	367651.000	6704952.000	-29.778688	151.630858	1235.4357	1,416	4,646
WTG21B	367774.000	6705217.000	-29.776310	151.632163	1232.9926	1,413	4,636

APPENDIX C

Glossary of Terms and Abbreviations

APPENDIX C
Glossary of Terms and Abbreviations

To facilitate the understanding of aviation terminology used in this report, the following is a glossary of terms and acronyms that are commonly used in aeronautical impact assessments and similar aeronautical studies. A full list of terms and abbreviations used in this report is included in this Appendix. It should be noted that, within aviation, the International standard unit for altitude is feet (ft.) and distance is nautical mile (nm).

AC (Advisory Circulars) are issued by CASA and are intended to provide recommendations and guidance to illustrate a means, but not necessarily the only means, of complying with the *Regulations*.

Aeronautical study is a tool used to review aerodrome and airspace processes and procedures to ensure that safety criteria are appropriate.

AHD (Australian Height Datum) is the datum to which all vertical control for mapping is to be referred. The datum surface is that which passes through mean sea level at the 30 tide gauges and through points at zero AHD height vertically below the other basic junction points.

AIP (Aeronautical Information Publication) is a publication promulgated to provide operators with aeronautical information of a lasting character essential to air navigation. It contains details of regulations, procedures and other information pertinent to flying and operation of aircraft. In Australia, the AIP may be issued by CASA or Airservices Australia.

Air routes exist between navigation aid equipped aerodromes or waypoints to facilitate the regular and safe flow of aircraft operating under Instrument Flight Rules (IFR).

Airservices Australia is the Australian government-owned corporation providing safe and environmentally sound air traffic management and related airside services to the aviation industry.

Altitude is the vertical distance of a level, a point or an object, considered as a point, measured from mean sea level.

AMSL (Above Mean Sea Level) is the elevation (on the ground) or altitude (in the air) of any object, relative to the average sea level datum. In aviation, the ellipsoid known as World Geodetic System 84 (WGS 84) is the datum used to define mean sea level.

ATC (Air Traffic Control) service is a service provided for the purpose of:

a. preventing collisions:
    1. between aircraft; and
    2. on the manoeuvring area between aircraft, vehicles and obstructions; and
b. expediting and maintaining an orderly flow of air traffic.

CASA (Civil Aviation Safety Authority) is the Australian government authority responsible under the *Civil Aviation Act 1988* for developing and promulgating appropriate, clear and concise aviation safety standards. As Australia is a signatory to the ICAO *Chicago Convention,* CASA adopts the standards and recommended practices established by ICAO, except where a difference has been notified.

CASR (Civil Aviation Safety Regulations) are promulgated by CASA and establish the regulatory framework *(Regulations)* within which all service providers must operate.

Civil Aviation Act 1988 (the Act) establishes the CASA with functions relating to civil aviation, in particular the safety of civil aviation and for related purposes.

ICAO (International Civil Aviation Organization) is an agency of the United Nations which codifies the principles and techniques of international air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth. The ICAO Council adopts standards and recommended practices concerning air navigation, its infrastructure, flight inspection, prevention of unlawful interference, and facilitation of border-crossing procedures for international civil aviation. In addition, the ICAO defines the protocols for air accident investigation followed by transport safety authorities in countries signatory to the Convention on International Civil Aviation, commonly known as the *Chicago Convention*. Australia is a signatory to the *Chicago Convention.*

IFR (Instrument Flight Rules) are rules applicable to the conduct of flight under IMC. IFR are established to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals. It is also referred to as, "a term used by pilots and controllers to indicate the type of flight plan an aircraft is flying," such as an IFR or VFR flight plan.

IMC (Instrument Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, less than the minimum specified for visual meteorological conditions.

LSALT (Lowest Safe Altitudes) are published for each air route segment. Their purpose is to allow pilots of aircraft that suffer a system failure to descend to the LSALT to ensure terrain or obstacle clearance in IMC where the pilot cannot see the terrain or obstacles due to cloud or poor visibility conditions. It is an altitude that is at least 1,000 feet above any obstacle or terrain within a defined safety buffer region around a route that a pilot might fly.

MOS (Manual of Standards) comprises specifications *(Standards)* prescribed by CASA, of uniform application, determined to be necessary for the safety of air navigation.

NASAG (National Airports Safeguarding Advisory Group) set up in May 2010 to implement the Australian Government's National Aviation Policy White Paper, *Flight Path to the Future* initiatives relating to safeguarding airports and surrounding communities from inappropriate development. NASAG comprises representatives from state and territory planning and transport departments, the Civil Aviation Safety Authority (CASA), Airservices Australia, the Department of Defence and the Australian Local Government Association (ALGA) and is chaired by the Department of Infrastructure and Regional Development (DIRD).

NOTAMs (Notices to Airmen) are notices issued by the NOTAM office containing information or instruction concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to persons concerned with flight operations.

Obstacles. All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

OLS (Obstacle Limitation Surfaces) are a series of planes associated with each runway at an aerodrome that defines the desirable limits to which objects may project into the airspace around the aerodrome so that aircraft operations may be conducted safely.

PANS-OPS (Procedures for Air Navigation Services - Aircraft Operations) is an Air Traffic Control term denominating rules for designing instrument approach and departure procedures. Such procedures are used to allow aircraft to land and take off under Instrument Meteorological Conditions (IMC) or Instrument Flight Rules (IFR). ICAO document 8168-OPS/611 (volumes 1 and 2) outlines the principles for airspace protection and procedure design which all ICAO signatory states must adhere to. The regulatory material surrounding PANS-OPS may vary from country to country.

PANS-OPS Surfaces. Similar to an Obstacle Limitation Surface, the PANS-OPS protection surfaces are imaginary surfaces in space which guarantee the aircraft a certain minimum obstacle clearance. These surfaces may be used as a tool for local governments in assessing building development. Where buildings may (under certain circumstances) be permitted to penetrate the OLS, they cannot be permitted to penetrate any PANS-OPS surface, because the purpose of these surfaces is to guarantee pilots operating under IMC an obstacle free descent path for a given approach.

Prescribed airspace is an airspace specified in, or ascertained in accordance with, the Regulations, where it is in the interests of the safety, efficiency or regularity of existing or future air transport operations into or out of an airport for the airspace to be protected. The prescribed airspace for an airport is the airspace above any part of either an OLS or a PANS OPS surface for the airport and airspace declared in a declaration relating to the airport.

Regulations (Civil Aviation Safety Regulations)

VFR (Visual Flight Rules) are rules applicable to the conduct of flight under VMC. VFR allow a pilot to operate an aircraft in weather conditions generally clear enough to allow the pilot to maintain visual contact with the terrain and to see where the aircraft is going. Specifically, the weather must be better than basic VFR weather minima. If the weather is worse than VFR minima, pilots are required to use instrument flight rules.

VMC (Visual Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, equal or better than specified minima

ABBREVIATIONS

Abbreviations used in this report, and the meanings assigned to them for the purposes of this report are detailed in the following table:

Abbreviation	Meaning
AC	Advisory Circular (document support CASR 1998)
ACFT	Aircraft
AD	Aerodrome
AHD	Australian Height Datum
AHT	Aircraft height
AIP	Aeronautical Information Publication
Airports Act	Airports Act 1996, as amended
AIS	Aeronautical Information Service
ALA	Aeroplane Landing Area
Alt	Altitude
AMSL	Above Mean Sea Level
A(PofA)R	Airports (Protection of Airspace) Regulations, 1996 as amended
APARs	Airports (Protection of Airspace) Regulations, 1996 as amended
ARP	Aerodrome Reference Point
AsA	Airservices Australia
ATC	Air Traffic Control(ler)
ATM	Air Traffic Management
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
Cat	Category
DAP	Departure and Approach Procedures (charts published by AsA)
DER	Departure End of (the) Runway
DEVELMT	Development
DME	Distance Measuring Equipment
Doc nn	ICAO Document Number nn
DIRD	Department of Infrastructure and Regional Development. (Formerly Department of Infrastructure and Transport)

Abbreviation	Meaning
DoIT	Department of Infrastructure and Transport. Also called “Infrastructure”. (Formerly Department of Infrastructure, Transport, Regional Development and Local Government (DITRDLG) and previously the Department of Transport and Regional Services (DoTARS))
DITRDLG	See DoIT above
DOTARS	See DITRDLG above
ELEV	Elevation (above mean sea level)
ENE	East North East
ERSA	Enroute Supplement Australia
FAF	Final Approach Fix
FAP	Final Approach Point
ft	feet
GA	General Aviation
GNSS	Global Navigation Satellite System
GP	Glide Path
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IHS	Inner Horizontal Surface, an Obstacle Limitation Surface
ILS	Instrument Landing System
ISA	International Standard Atmosphere
km	kilometres
kt	Knot (one nautical mile per hour)
LAT	Latitude
LLZ	Localizer
LONG	Longitude
LSALT	Lowest Safe Altitude
m	metres
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MGA94	Map Grid Australia 1994
MOC	Minimum Obstacle Clearance
MOS	Manual of Standards, published by CASA
MSA	Minimum Sector Altitude
SSR	Monopulse Secondary Surveillance Radar
MVA	Minimum Vector Altitude

Abbreviation	Meaning
NASAG	National Airports Safeguarding Advisory Group
NDB	Non Directional Beacon
NE	North East
NM or nm	Nautical Mile (= 1.852 km)
nnDME	Distance from the DME (in nautical miles)
NNE	North North East
NOTAM	NOtice To AirMen
OAS	Obstacle Assessment Surface
OCA	Obstacle Clearance Altitude
OCH	Obstacle Clearance Height
OHS	Outer Horizontal Surface
OIS	Obstacle Identification Surface
OLS	Obstacle Limitation Surface
PANS-OPS	Procedures for Air Navigation Services – Aircraft Operations, ICAO Doc 8168
PRM	Precision Runway Monitor
PROC	Procedure
PSR	Primary Surveillance Radar
QNH	An altimeter setting relative to height above mean sea level
Rnnn	Restricted Airspace – promulgated in AIP as R with 3 numbers
REF	Reference
RL	Relative Level
RNAV	aRea NAVigation
RNP	Required Navigation Performance
RPA	Rules and Practices for Aerodromes — replaced by the MOS Part 139 — Aerodromes
RPT	Regular Public Transport
RTCC	Radar Terrain Clearance Chart
RWY	Runway
SFC	Surface
SID	Standard Instrument Departure
SOC	Start Of Climb
SSR	Secondary Surveillance Radar
STAR	Standard ARrival
TAR	Terminal Area Radar
TAS	True Air Speed
THR	Threshold (Runway)
TNA	Turn Altitude
TODA	Take-Off Distance Available
VFR	Visual Flight Rules

Abbreviation	Meaning
V_n	aircraft critical Velocity reference
VOR	Very high frequency Omni directional Range
WAC	World Aeronautical Chart

Appendix D

Aviation Risk Assessment

FINAL REPORT
AVIATION RISK ASSESSMENT

GLEN INNES WIND FARM

LB00100.ARA

Report to:

Glen Innes Wind Farm

11 September 2017

The Ambidji Group

(A Division of Landrum & Brown)

Level 5, 114 Flinders Street, Melbourne

VIC 3000, Australia

THE AMBIDJI GROUP

DOCUMENT RELEASE APPROVAL

Approved for Final Release: Final Report V1.0

Name: Barrie Slingo

Title: Senior Managing Consultant

Date: 11 September 2017

Distribution: David Brown, Glen Innes Wind Farm
Steve McCall, Environmental Property Services Pty Ltd

REV NO	DESCRIPTION	DATE	Prepared	QA
V0.1	Draft Risk Assessment	11 Aug 2017	HS	BWS
V1.0	Final Report	11 Sep 2017	BWS	HS

Executive Summary

Glen Innes Wind Farm have commissioned Ambidji to undertake an aviation risk assessment of the potential impact to aviation of the proposed changes to increase the Glen Innes Wind Farm (GIWF) wind turbine tip heights from 150m to 180m Above Ground Level (AGL).

An updated Aviation Impact Statement (AIS) completed in June 2017 found that the GIWF development will not impact the use or operation of:

- Published Obstacle Limitation Surface (OLS);
- Navigation Aids,
- Communication facilities, and
- Airspace Surveillance

The GIWF development will however require the 25 nm Minimum Sector Altitude (MSA) for Glen Innes Aerodrome to be increased by 100ft (from 5500ft to 5600ft) which is considered to have minimal impact on flight operations.

This aviation risk assessment considers the proposed changes to the GIWF in terms of potential risk to aircraft, airport operations and airspace in the vicinity of the proposed wind farm development arising from:

- the intention to increase turbine heights from 150m to 180 m AGL (i.e. increased obstacle height);
- any resultant changes to flight procedures and prescribed airspace in the vicinity of the wind farm; and
- any additional risks or considerations which are apparent since the original aviation risk assessment was undertaken.

For VFR flights, no existing highly trafficked routes transit through the wind farm location and sufficient vertical and lateral separation can easily be achieved within the existing surrounding navigable airspace. For operations compliant with Visual or Instrument Flight Rules (VFR/ IFR), the proposed increased height in the turbines has been shown to offer no increase in risk to aviation.

Three threats have been identified and assessed which could lead to a loss of separation event occurring in the vicinity of the wind farm:

- Authorised Low Level Operations;
- VFR flights into Instrument Meteorological Conditions (IMC) conditions; and
- IFR navigational error in IMC.

It is demonstrated that only in the event of Authorised Low Level flights (e.g. aerial application or emergency response) or flights operating outside prescribed rules and conditions (accident / incident conditions) that the increased height of the wind farm turbines offer any potential additional risk to aviation. It is these flights that are the subject of this risk assessment.

Because the outcomes of these events all relate to “severe” outcomes (1 or 2 fatalities), the risk scores cannot be reduced below a Medium on the Civil Aviation Safety Authority (CASA) risk matrix. The inherent risks of aviation activity in the area associated with a loss of separation leading to a collision with terrain (CFIT into the ground) are all assessed as High on the CASA matrix.

Collisions with a turbine or a Loss of Control (LOC) (e.g. due to encountering turbine wake or manoeuvring to avoid a turbine) are also assessed to present a Medium or High risk and therefore do not increase the inherent risk profile for flights in the area. It is therefore concluded that the increased turbine heights do not increase the risk to aviation.

When considering the need for Obstacle Lighting, the accumulative effects of the neighbouring wind farms in close proximity (and the decision to light these) has been taken into account. Assessment of a “non-standard application of aviation obstacle lighting” to these wind farms for night VFR flights concludes that there is potential for confusion if some of the wind turbines (clusters) are lit and others aren’t – i.e. a “false negative”. It is recommended that the same obstacle lighting regime plan be adopted, (i.e. lighting intensity, type, spacing) to ensure against the “false negative” issue identified in this report.

Other recommendations to further reduce the potential for loss of separation events to occur in the vicinity of the wind farm include:

- Reinforcement with local pilots through consultation with the local flying schools, clubs and companies operating in the area;
- Pilot Education through CASA and RAA regarding the hazards associated with flights in the vicinity of windfarms;
- Pilot Education through CASA and RAA regarding the commonly misunderstood aspect of the aviation regulations with respect to navigable airspace for in VFR flights – i.e. that day VFR flights MUST be conducted with a minimum vertical separation of 500 ft above the ground **and any object on it**; and
- Clearer designation of wind farms on the navigation charts to aid pilot comprehension where multiple wind farms exist.

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TABLE OF CONTENTS

1. INTRODUCTION

This report provides the results of the Glen Innes Wind Farm (GIWF) Aviation Risk Assessment recently conducted by Ambidji following a request by Environmental Property Services Pty Ltd.

The Aviation Risk Assessment focuses on the potential impact to aviation of the proposed changes to increase the wind turbine tip height from 150m to 180m AGL.

2. BACKGROUND

Aviation Risk Assessments for the GIWF had been prepared by Aurecon in 2013 and 2014. However, since the 2014 risk assessment, a further increase in the proposed turbine tip height from (150m AGL to 180m AGL) and changes to navigational aids make the review and update of the aviation risk assessment prudent.

The proposed GIWF will comprise 25 wind turbines with a tip height of 180 m AGL. The highest turbine tip is WTG19 at 1446 m AHD rounded up to 4745 ft. AHD

An updated Aviation Impact Statement (AIS) completed in June 2017 finds that the GIWF development will not impact the use / operation of:

- Published OLS;
- Navigation Aids;
- Communication facilities; and
- Airspace Surveillance

However, the GIWF development will require the 25 nm Minimum Sector Altitude (MSA) for Glen Innes Aerodrome to be increased by 100ft (from 5500ft to 5600ft) which is considered to have minimal impact on flight operations.

3. SCOPE

This aviation risk assessment considers the proposed changes to the GIWF in terms of potential risk to aircraft, airport operations and airspace in the vicinity of the proposed wind farm development arising from:

- the intention to increase turbine heights from 150m to 180 m AGL (i.e. increased obstacle height);
- any resultant changes to flight procedures and prescribed airspace in the vicinity of the wind farm; and
- any additional risks or considerations which are apparent since the original aviation risk assessment was undertaken.

There are a series of Australian and International regulatory publications (regulations, standards and guidelines) that either require or apply to aviation risk assessments (impacting airspace, airport and aircraft safety). Tall structures at proposed wind farms (such as turbines and wind monitoring towers) present an aviation obstacle in otherwise navigable airspace and therefore require such assessment.

The following are the most relevant to this assessment of the proposed changes to the GIWF:

- Airservices Australia (AsA) - Aviation Impact Assessment;

- National Airports Safeguarding Framework (NASF). Guideline D "Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers";
- Airports (Protection of Airspace) Regulations 1996;
- CASA Advisory Circular 139-08 (0) Reporting of Tall Structures;
- International Civil Aviation Organisation (ICAO) Annex 14 – Aerodromes; and
- Relevant State Government planning requirements.

These requirements are taken into account and referenced where relevant in the scoping and assessment of risks.

The objective of the risk assessment is to identify and assess potential safety risks to aviation, determine their acceptability and whether any further risk mitigation is required. Most specifically an Obstacle Lighting Review (OLR) forms part of this risk assessment and establishes the need (or otherwise) and utility of aviation obstruction lighting as risk mitigation.

AsA require an Aviation Impact Statement (AIS) for wind farm developments to be submitted to them for evaluation and consideration. The AIS identifies any impacts on published air routes, instrument procedures, aerodrome OLS / PANS-OPS, LSA's, airspace Communication, Navigation and Surveillance (CNS) facilities. The AIS therefore ensures that any impacts on systems and procedures necessary for the safe flight of aircraft operating under Instrument Flight Rules (IFR) are identified and managed.

An AIS for the proposed changes has been completed and has confirmed that there is no impact on:

- published instrument approaches (including missed approach procedures) for the neighbouring airports (Inverell and Glen Innes);
- published air routes in the vicinity of the wind farm; and
- any communication / navigation facilities.

A small (100ft) increase required in the Minimum Sector Altitude (MSA) over the turbines (from 5500ft to 5600ft) is required to accommodate suitable clearance over the highest proposed wind turbine. It has been concluded that this will have minimal impact on flight operations given that the neighbouring MSA is 6100ft and the Initial Approach Fixes (IAF) for RNAV approaches are 6200ft. (Note: On 4 September 2017, AsA advised the NSW Department of Planning that the proposed airspace changes will be effected on 24 May 2018 and that "After this date the proposed Glenn Innes Wind Farm will have no impact on procedures at Glenn Innes Airport.")

The risk to aircraft operating normally under Instrument Flight Rules (IFR) (including IFR Training Flights) is therefore concluded to be unchanged as a result of the proposed increased turbine height.

Similarly, for flights compliant with the vertical and lateral separation requirements for Visual Flight Rules (VFR), there is no change in risks to the aircraft as a result of the proposed increased turbine height.

It is therefore only in the event of Authorised Low Level flights (e.g. aerial application, emergency response) in the immediate vicinity of the wind farm, or VFR/IFR flights operating outside prescribed rules or normal conditions (accident / incident conditions) that the wind farm obstacles could offer any additional risk to aviation. It is these flights that are the subject of this risk assessment.

4. RISK ASSESSMENT METHODOLOGY

A standard risk assessment methodology as per International Organization for Standardization (ISO) 31000 has been adopted (as indicated in Figure 4-1 below:

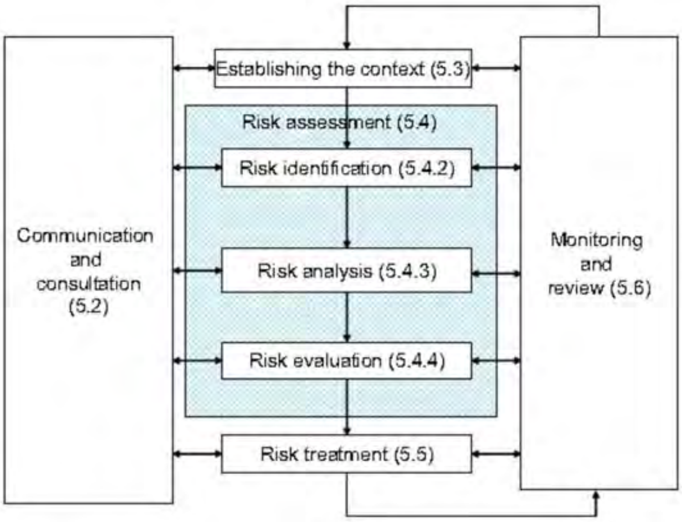


Figure 4-1 Risk Assessment Stages

The following sections describe the process that has been undertaken to identify and assess these aviation risks.

4.1 Hazard Identification

The proposed changes to the height of wind turbines may present a potential hazard to VFR flights operating within the vicinity of the wind farm. In effect, from an aviation safety perspective any obstacles raise the level of clearance above terrain required for safe flight by the height of the obstacle (as per Civil Aviation Regulation (CAR) 157[1]).

For the purpose of this assessment therefore, the hazard is defined as the loss of minimum separation with terrain (including obstacles) in the vicinity of the wind farm.

The scenarios that could potentially lead to a realisation of this hazard (i.e. the threats) have been identified through:

- Identification of the current and near term operational context (i.e. what aviation activities are (and likely to be) undertaken in the area;
- A review of proposed change implications on the previous GIWF Aviation Risk Assessments;
- A review of the recently completed Qualitative Risk Assessment (QRA) for the proposed neighbouring Sapphire Wind Farm;
- Review of current topographical maps to assess the local terrain and identify any local airstrips and any other relevant features;

[1] From CAR 157 – Low Flying. The pilot in command of an aircraft must not fly the aircraft over an (unpopulated) area at a height lower than 500ft where the height is the height above the highest point of the terrain and any object on it.

- Consultation with identified key stakeholders, including local operators, recreational aviation groups, Air Ambulance and Fire Services, local airport representatives, local council;
- A search for any relevant data in the Australian Transport Safety Bureau (ATSB) occurrences database; and
- A review of readily available global wind farm accident information.

4.1.1 Consultation with Stakeholders

Consultation (by telephone) with aviation and other relevant stakeholders was sought in regard to local aviation activity, aviation concerns relating to windfarms and confirmation of local airstrips and their utilisation. For this review, these included:

- Aerial Agricultural Operator;
- Regional Aviation Association of Australia;
- Recreational Aviation Australia;
- Aircraft Owners and Pilots Association;
- State Aircraft Unit;
- Air Ambulance Service;
- General Aviation Operators;
- Aerodrome operator;
- CASA; and
- Local Council

A record of this consultation is provided in Appendix B.

4.2 Risk Assessment Criteria

The CASA Airspace Risk and Safety Management Manual[2] provides a link to a risk assessment template which includes the following qualitative risk assessment matrix and associated consequence and likelihood definitions. These have been applied directly in the assessment of identified risks associated with the GIWF proposed changes.

Risk Category / Descriptor	Consequence					
	Insignificant	Minor	Moderate	Major	Severe	Catastrophic
	0	1	2	3	4	5
Aviation Safety	Not having aviation safety implications	Associated with minor breaches of aviation safety regulations	Major issues of compliance with aviation safety regulations but would not in itself lead to a safety incident.	Major issue of compliance with aviation safety regulations and leading to potential for unsafe aviation operations.	Potential for aviation safety incident involving multiple life threatening injuries, or 1/2 fatilities	Potential for aviation safety occurrence(s) causing multiple (>3) fatalities.
Safety of Flight / Training	No operational or safety-of-flight implications.	Deviation with minimal potential to impact safe operation of an aircraft.	Deviation with some potential to impact safe operation of an aircraft.	Deviation impacting the continued safe operation of an aircraft.	Operational Emergency, impacting the immediate safe operation of an aircraft.	Loss of aircraft / multiple fatalities
	Deviation managed by PIC using standard procedures	Managed by PIC using normal procedures	Managed by PIC using non-normal checklist procedures	Managed by PIC using multiple non-normal checklist procedures or additional actions.	Management requires emergency actions by PIC to preserve aircraft integrity and/or life.	
Airspace	No airspace occurrence	Airspace occurrence resulting in minor injury or requiring first aid treatment	Airspace occurrence resulting in serious injury causing hospitilisation or multiple medical cases	Mid Air collision or LOC leading to CFIT - life threatening injuries or multiple serious injuries requiring hospitilisation	Mid Air Collision or loss of control leading to CFIT event, either of which leads to multiple fatalities (1 or 2 persons)	Mid Air Collision or loss of control leading to CFIT event, either of which leads to multiple fatalities (3 or more)

Figure 4-2 Consequence Descriptors

[2] CASA Airspace Risk and Safety Management Manual, September 2016

	ID	Descriptor	Numerical	Historical
Likelihood	5	Almost Certain	>1 in 10	Is expected to occur in most circumstances
	4	Likely	1 in 10 – 100	Will probably occur
	3	Possible	1 in 100 – 1000	Might occur at some time in the future
	2	Unlikely	1 in 1000 – 10000	Could occur but considered unlikely or doubtful
	1	Rare	1 in 10000 - 100000	May occur in exceptional circumstances
	0	Extremely Rare	< 1 in 100000	Could only occur under specific conditions and extraordinary circumstances

Figure 4-3 Likelihood Descriptors

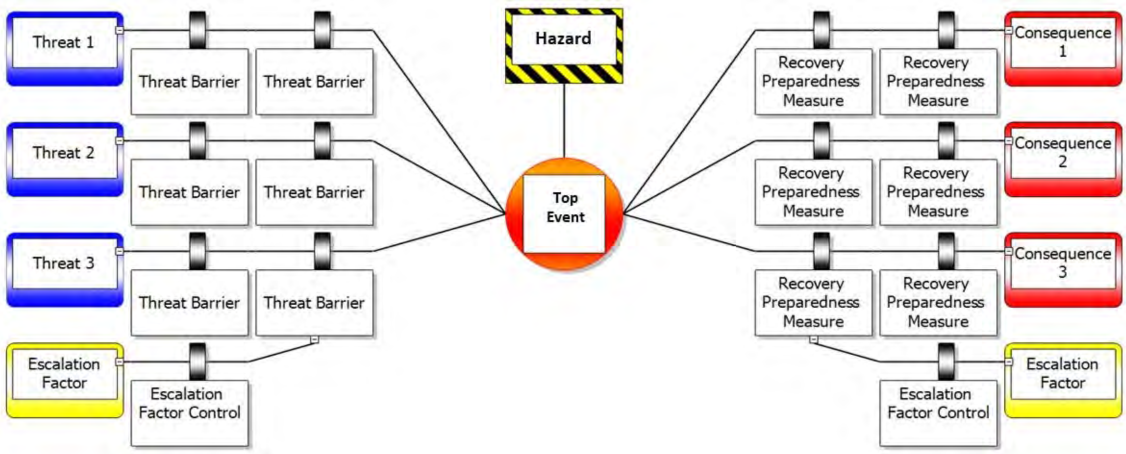
Likelihood / Consequence		Insignificant	Minor	Moderate	Major	Severe	Catastrophic
		0	1	2	3	4	5
Almost Certain	5	5	6	7	8	9	10
Likely	4	4	5	6	7	8	9
Possible	3	3	4	5	6	7	8
Unlikely	2	2	3	4	5	6	7
Rare	1	1	2	3	4	5	6
Extremely Rare	0	0	1	2	3	4	5

Risk Acceptance & Treatment Plan: >7:Extreme risk – detailed treatment plan required; 6&7:High risk – senior management attention /treatment plan; 4&5:Medium risk – manager level attention and monitoring as appropriate; <4:Low risk – manage by local level procedures. Extreme and High risks must be reduced in accordance with the ALARP principle.

Figure 4-4 CASA Risk Matrix

4.3 Bowtie Risk Assessment

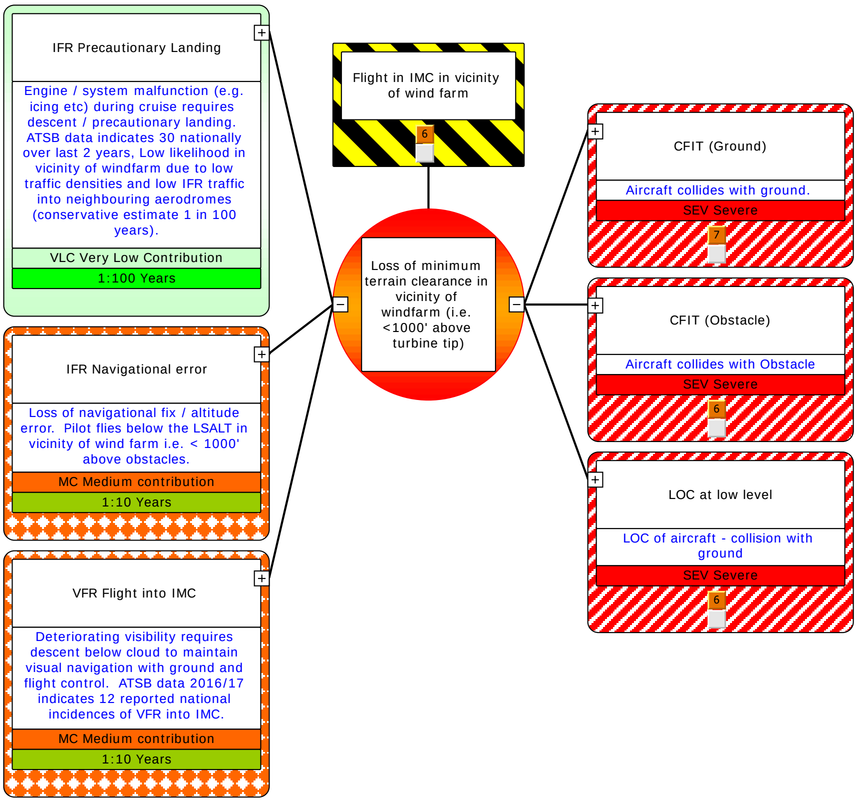
In order to provide a risk assessment which clearly identifies the threats, barriers, potential outcomes and is useful in communicating these, the Bowtie methodology has been chosen. This methodology is based on the "Swiss Cheese" barrier failure theory and simply provides a graphical representation of the timeline between a threat occurring (e.g. low-level VFR flight in vicinity of windfarm), the preventative barriers that need to fail to get to the loss of control point (loss of separation with a terrain / obstacle in this case) and the mitigating barriers that need to then fail before the final outcomes (e.g. collision with turbine) occurs.



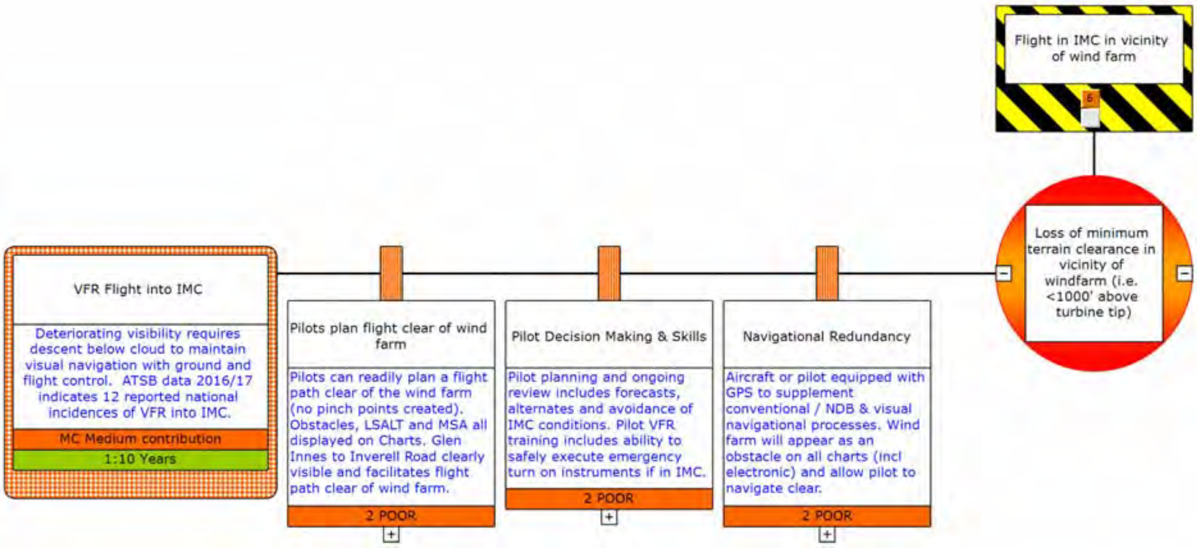
In this way, a systematic review of the independent events, their likelihood and barrier effectiveness is clearly evident – i.e. the likelihood that a collision with terrain occurs.

Similarly, it is important that we define and describe each hazard, threat and consequence sequence accurately so that it is clearly evident which elements of risk are due to the presence of the wind turbines, and which elements exist irrespective of the wind farm.

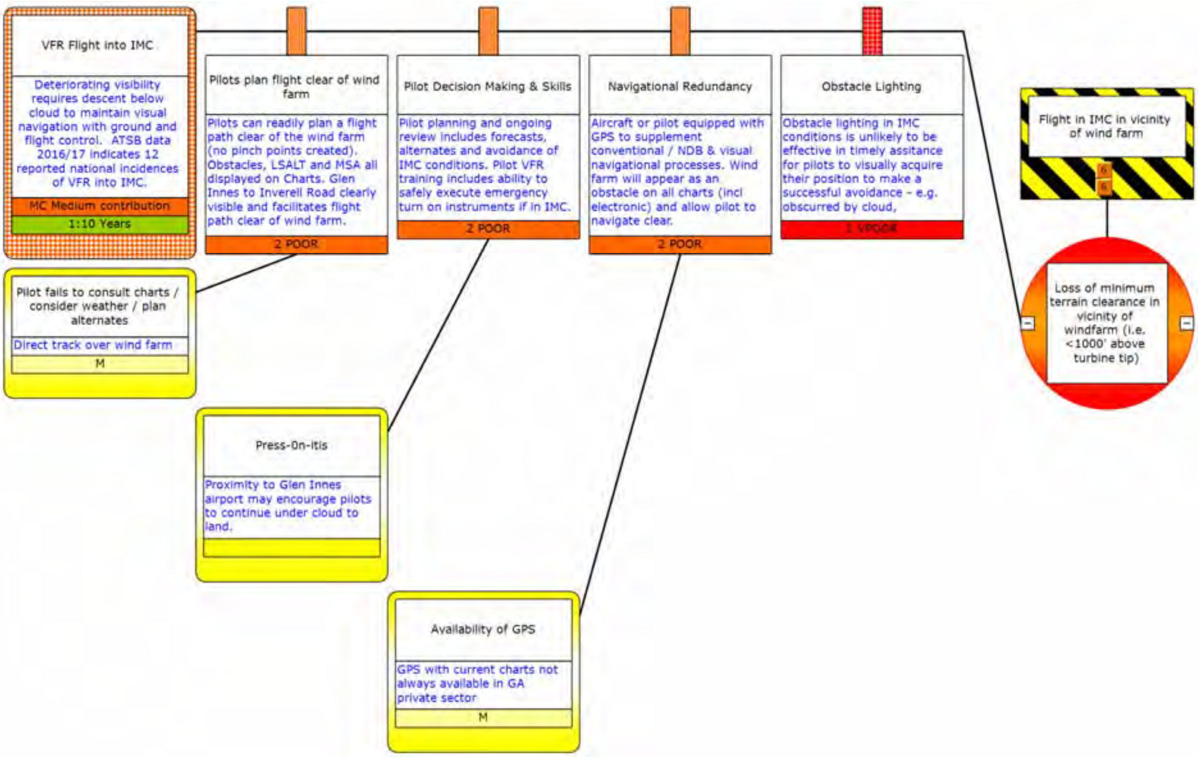
As an example of this, a collision of an aircraft with a wind turbine requires the failure of a number of preventative barriers to occur before a loss of separation occurs (i.e. aircraft is flying at a low level in close proximity to the wind farm). The two main outcomes of interest and comparison for this assessment are collision with an obstacle (turbine or WMT) and collision with terrain. This scenario is illustrated (at a summary level) in the bowtie diagram below.



If we look in more detail below at one of the LHS threat lines (expand it), we can see the individual preventative barriers that may act to prevent (reduce the likelihood) of the loss of separation occurring:



If it is further expanded, we can now see any escalating factors (yellow boxes) which have been applied to these barriers – i.e. reasons why these barriers may fail to successfully prevent the Loss of Control occurring:



A discussion of the fully developed bowties is provided in Section 5 below.

4.3.1 Assigning Risk Measures

Given the lack of location specific data (e.g. total flight numbers in the vicinity, flight into cloud occurrences, loss of navigation), it is not possible to accurately determine each of the threat and consequence likelihoods, however based on national incident data in the ATSB incident database, the qualitative description of operations, the absence of reports of incidents from stakeholders, judgement has been used to assign likelihoods in the risk assessment in terms of their likely frequency:

Color legend of Frequencies

- <NULL> <No Value Assigned>
- 1:1000 Years 1000 Years
- 1:100 Years 100 Years
- 1:10 Years 10 Years
- 1:1 Year Yearly
- 2:1 year 6 Monthly
- 4:1 year 3 Monthly
- 1:1 Month Monthly
- Weekly Weekly
- Daily Daily

Based on the assigned frequency and the significance of the threat (i.e. whether it could directly lead to a loss of separation), a contribution ranking has been assigned:

Color legend of Threat Categories

- <NULL> <No Value Assigned>
- HC High Contribution
- MC Medium contribution
- LC Low contribution
- VLC Very Low Contribution

4.3.2 Control Effectiveness and their Adequacy

Unlike many other major hazard industries, there are very few "automated" controls that can be credited in aviation. The vast majority of controls still currently require human intervention (pilot / ATC).

In applying effectiveness rankings to these identified "human intervention" barriers, consideration has been given to whether the control is a legislated requirement, common practice, the scenario it is required to operate in (e.g. high workload / stress).

Color legend of Effectivenesses

- <NULL> <No Value Assigned>
- 0 NE 0 Non Existent
- 1 VPOOR 1 V Poor Eff
- 2 POOR 2 Poor Eff
- 3 GOOD 3 Good Eff
- 4 VGOOD 4 V Good Eff

Given that these bowties relate to events that could lead to catastrophic consequences (fatalities, loss of aircraft, turbine loss), we should therefore ideally be looking for a high level of defence in depth (redundant & independent controls). In terms of effective risk minimisation, very strong preventative (LHS) controls to prevent Loss of Separation events occurring should be the priority. These should then be supported by mitigative controls on the RHS of the bowtie to minimise the consequences of the loss of separation.

This differentiation between preventative and mitigative controls is important since controls on the LHS operate in a more controlled environment (many during the planning stage) with less time criticality and hence, since in aviation we are highly reliant on human intervention rather than automation, the reliability of a human action performed in a non-time critical environment will be much higher. Once the loss of control point has been reached (centre of the bowtie), controls on the RHS of the bowtie are now highly time critical and human reliability reduces significantly with increased stress and workload.

So, in practice we are seeking each threat / consequence line (from threat through to each identified consequence) to be protected by at least 1 preventative control with very good effectiveness rating (or 2 independent good effectiveness controls) and, at least one good control on the RHS to mitigate each consequence.

So, as well as comparison of risk outcomes with risk acceptance criteria (incl. As Low As Reasonably Possible (ALARP)), the bowtie methodology also requires some consideration / discussion of the level of defence in depth with a focus on prevention of the loss of control point being reached. Mitigative controls on the RHS of the bowtie are considered to be the last lines of defence and as such are not generally assigned the same level of credit or focus as the preventative controls on the LHS of the bowtie.

A simple non-aviation example would be the focus on the prevention of car collisions through driver education regarding impairment (fatigue, alcohol, drugs) rather than simple reliance on seat belts, air bags and crumple zones to protect the car occupants once the loss of control has occurred. Similarly, another aviation example of this comparison of preventative and mitigative controls is the provision of accurate vertical guidance on runway approach coupled with excellent pilot decision making skills in the prevention of runway over/under shoots rather than reliance on airport fire-fighting capability to reduce the consequences of a loss of control.

When considering defence in depth and multiple barriers, the level of independence is also considered, so for example for a VFR flight into IMC, we must assume that the pilot may not have properly planned the flight and so similarly subsequent defences (pilot decision making, flight planned clear of the wind farm etc.) are unlikely to be highly effective.

5. RISK ASSESSMENT RESULTS

5.1 Risk Assessment Context

The following section provides a description of the relevant flying environment and types of operations undertaken in the vicinity of the GIWF site. Based on this information, a list of possible hazards has been generated as input into the risk assessment.

5.1.1 Wind Farm Location

GIWF is located on the Waterloo Range about 12 kilometres to the west of Glenn Innes and just south of the Gwydir highway (running from Glen Innes to Inverell) as shown in Figure 5.1. The project area spans approximately 8.5 kilometres from north to south and about 3 kilometres from east to west. The topography across the project site generally decreases in height from the south towards the north. The Aerodrome Reference Points (ARP) for Glen Innes (YGLI) and Inverell (YIVL) are also shown in Figure 5.1.

Figure 5.1 General Location of the Proposed GIWF

5.1.2 Aviation Obstacles

As presented in detail in the AIS, the proposed windfarm will consist of 25 180m AGL wind turbines, the highest obstacle, turbine WTG 19 at 1446 m or 4745 ft AHD is shown in yellow shading in Figure 5.2.

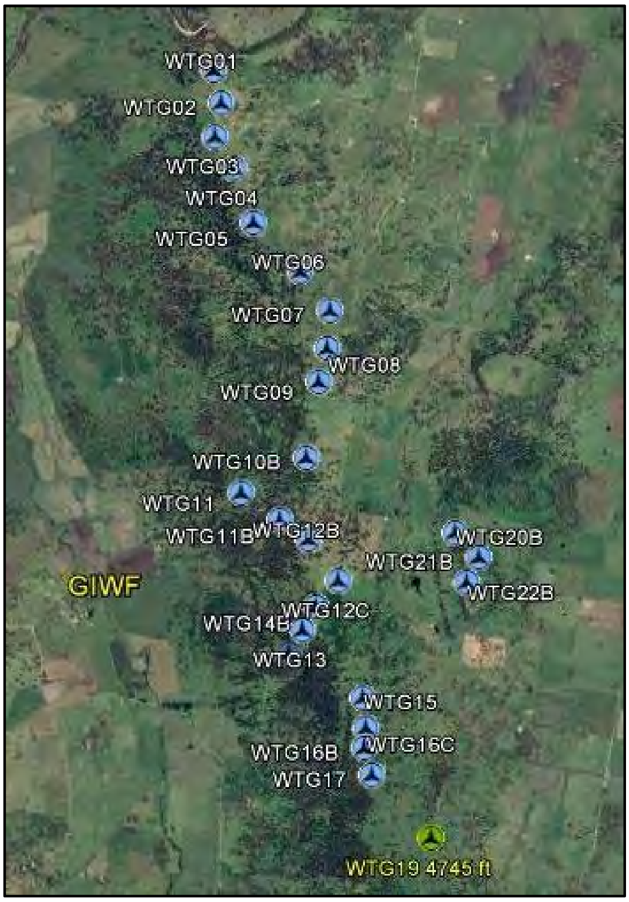


Figure 5.2 Layout of the GIWF showing Wind Turbine Locations

5.1.3 Aerodromes Within 30 Nautical Miles

There are two registered or certified aerodromes within 30 nm of the nearest wind farm turbine:

- Glen Innes (YGLI) 5.67 nm (10.5 km) to the North East of the nearest turbine; and
- Inverell (YIVL) 25.15 nm (46.6 km) to the South West of the nearest turbine.

Fig 5.3 below shows the location of GIWF, nearby wind farms and the Glen Innes airport R_NAV surfaces.

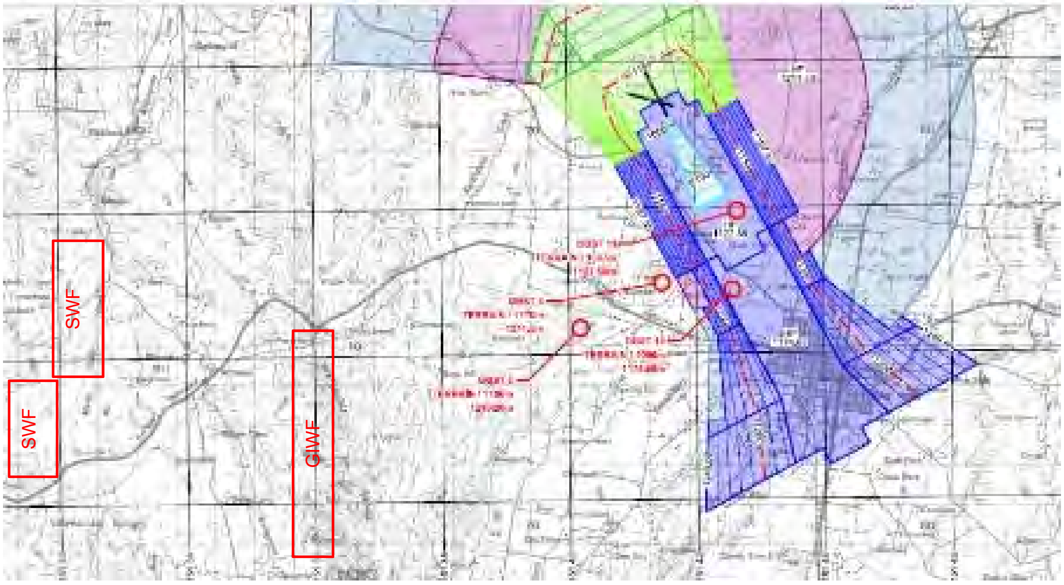


Figure 5-3 Location of Wind Farms and YGLI R-NAV surfaces

5.1.4 Airspace

The GIWF is situated in Class G airspace, beneath Class E airspace with a lower limit of 8500 ft. and there are no Military Restricted airspaces in the vicinity.

5.1.5 Other Airstrips

The previous risk assessment identified 6 unregistered airstrips within the vicinity of the wind farm. SuperAir, (a local aerial application operator) have confirmed July 2017 that as far as they know, they are the only operator that would use any of these airstrips when contracted to do so. No other operations are undertaken here to their knowledge as they are not suitable for use by the average "private pilot" and should be considered as "Ag strips".

5.1.6 Operational Context

The wind farm will be located at a point where the closest aerodrome will be Glen Innes. Therefore, this section predominantly discusses the VFR aviation activity associated with this aerodrome.

5.1.6.1 *Current Operations*

No significant changes in current aviation operations were identified in comparison with the original aviation risk assessment for Glen Innes or the Sapphire wind farms.

- Currently a freight run is made on a daily basis between Inverell and Glen Innes and is often flown under VFR if conditions permit, including below cloud to obviate the need for an instrument approach on landing at Glen Innes.
- Air Ambulance operations are based out of Glen Innes and they utilise the published R-NAV procedures.
- There is a flying training school at Inverell that conducts ab-initio flying training. They use the route between Inverell and Glen Innes as part of the training and also conduct some low-level training in the vicinity.
- There are flying schools at Tamworth and Armidale who occasionally use the area around Inverell and Glen Innes for navigation training purposes.
- A small number of recreational (RA-Aus) pilots fly from Glen Innes / Inverell airports, plus additional visiting recreational pilots from surrounding areas. These aircraft are limited to VFR flight by day in VMC.

- Aerial Application – Superair have confirmed their continuing desire to operate in the vicinity of the wind farm and that they are the only operator utilising the Ag strips located in close proximity to the wind farm.
- No published or highly trafficked VFR desire line was identified through charts or the consultation process.
- No gliding, micro-light or ballooning activities were identified.
- No scheduled commercial or RPT flights to/from Inverell or Glen Innes airports have been identified.
- The previous risk assessment and current AIS have confirmed that the wind farm is outside of designated military operations / communications.

5.1.6.2 *Planned Future Pilot Training Operations*

Glen Innes Regional Airport Pty Ltd is about to commence construction of a commercial flight academy on the Glen Innes airport (due to start November 2017). The planned capacity is to have 35 aircraft on-line, with up to 600 students which will equate to an aircraft movement every 6 minutes when complete. The flight academy will take international students with no previous flight experience (ab-initio) and offer training from basic through to advanced culminating with students suitably qualified for direct entry into airline pilot positions. This represents a significant future change in aviation activity in the area.

All ab-initio flying training is conducted in accordance with the Visual Flight Rules (VFR) and in Visual Meteorological Conditions (VMC). As the name implies, such flying is conducted by visual reference to the ground or water, at a prescribed distance clear of cloud, with a specified visibility range and a minimum height above the terrain or highest obstacle thereon. VFR operations may be flown in accordance with CAR 157 Low Flying, which states, in part, that an aircraft must not be flown lower than 500ft (152m) above the highest terrain or obstacle on or within a radius of 600m for fixed wing aircraft and 300m for helicopters. This requirement does not apply if the aircraft is engaged in approved low flying activity.

Advanced flying training introduces instrument flying which is conducted in accordance with the Instrument Flight Rules (IFR) allowing flight at night and in cloud. IFR flight is protected by Lowest Safe Altitudes (LSALT) and prescribed airspace associated with published Departure and Approach Procedures (DAP). IFR flight utilises terrestrial radio navigation aids (Navaids) and Global Navigation Satellite System (GNSS) equipment to guide the aircraft at suitably equipped aerodromes. Where there are no published DAP at an aerodrome, IFR flight must revert to VFR flight and be able to see the aerodrome prior to descending below the prescribed airspace. VFR at Night is also governed by LSALT and visual reference to the aerodrome for approach and landing.

Activity generated by the Glen Innes flight academy will be initially circuit area training where the students learn and practice the techniques of aircraft ground handling, take-off and landing within sight of the aerodrome. Progressively students practice emergency procedures such as engine failure, forced landing, dealing with aerodynamic stall and abnormal aircraft attitude recovery. These activities are conducted in specific airspace near the aerodrome, but clear of the circuit area over suitable terrain that is open, flat and clear of obstacles such as trees, powerlines and buildings. Once students have mastered the control of the aircraft they learn to plan and navigate aircraft flights on progressively more complex tasks to achieve the competency required for the granting of a private pilot's licence. All of this training is conducted as VFR flight.

The Glen Innes flight academy will cater for advanced flying training into multi-engine aircraft and Instrument Flying in accordance with the Instrument Flight Rules. IFR training is conducted in suitably equipped aircraft and utilises the published instrument departure and approach procedures for the aerodrome. Consequently, these aircraft will operate above the LSALT and MSA associated with the relevant approach procedure.

5.1.6.3 *Glen Innes Circuit Area Operations*

The Glen Innes aerodrome is at an elevation of 3433ft AHD. Aerodrome Traffic Circuit heights are measured above the aerodrome elevation. The circuit direction at Glen Innes is a standard left hand pattern[3] (see Appendix A). Standard traffic circuit pattern dimensions are dependent on aircraft approach category. High performance aircraft, large turbo-prop or medium jet passenger aircraft operate at a circuit speed over 150 knots and use a larger circuit pattern which is generally no more than 5nm radius at a height of 1500ft above the aerodrome elevation. Most general aviation aircraft use a circuit speed between 55 and 150kts, a circuit radius of no more than 3nm at a height of 1000ft above the aerodrome elevation. Low performance aircraft such as ultralights, trikes, powered parachutes and small fixed wing aircraft operate at a circuit speed below 55kts at a height of 500ft above the aerodrome elevation. From diagrams associated with noise abatement requirements, the depicted circuit patterns for training at Glen Innes will not extend beyond 1.7nm (3km) from the aerodrome.

The circuit patterns at Glen Innes aerodrome, even for high performance aircraft using a 5nm radius, would still remain clear of the closest Glen Innes Wind Farm turbine.

For VFR aircraft departing the Glen Innes circuit the wind turbines will be highly visible due to their contrasting colour and size. For aircraft departing IFR or VFR at night the flight rules applicable ensure the aircraft climbs and tracks to remain clear of obstacles, including terrain and turbines.

5.2 Hazard ID

The following sections summarise the various concerns / hazards raised during the various phases of research and consultation for this project with relation to the proposed increase in height of the turbines.

5.2.1 Review of previous Aviation Risk Assessments

The potential risks to aviation identified previously in the GIWF aviation risk assessment related to a risk of collision with the turbines from:

- Over flying air routes – large vertical separation;
- Flights to and from the neighbouring aerodromes – obstacles clear of OLS;
- Low flying aerial application on land in the vicinity of the wind farm – landowners for wind farm have agreed compensation for additional costs of alternate methods;
- Operations from private airstrips in proximity to windfarm – VFR operations only, not affected;
- Recreational aviation (regular microlight activities) – located some 30 miles west; and
- Defence operations – none identified for the area.

A review of the risk assessment for the neighbouring Sapphire wind farm additionally identified the following collision risks:

- General Aviation Flight Training – undertaken within VFR rules and protected by separation requirements;
- VFR Night flights – aircraft protected by LSALT until within 3nm of the aerodrome to make a visual approach; and
- IFR flights – protected by LSALT and PANS-OPS surface.

It can be seen that the existing assessment of risks refer to “normal operations” where compliance with flight rules and procedural requirements are successfully achieved. This represents the majority of flights, however it is also appropriate in a risk assessment to consider the level of additional risk the turbines may offer to flights in “off-normal operations”, where compliance with flight rules and requirements is not observed and a loss of separation has occurred. Establishing

[3] CAAP 166 – 1(3) Operations on the Vicinity of non-controlled aerodromes, August 2014, Figure 3.

some qualitative feel for the likelihood of these potential off-normal flights or incidents in the vicinity of the wind farm is also desirable and should take into account the operating context described previously.

5.2.2 Review of ATSB Reported Incidents and Accidents

In order to achieve an understanding of any relevant reported incidents / accidents in the vicinity of the wind farm (terrain, weather, pilot behaviour), or other national incidents relevant to the identification of hazards posed by the increased turbine tip height (e.g. descent below cloud, VFR into IMC, wirestrikes), interrogation of the ATSB AvData database[4] was undertaken.

Whilst it is recognised that not all incidents are reported and that statistically the numbers cannot be relied upon as a good predictor of past or future incidents, the consideration of the types of incidents that do occur can help prompt the application of similar situations to the area in question – i.e. flights in the vicinity of the wind farm.

Incident Type	Comments
Incidents in vicinity of Glen Innes Aerodrome (+50km)	Only 4 reported in the last 2 years. One of relevance was the failure of transponder altitude indication.
Unforecast Weather	12 incidences of VFR into IMC incl Charter, Private and 1 training flights. No aerial application flights.
Encountering cloud	7 reported occurrences of flying through cloud during VFR ops.
Loss Of Control (LOC)	Flight training and aerial work are the most common flight types reported.
Flight below minimum altitude	49 total reports for the period with a full mix of private / commercial / RPT flights in VFR and IFR. Many relate to descent below LSALT on approach to an airport (i.e. where there is surveillance). There are a few related to being below min safe altitude in cruise due to a failure in altitude indication, pilot becoming disorientated in cloud.
WireStrike	No collisions with wind turbines have been reported. 73 total incident reports, 69 during aerial work. None reported “visibility, visual, IMC or cloud” within the occurrence details, leading to the conclusion that all wirestrikes occurred during good visibility conditions. Remainder included, private, charter, business and glider operations occurring predominantly on approach to an airport.
Forced landing & collisions with terrain	108 total incidents reported, predominantly on approach or take-off. 30 incidents occurred during cruise.

5.2.3 Stakeholder Consultation

During stakeholder consultation (see Appendix B) the following issues / hazards were identified:

- Collision with WMT – need for marking / lighting;
- Collision with wind turbine – Aerial Application;
- Loss of Control due to Turbine turbulence;
- Day VFR Collision with Turbine - Pilot descending in low visibility conditions;

[4] https://www.atsb.gov.au/avdata/

- Day VFR collision – student pilots;
- Night VFR Collision with Turbine – false negative due to light placement / operation;
- Night VFR – Westpac rescue helicopters performing medical rescue;
- Loss of Control – Turbulence from wind turbines (vertical & horizontal); and
- Cumulative Effect of multiple wind farms.

5.2.4 Review of reported Global Accidents with Wind Farms

It is estimated by the Global Wind Energy Council[5] that there were 341,320 wind turbines generating power around the world at the end of 2016, with Asia, Europe and North America dominating the level of power generated through wind.

A review of the global reported accidents has revealed 6 fatal aircraft accidents associated with wind farms in the US [6], 5 of which are as a result of a collision with a wind monitoring tower, 1 with a wind turbine. Of these, 4 occurred during Low Flying Aerial application operations.

Table 5-5 US Fatal Aviation Accidents at Wind Farms

Date / Location	Activity / Collision	Investigation Ref	Key Facts
2003, Vansycle, OR	Transport (WMT)	NTSB Accident ID SEA04LA027	ATPL pilot in experimental class tail wheel Low Flight in VMC with passenger 50m high WMT, No marking / lights
2005, Ralls, TX	Ag Spray (WMT)	NTSB Accident ID DFW05LA126	VMC No marking or lights
2011, Oakley, CA	Ag Spray (WMT)	NTSB Accident ID WPR11LA094	VMC No marking or lights
2013, Balko, OK	Ag Spray (WMT)	NTSB Accident ID CEN13FA465	VMC No marking or lights
2014, Highmore, SD	Transport (Turbine)	NTSB Accident ID CEN14FA224	Obstacles not marked on charts. Local CPL Ag pilot flying VFR into IMC at night. Collision with blades. Witnesses saw a/c fly over at 200'. Obstacle Light on turbine failed
Aug 19, 2016	Ag Spray (WMT)	NTSB Accident ID CEN16LA326	VMC No marking or lights

A recent collision with a wind turbine in Germany occurred in February 2017. No investigation report is available, but from media reports it seems that there was good VMC conditions and that the recreational aircraft struck the turbine at a height of 40m AGL. The turbine was located 1.5km from an airstrip, but whether the aircraft was operating from this airstrip has not been confirmed.

So, it can be concluded that collisions with wind turbines have been very rare events. Whilst not statistically relevant, the two collisions noted above are however informative, since the 2014 collision in Highmore appears to have several contributing factors relevant to the identification of hazards. The cause of the accident sequence seems to be the continuation of a VFR flight into IMC conditions, resulting in a very low-level flight. Complicating factors are that the pilot was aware of the wind turbines, that they were not recorded on the navigational charts and that obstacle lights were installed but reportedly not operating on this particular turbine at the time of the accident. NTSB investigators stated in their report that "[if] the pilot observed the lights from the surrounding wind turbines, it is possible that he perceived a break in the light string between

[5] http://www.gwec.net/global-figures/interactive-map/#

[6] https://www.masterresource.org/windpower-safety-issues/wind-aviation-safety-v/

the wind turbines as an obstacle-free zone". This potential effect is what we refer to as a "false negative" in this risk assessment.

5.2.5 Consideration of Cumulative Wind Farm Risks

UK CAA CAP 764 offers guidance in relation to considerations when assessing the aviation impacts from wind farms. One recommendation is that consideration to the potential cumulative effect of multiple wind farms co-located in an area is given.

There are two other proposed wind farms in the region (White Rock and Sapphire), and the Sapphire Wind Farm is located north of the Gwydir Highway between Glen Innes and Inverell and at a close distance west of the GIWF (see Figure 5-3). The Sapphire wind farm consists of 3 clusters of turbines.

The White Rock Wind Farm is located to the South West of the GIWF as shown in Figure 5-6 below (as presented in the White Rock Wind Farm Environmental Impact Assessment).

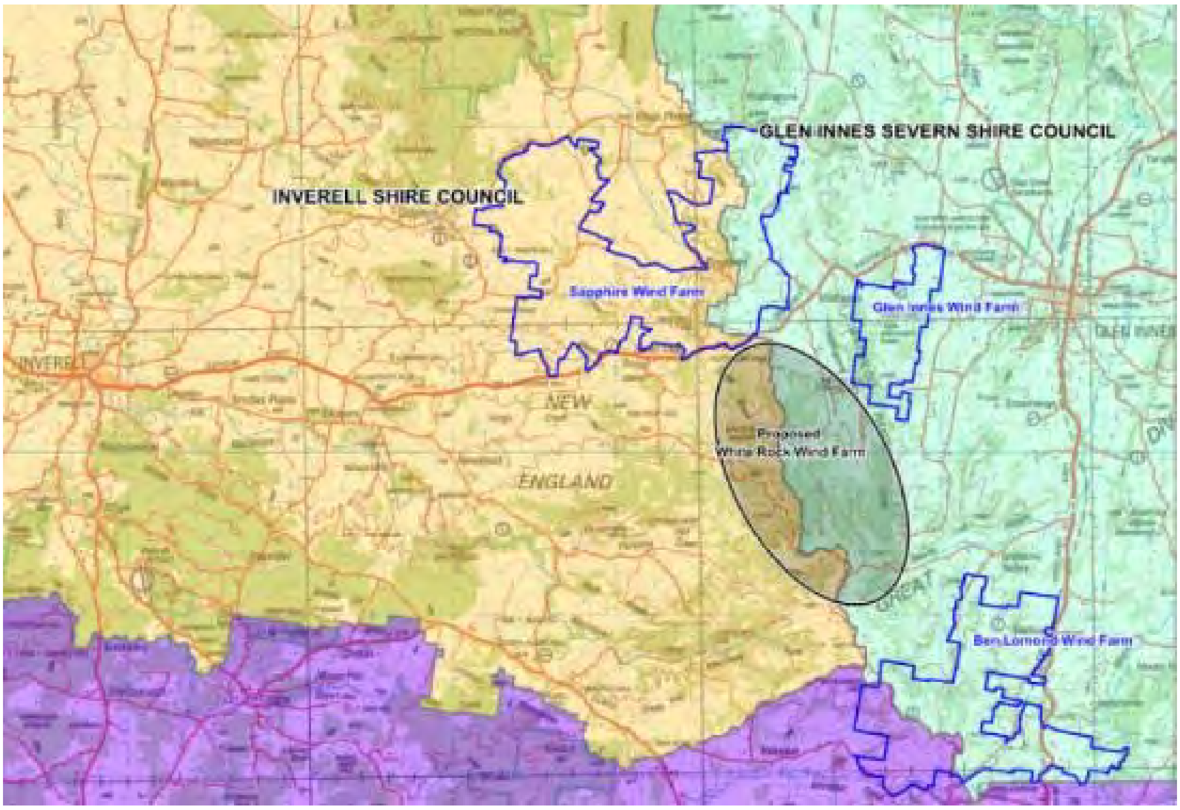


Figure 5-6 Location of neighbouring wind farms

There are two concerns identified related to the cumulative risks of these wind farms:

- Potential for navigational "Pinch Points"; and
- Human Factors implications for a Non-Standard approach to Obstacle Lighting.

VFR aircraft travelling between Glen Innes and Inverell, in the event of reduced visibility, aircraft can visually follow the Gwydir highway. The wind farms are located sufficiently far away from each other that aircraft undertaking this method of visual navigation will have sufficient room to navigate clear of the wind farms whilst maintaining visual contact with the road. It is therefore concluded that no "pinch point" exists to hinder visual navigation in VMC.

For the non-standard application of aviation obstacle lighting it is considered that for night VFR flights, there the potential for confusion if some of the wind turbines (clusters) are lit and others aren't – i.e. a "false negative" can be created whereby pilots feel they are clear of all obstacles when in fact they are not. This potential threat has been added to the scenarios for risk assessment.

5.3 Bowtie Risk Analysis

The following hazards to aviation in the vicinity of the wind farm were identified for detailed analysis:

1 VFR Flights in VMC in vicinity of wind farm;
2 Night VFR flights in vicinity of wind farm;
3 Flights in IMC in vicinity of wind farm;
4 Authorised Low Level Operations in VMC in vicinity of wind farm.

Each of these have been developed as a Bowtie.

The potential consequences of concern from these loss of separation hazards are:

- Loss Of Control (LOC) of the aircraft (due to collision avoidance manoeuvring or turbine wake turbulence); and
- Controlled Flight Into Terrain (CFIT), where an aircraft, still under effective control by the pilot, collides with terrain or an obstacle.

When considering these hazards, it is important to make sure we are focussed on the additional risk that the wind turbines pose to an aircraft already in these identified ”accident” conditions, where collision with terrain or loss of control is a potential risk, irrespective of whether the turbines exist or not. The majority of the identified threats that could lead to an aircraft loss of separation event with the turbines can only occur once a system or compliance failure with existing aviation requirements has occurred:

- Precautionary Landing due to system failure;
- Pilot / System Navigational error;
- Pilot Training Activities;
- VFR Flight into IMC; and
- Authorised Low Level Operations.

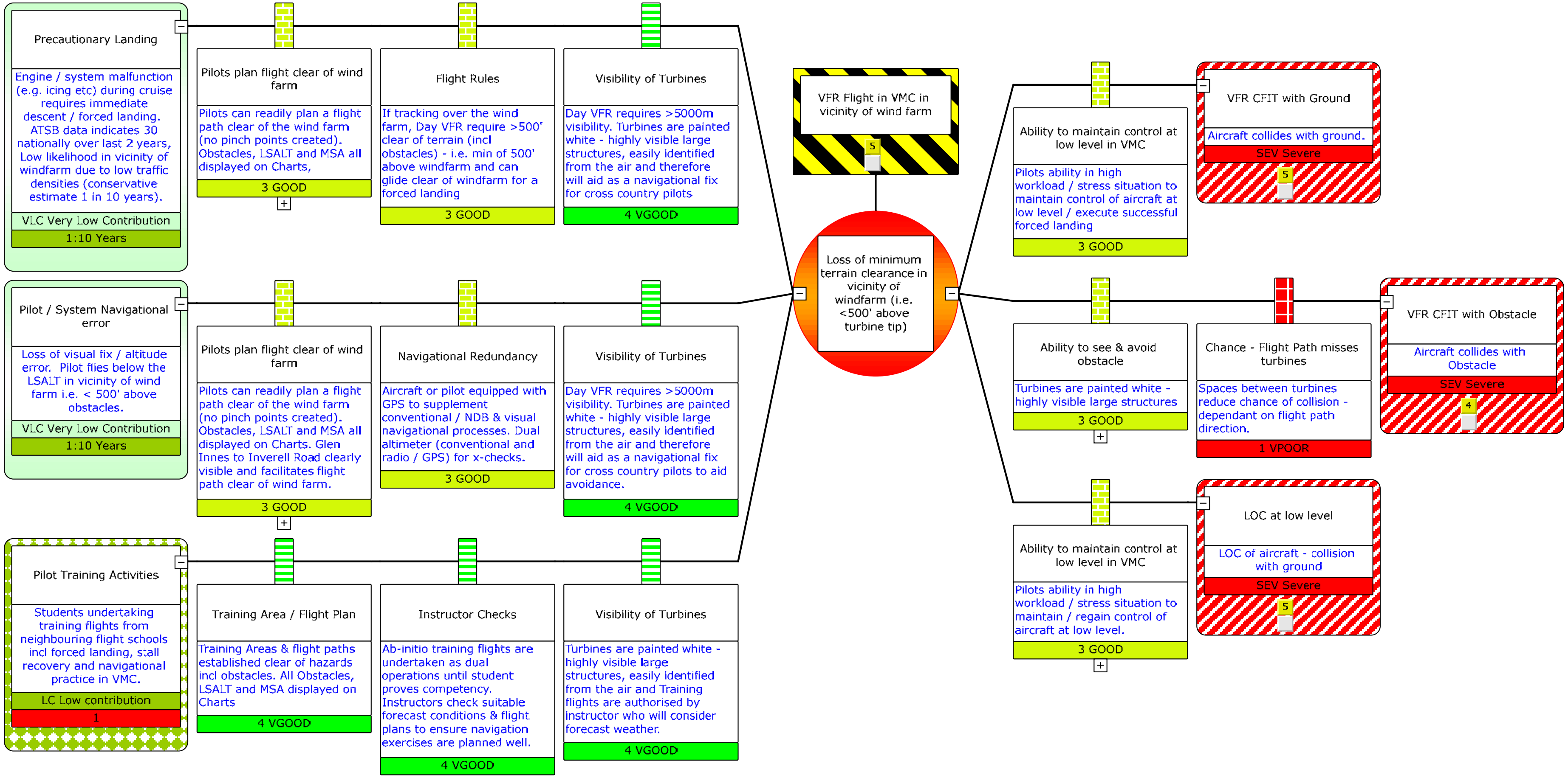
The main effect that the presence of the wind turbines has is to raise the level of minimum terrain separation (LSALT) required, which has not been identified as a cause for any threat sequences.

Hence for these Bowties, the two outcomes or consequences relating to CFIT (into ground or collision with an obstacle) are intended to provide a relative comparison of the risks for the event outcomes dependant on whether a wind turbine is present (CFIT -obstacle collision) or not (CFIT – ground).

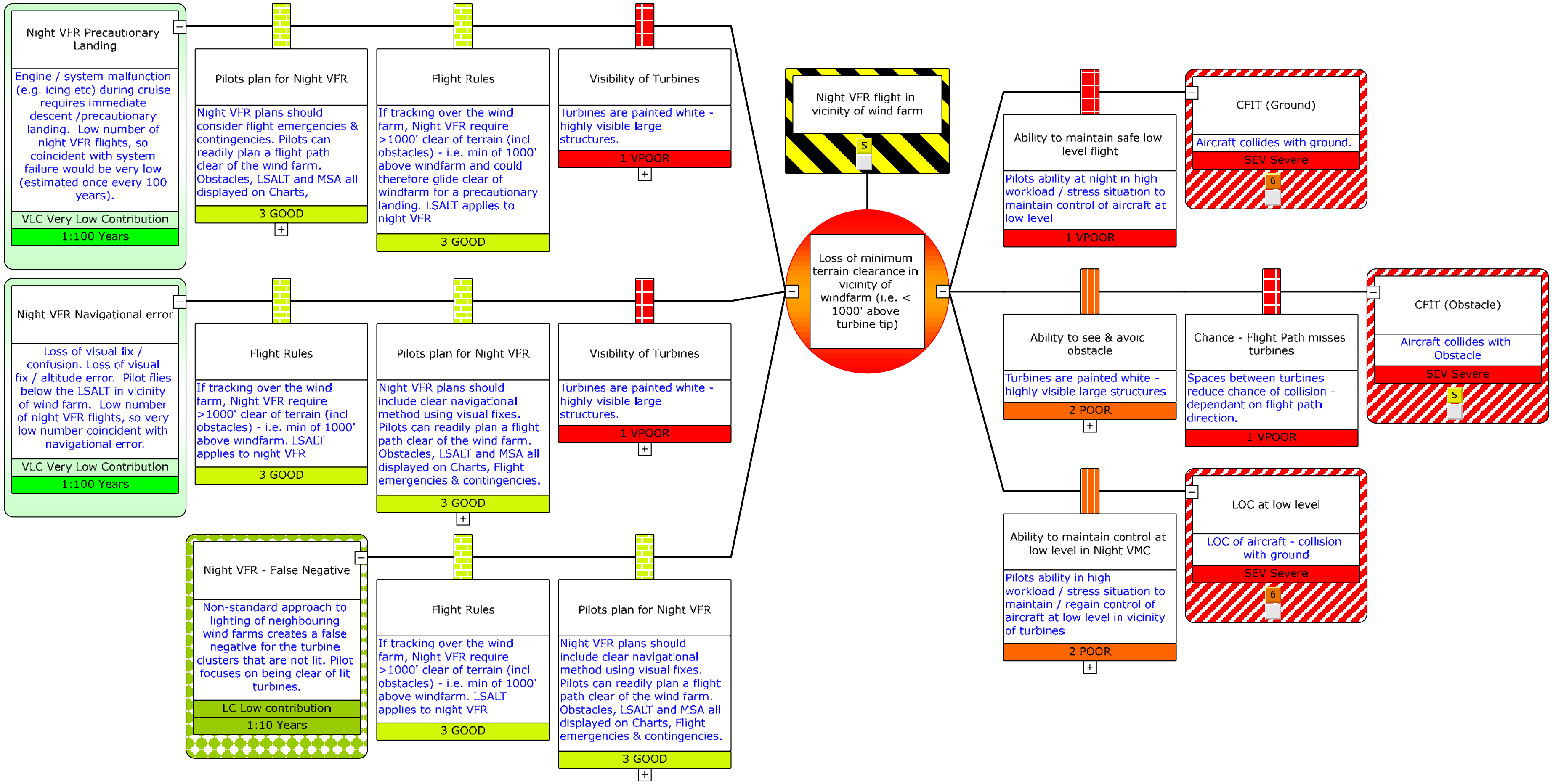
When considering the cumulative effect of this wind farm with other neighbouring ones in close proximity (in particular the Sapphire wind farm clusters), an additional hazard has been identified which relates to the recent determination that obstacle lighting should be provided on the Sapphire wind farm. There is potential to create confusion for Night VFR pilots if the GIWF is not lit – i.e. the potential for what is described as a “false negative” (i.e. a VFR pilot believes that the end of a string of obstacle lights indicates that they are clear of all turbines and hence in an obstacle free zone. This is discussed further in the Obstacle Lighting review.

The full expanded Bowties are provided as Appendices C and D to this report, but the top level summary Bowties are provided on the following pages.

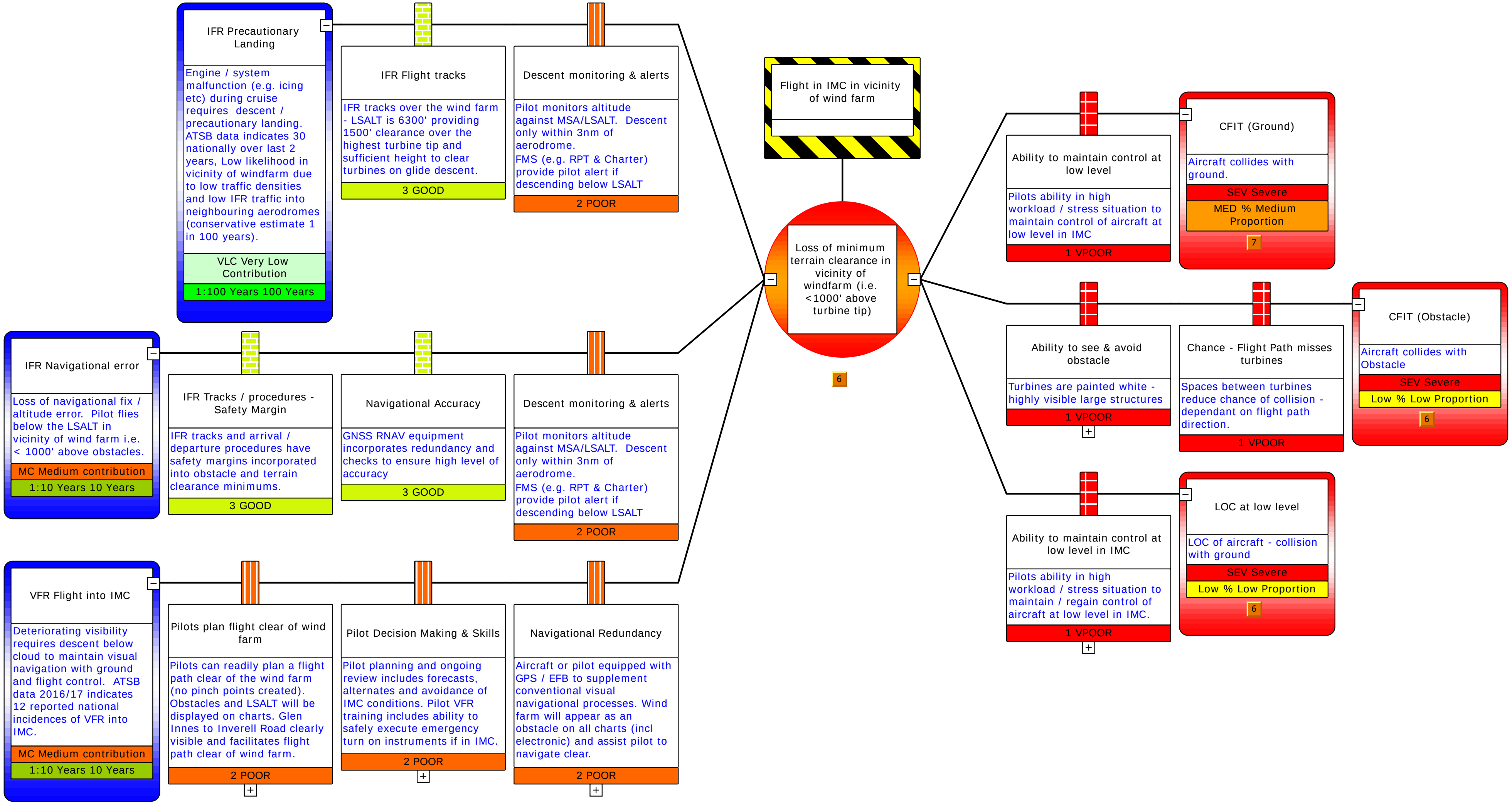
5.4 VFR Flights in VMC in vicinity of wind farm



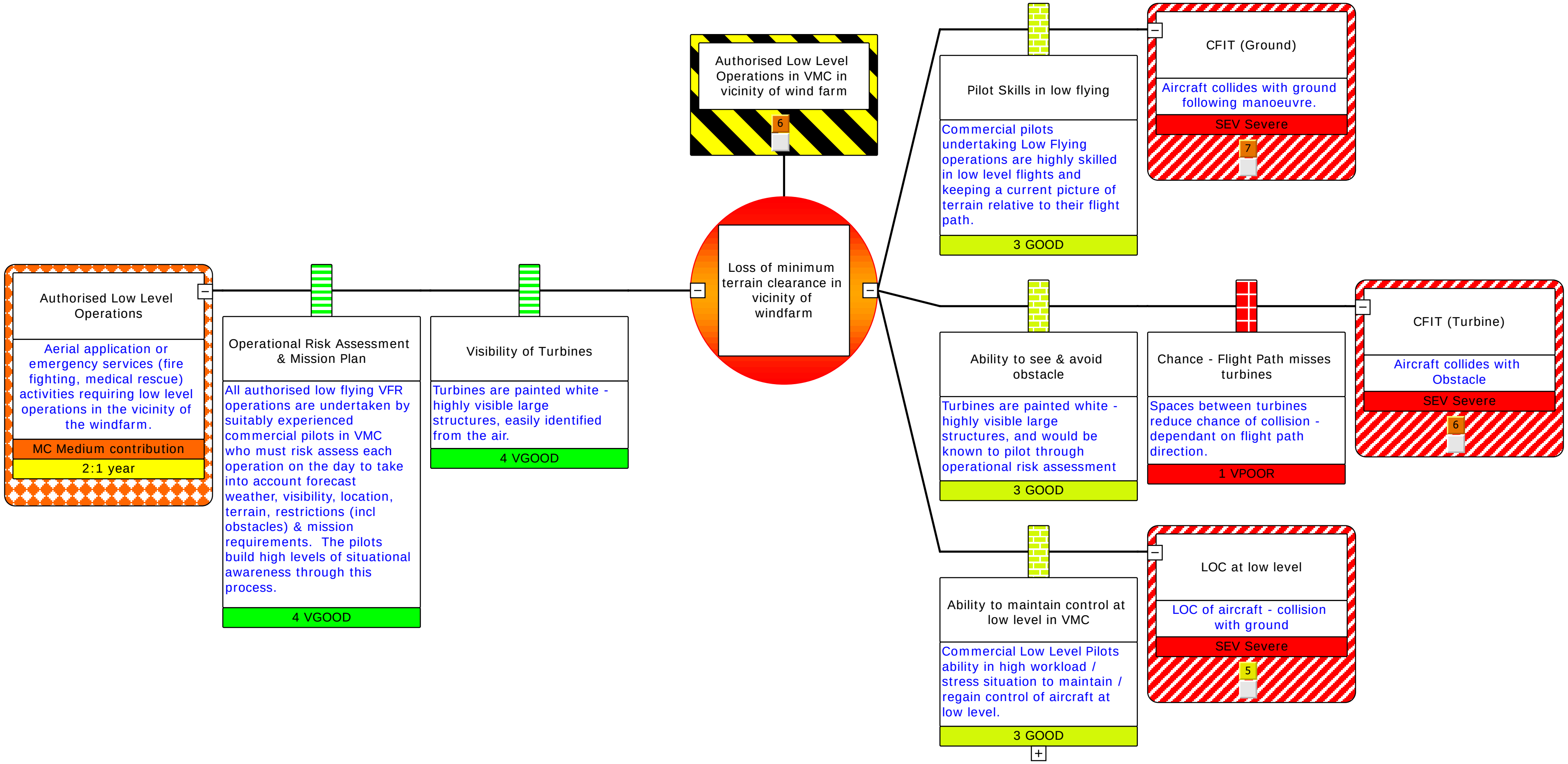
5.5 Night VFR flights in vicinity of wind farm



5.6 Flights in IMC in vicinity of wind farm



5.7 Authorised Low Level Operations in VMC in vicinity of wind farm.



5.8 Risk Acceptability

It can be seen from these summary level bowties, that there are three threats which are considered to be Medium Contributors to a loss of separation event occurring in the vicinity of the wind farm:

- Authorised Low Level Operations;
- VFR flights into IMC conditions; and
- IFR navigational error in IMC.

There are 7 risk outcomes that have an inherent high risk ranking. Because the outcomes all relate to severe outcomes (1 or 2 fatalities), the risk scores cannot be reduced below medium on the CASA risk matrix. The 7 high risk outcomes relate to:

- Night VFR – CFIT ground;
- Night VFR – LOC at low level;
- Flight in IMC – CFIT ground;
- Flight in IMC – CFIT Obstacle;
- Flight in IMC – LOC at low level;
- Authorised Low Level Flights - CFIT ground; and
- Authorised Low Level Flights - CFIT obstacle

	GIRF Safety [Baseline]	0 Insignificant	1 Minor	2 Moderate	3 Major	4 Severe	5 Catastrophic
5	Almost Certain						
4	Likely						
3	Possible					[2]	
2	Unlikely					[5]	
1	Rare					[4]	
0	Extremely Rare					[1]	

Of these 7scenarios, 3 are inherent risks associated with a loss of separation with the terrain (CFIT into the ground). The other 4 outcomes relate to collisions with a turbine (obstacle) or a LOC due to encountering turbine wake or manoeuvring to avoid a turbine during IMC flights or during Low Level Operations.

The presence of the wind turbines therefore does not increase the risk of accidents beyond the inherent (high) level associated with these loss of separation events occurring in these particular conditions.

5.8.1 Obstacle Lighting Review

The risk assessment finds that the addition of obstacle lighting will not significantly benefit in the prevention of the identified dominant threat lines which contribute to the high risks (higher likelihood collision events) which are flights in IMC and authorised low flying.

Similarly, obstacle lighting will not benefit day VFR flights in VMC, since the turbines themselves are already highly visible. Hence the addition of obstacle lighting is unlikely to significantly further reduce the likelihood of these rare events caused by the siting of the wind turbines.

However, when considering the effect of obstacle lighting in terms of reducing the identified risks associated with Night VFR aviation activities in the vicinity of the wind farm, it has been determined that lighting would offer some benefit, mainly because they will act to assist night VFR pilots in avoiding the area (act as a navigational fix) so that aircraft are not at risk in the rare event of needing to descend (system failure / weather) (i.e. the RHS of the bowtie).

As a barrier on the RHS of the Bowtie, (i.e. a final mitigation measure), once required obstacle separation has been lost, lighting as a collision avoidance mechanism will be less effective for the following reasons:

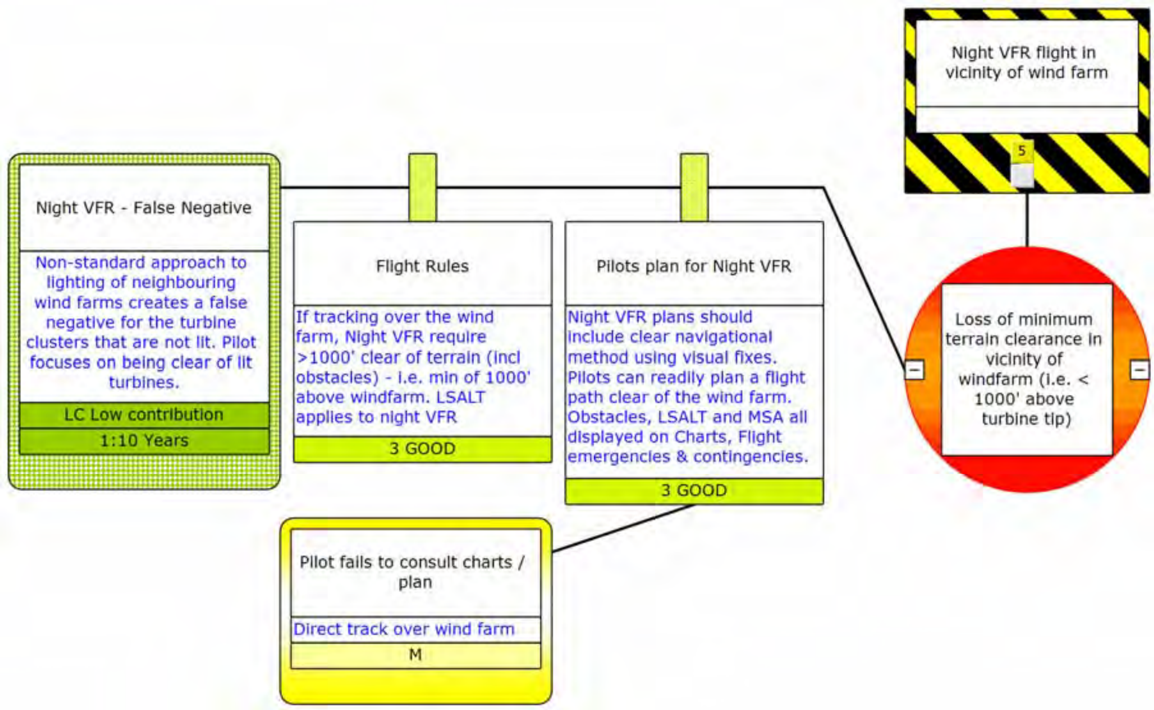
- Pilot ability to see, avoid and react during night-time low level flying would be poor;
- Lights are not an accurate representation of obstacle height (not mounted on the highest point); and
- Lights are not provided on every individual turbine;

Therefore, it is concluded that avoidance actions reliant on sighting and avoiding the lights (once separation is lost) would have a low success rate.

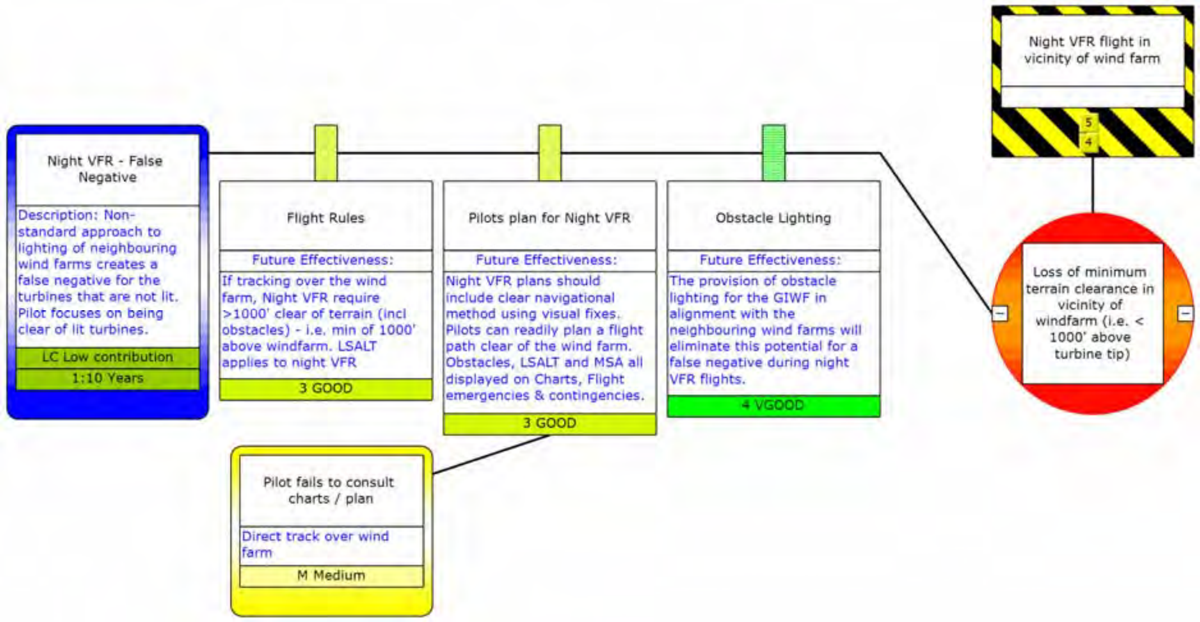
When obstacle lighting is applied as a barrier in the Bowties, the reduction of risk associated with potential accident outcomes is marginal and overall risk remains at a high level overall due to the remaining inherent risk of collision with terrain.

Collision with an obstacle at night was determined to be a Medium risk and remains as a Medium risk following application of the obstacle lighting, however the risk of a LOC due to an encounter with wake turbulence reduces from High to Medium.

When considering the cumulative effect of neighbouring wind farms, one of the loss of separation threat lines identified for aircraft undertaking night VFR flights was the potential for a “false negative” to be generated if (as is the case) the planned neighbouring wind farms are to incorporate obstacle lighting:



The addition of obstacle lighting will eliminate the above potential issue of a navigational "false negative".



No benefits were derived for authorised low flying activities (in VMC) or VFR flights in VMC.

The overall cumulative risk reduction is illustrated on the following risk matrix:

	Risks [Baseline] Residual	**0** Insignificant	**1** Minor	**2** Moderate	**3** Major	**4** Severe	**5** Catastrophic
5	Almost Certain						
4	Likely						
3	Possible					**[2]2**	
2	Unlikely					**[5]4**	
1	Rare					**[4]4**	
0	Extremely Rare					**[1]2**	

It can be seen that there is a marginal reduction in risk, with one outcome reducing from a high to a medium risk.

5.8.2 Wind Monitoring Towers

Whilst outside the scope of this risk assessment (the proposed turbine height increase will not affect the placement or height of WMT), the majority of aviation accidents associated with wind farms relate to the collision with WMT during low flying activities. This is because they are narrow tall structures that are very difficult to see from the air.

WMT's may be permanent or temporary and hence their presence is not always apparent to aviation operators.

Marking and lighting of WMT's is specified in NASF Guideline D.

5.9 Summary of Findings

For operations compliant with Visual or Instrument Flight Rules (VFR/ IFR), the proposed increased height in the turbines has been shown to offer no increase in risk to aviation.

The Aviation Impact Assessment has confirmed there is no impact on the protected obstacle free surfaces required to maintain the safety of IFR flights.

For VFR flights, no existing highly trafficked routes transit through the wind farm location and sufficient vertical and lateral separation can easily be achieved within the existing surrounding navigable airspace.

It is therefore only in the event of Authorised Low Level flights (e.g. aerial application, emergency response) in the immediate vicinity of the wind farm, and flights operating outside prescribed rules and conditions (accident / incident conditions) that the wind farm obstacles can be shown to offer any additional risk to aviation. It is these flights that are the subject of this risk assessment.

6. RECOMMENDATIONS

6.1 Obstacle Lighting Plan & Maintenance

Primarily as a result of the decision to install obstacle lighting on the neighbouring Sapphire wind farm (rather than collision risk per se), it is recommended that the same obstacle lighting regime plan be adopted, (i.e. lighting intensity, type, spacing) to ensure against the false negative issue identified in this report.

Once turbines are constructed and lights installed, it is critical to aviation safety that continuous monitoring of light status and the detection of failures is guaranteed, such that the prompt reporting and rectification of a failed obstacle light is achieved.

The lighting plan for the GIWF should be developed with reference to CASA Manual of Standards (MOS) 139 and NASF Guideline D (as outlined in Appendix F).

6.2 Avoiding Low Level flights in vicinity of wind farms

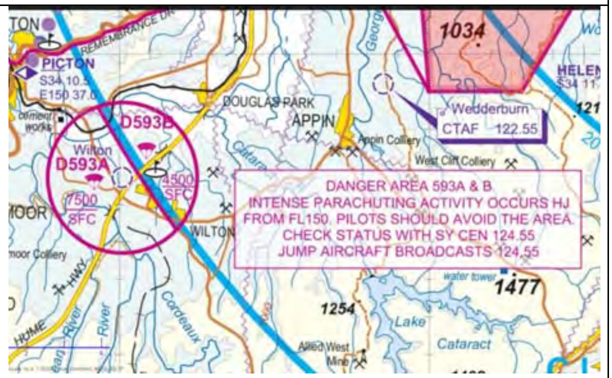
Whilst obstacle lighting may assist in the avoidance of the area for night VFR flights, it is worth reviewing other available mechanisms for strengthening the prevention of the loss of separation events that may be effective in all conditions. The key to prevention of a collision with a turbine is to ensure that pilots, when planning flights, avoid overflying the wind farms.

This could be achieved through a combination of:

- Reinforcement with local pilots through consultation with the local flying schools, clubs and companies operating in the area;
- Pilot Education through CASA and RAA regarding the hazards associated with flights in the vicinity of windfarms;
- Pilot Education through CASA and RAA regarding the commonly mis-understood aspect of the aviation regulations with respect to navigable airspace for in VFR flights – i.e. that day VFR flights MUST be conducted with a minimum vertical separation of 500’ above the ground **and any object on it**; and
- Clearer designation of wind farms on the navigation charts to aid pilot comprehension where multiple wind farms exist.

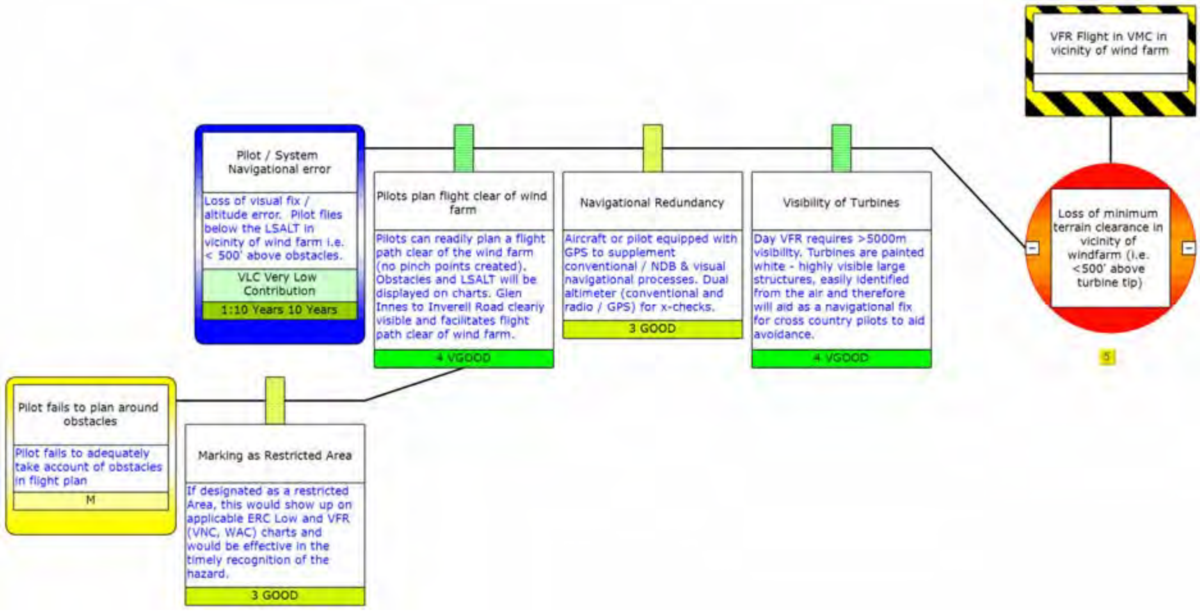
It is considered that for those itinerant pilots who are planning cross country flights, within an area occupied by multiple tall structures (wind farms), that it is important that these are as obvious as possible when consulting the navigation charts (paper or digital). To this end, Ambidji recommend that CASA consider designation of wind farms, particularly where there are multiple wind farms) as Restricted Access areas (SFC – LSALT).

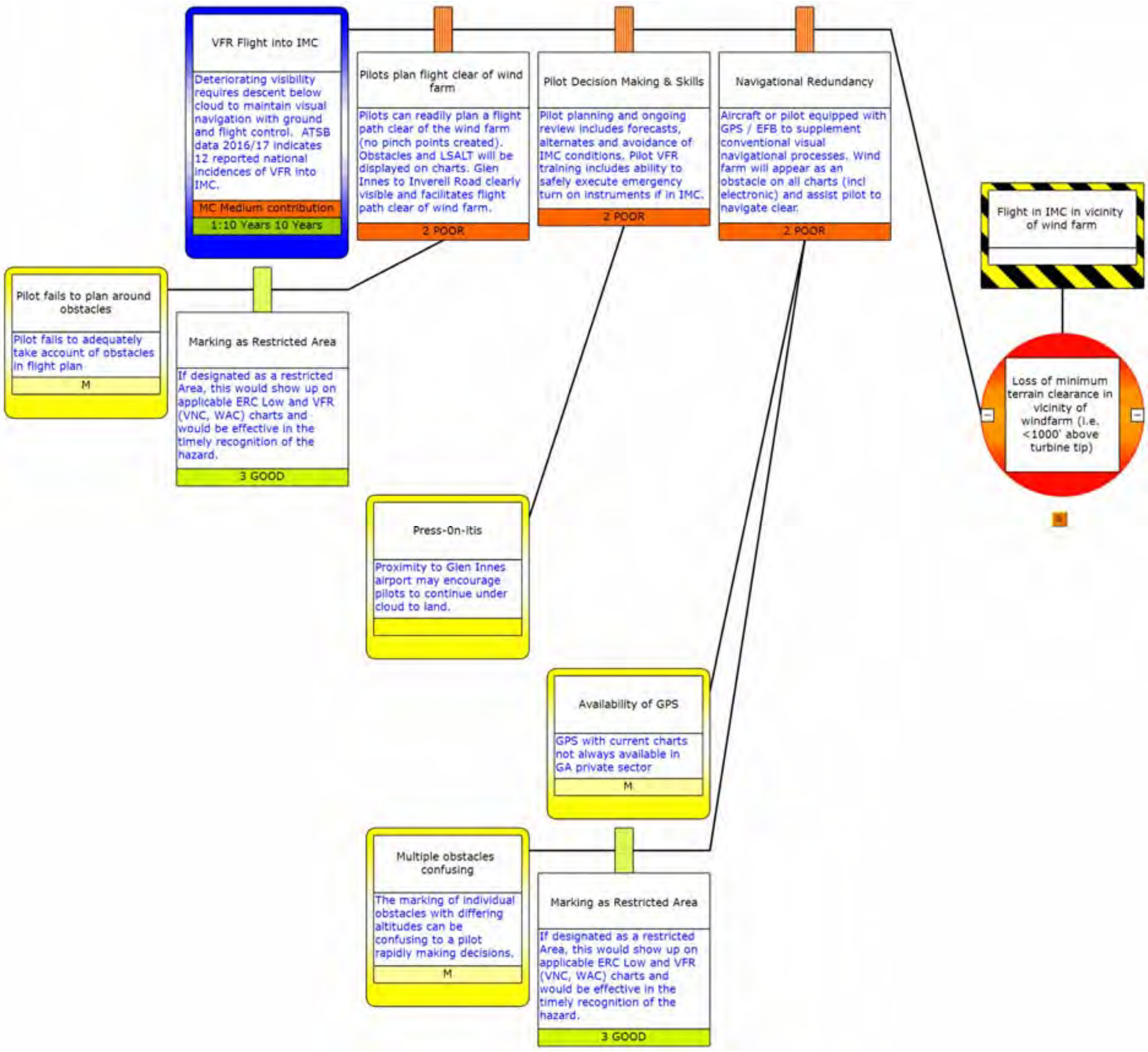
Restricted and Danger areas are defined more clearly on the navigation charts (VFR and IFR) than obstacles and would assist in more immediate pilot recognition of their presence (particularly during time critical identification hazards during flights where flight abnormalities must be managed). With each wind farm marked as a restricted area, Ambidji believes that pilot recognition of the hazard, and options for navigation clear of them would therefore be more readily apparent. The level of compliance with maintaining necessary clearance from a restricted area may also be higher than that of marked individual obstacles.

Hazard Marked as Obstacles	Hazards marked as Danger Area
	

Access for authorised low flying activities would then be agreed through consultation with the wind farm operator.

These preventative measures (i.e. preventing a pilot choosing to fly in the vicinity of the windfarm), will further reduce the unlikely chance that a pilot would collide with a wind turbine in VMC (abnormal operations) and VFR flight into deteriorating conditions:





It is considered that collectively these measures should further reduce the likelihood of these collision scenarios and are justifiable as they are low cost measures to implement, with no ongoing maintenance costs.

6.3 Notification and Update of Charts

The wind farm must be reported to aviation authorities in accordance with AC 139-08(0) “Reporting of Tall Structures” and marked on the appropriate aeronautical charts e.g. the World Aeronautical Chart (WAC) 3357 Armidale, Enroute Chart (ERC L3 Eastern NSW), Visual Navigation Chart (Brisbane VNC), published by Airservices Australia cover the windfarm area.

Prior to the commencement of construction and operation of the wind farm, Glen Innes Power Pty Ltd must provide the following information to CASA, Royal Australian Air-Force-Aeronautical Information Service and Airservices Australia:

- As constructed coordinates in latitude and longitude of each wind turbine;
- Final height of each wind turbine in AHD; and
- Ground level at the base of each wind turbine in AHD.

A Notice to Airmen (NOTAM) will be issued (by AsA) until this change is accurately reflected in the WAC.

Additionally, formal notification of the location and height of the turbines should be made to:

- Local aviation operators;
- Local Aerial Agricultural Applications Operators at Armidale and surrounding area;
- NSW Police Air Wing;
- NSW Ambulance Service;
- NSW Rural Fire Service;
- Aerial Agricultural Association of Australia (AAAA); and
- Recreational Aviation Australia (RA-Aus).

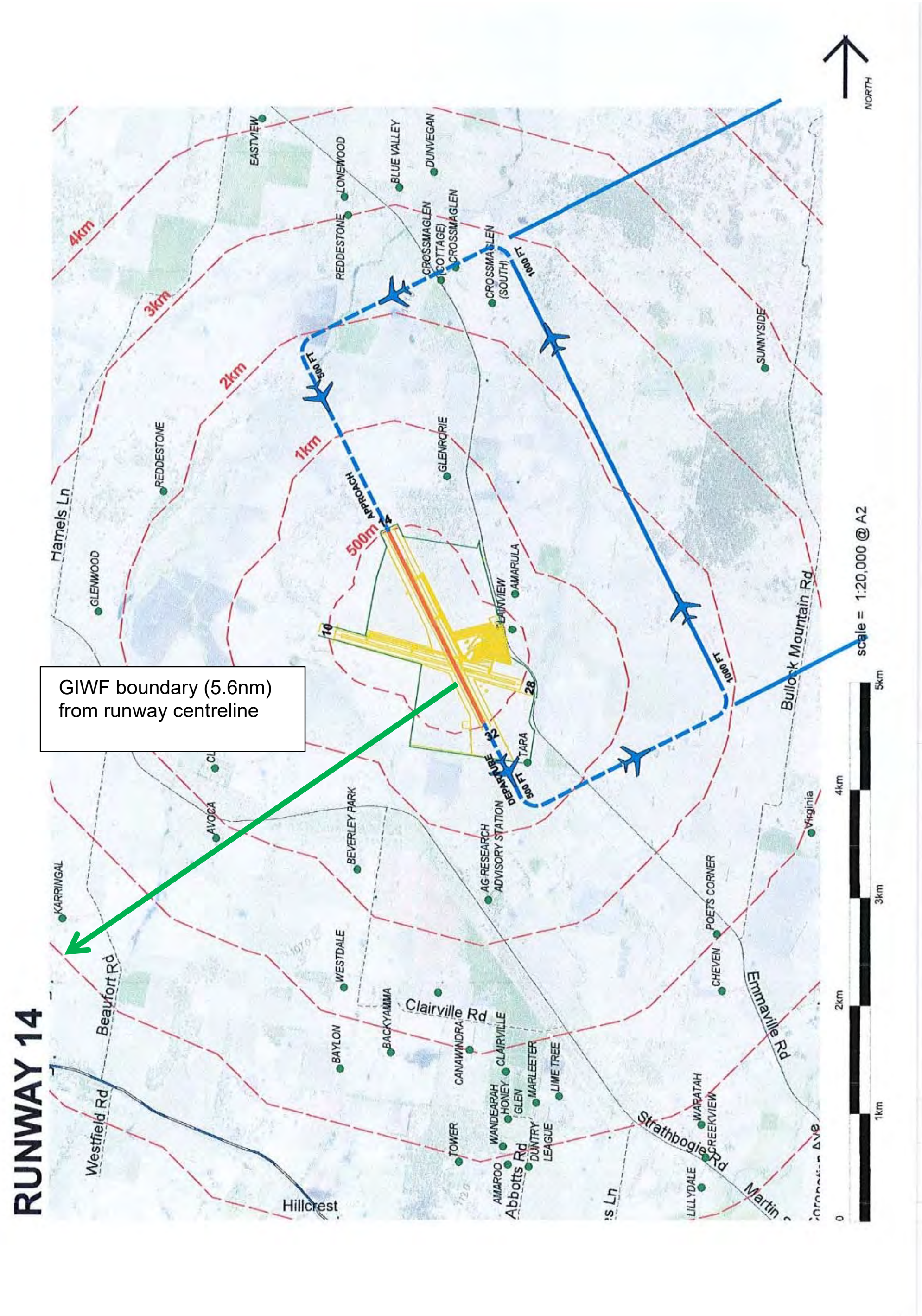
6.4 Marking of Wind Monitoring Towers

Ambidji recommend that as per MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D), any WMT's deployed on the GIWF be suitably marked and notified through NOTAM's. This should include the marking of masts, poles and towers in contrasting bands and the attachment of three-dimensional coloured objects such as spheres and pyramids to wires or cables.

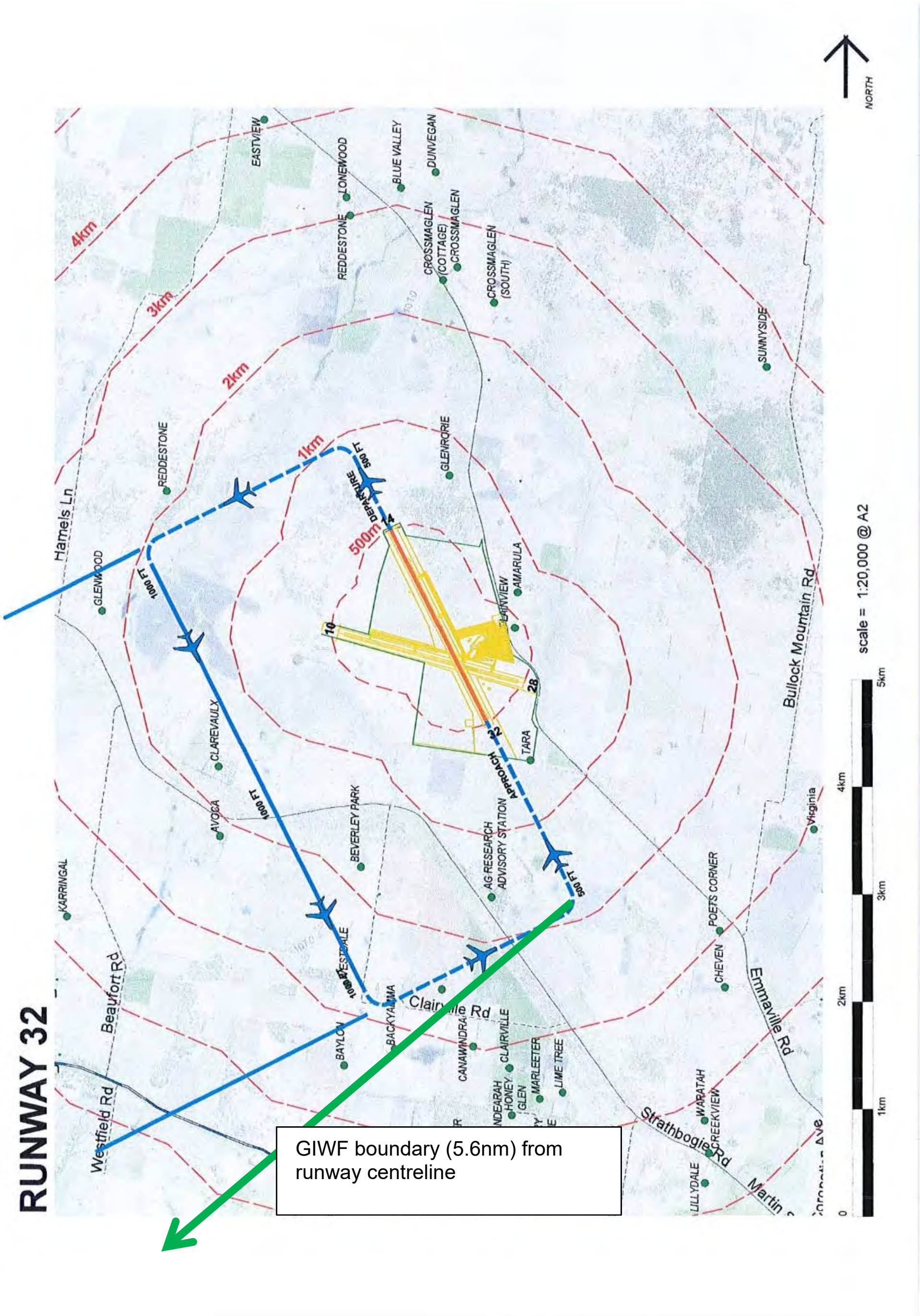
The proponent should ensure details of all wind monitoring towers on the Project site are communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction.

APPENDIX A. Glen Innes Circuit Patterns

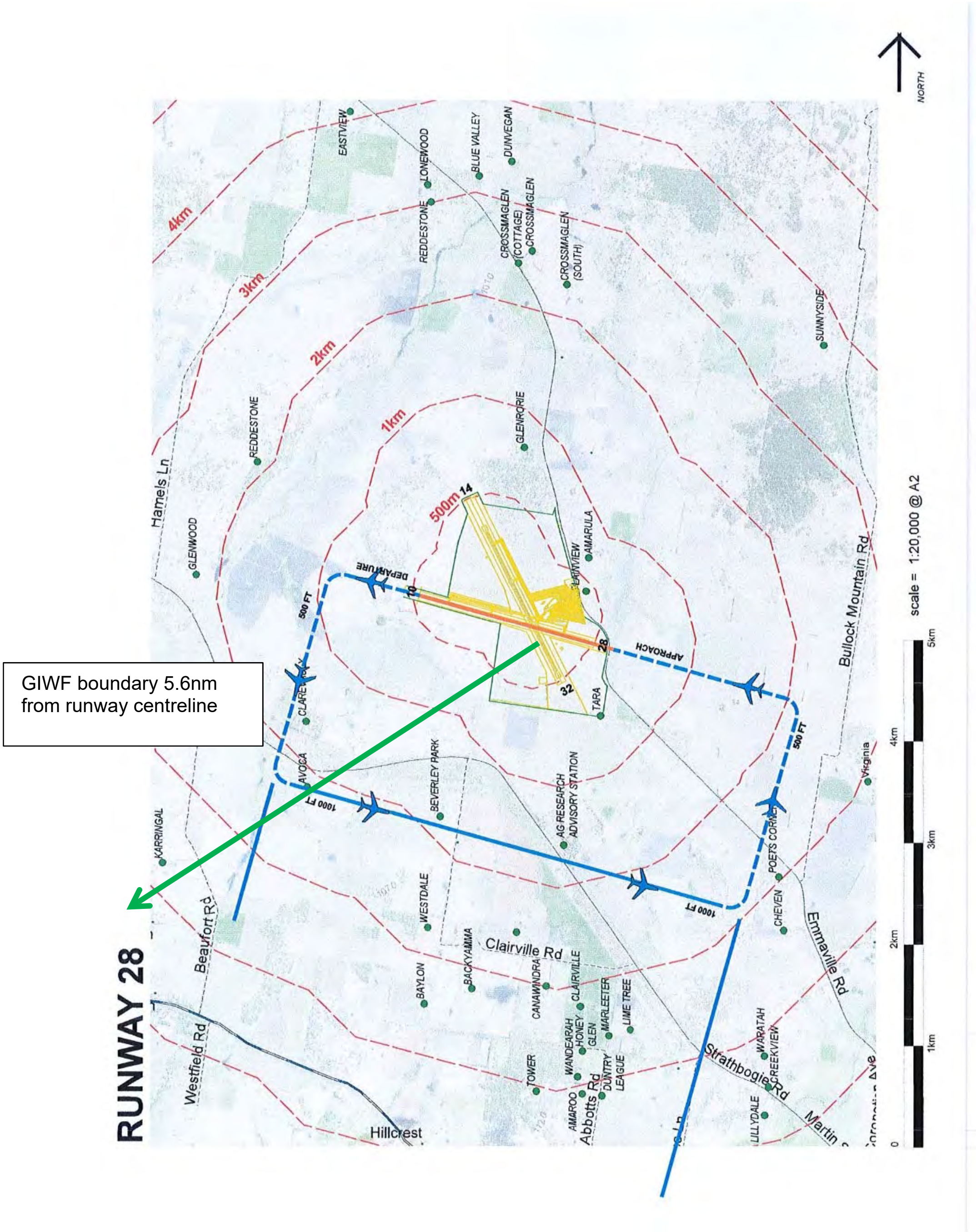
Runway 14



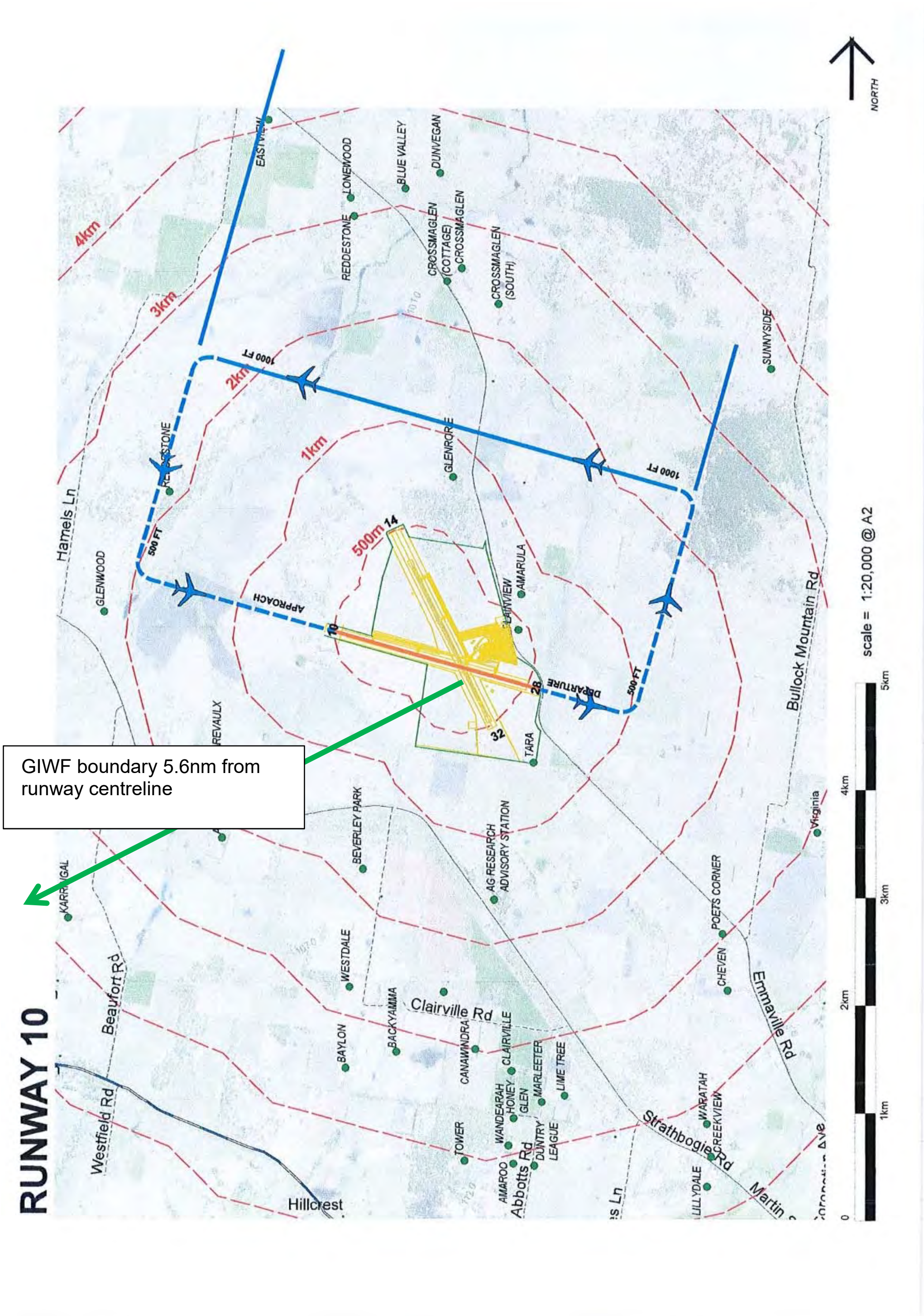
Runway 32


RUNWAY 32
GIWF boundary (5.6nm) from runway centreline
scale = 1:20,000 @ A2
NORTH

Runway 28


GIWF boundary 5.6nm from runway centreline
RUNWAY 28
NORTH
4km
3km
2km
1km
500m
14
10
28
32
DEPARTURE
APPROACH
500 FT
1000 FT
scale = 1:20,000 @ A2
0
1km
2km
3km
4km
5km
Hamels Ln
Beaufort Rd
Westfield Rd
Hillcrest
Clairville Rd
Abbotts Rd
Bullock Mountain Rd
Emmaville Rd
Strathbogie Rd
EASTVIEW
LONEWOOD
BLUE VALLEY
DUNVEGAN
REDDESTONE
CROSSMAGLEN (COTTAGE)
CROSSMAGLEN
CROSSMAGLEN (SOUTH)
SUNNYSIDE
REDDESTONE
GLENRORIE
GLENWOOD
AMARULA
TARA
AVOCA
BEVERLEY PARK
AG RESEARCH ADVISORY STATION
KARRINGAL
WESTDALE
BACKYAMMA
BAYLON
CANAWINDRA
CLAIRVILLE
TOWER
MARLEETER
LIME TREE
POETS CORNER
CHEVEN
WARATAH
CREEKVIEW
LILLYDALE
Virginia

Runway 10


RUNWAY 10
NORTH
scale = 1:20,000 @ A2
GIWF boundary 5.6nm from runway centreline
4km
3km
2km
1km
500m
1000 FT
500 FT
APPROACH
DEPARTURE
Hameis Ln
Bullock Mountain Rd
Beaufort Rd
Westfield Rd
Clairville Rd
Abbotts Rd
Strathbogie Rd
Emmaville Rd
Hillcrest
EASTVIEW
LONEWOOD
BLUE VALLEY
DUNVEGAN
REDDESTONE
CROSSMAGLEN (COTTAGE)
CROSSMAGLEN
CROSSMAGLEN (SOUTH)
SUNNYSIDE
GLENROPE
GLENWOOD
AMARULA
TARA
REVAULX
BEVERLEY PARK
AG RESEARCH ADVISORY STATION
POETS CORNER
CHEVEN
WESTDALE
BACKYAMMA
BAYLON
CANAWINDRA
CLAIRVILLE
MARLEETER
LIME TREE
TOWER
WARATAH
CREEKVIEW
LILLYDALE
Virginia
14
10
28
32
0
1km
2km
3km
4km
5km

APPENDIX B. RECORD OF STAKEHOLDER CONSULTATION

The following table provides a record of the discussions held between Ambidji and identified key stakeholders when undertaking the risk assessment for the increase from 150m to 180m tip height turbines.

Date	Organisation / Contact	Discussion Points / Comments	Hazard Identification (HAZID) items
7/7/2017	CASA / Matthew Windebank. Telecon.	Matt presented the following view in regard to windfarm risk assessments and lighting requirements: CASA take the view that they must consider their liability in any recommendations regarding lighting of wind turbines. This means that even though a risk assessment might indicate no lighting requirement, CASA may still recommend that lighting be installed. There are a couple of wind farms in remote areas (e.g. Broken Hill & Dubbo – 180m turbines) where CASA have recommended that no lighting is required. For the neighbouring Sapphire wind farm, Matthew understood that Medium Intensity lighting had been recommended. Ambidji pointed out that this approach undermines one of the purposes of the risk assessment. Matthew indicated that CASA consider that a "cookie cutter" approach to many aviation risk assessments is taken and therefore do not have great confidence in their findings / recommendations. The potential effectiveness of lighting as a last line of defence as collision mitigation was discussed and Ambidji presented that this needs to be presented in comparison to other controls that may be more effective in preventing pilots descending to a low level in the vicinity of the wind farms. This includes the clear identification of key accident scenarios and the relevant preventative / mitigative controls so that a logical and well-founded outcome could be presented. Ambidji suggested that the Bowtie risk assessment methodology would be well suited and arranged to follow up with a face to face meeting on the 11th July in Canberra to discuss further. Matthew was unavailable on the day.	Traffic Density Cumulative Effect of multiple wind farms.

Date	Organisation / Contact	Discussion Points / Comments	Hazard Identification (HAZID) items
		The cumulative risk from multiple wind farms and the potential additional hazard that could be introduced if a non-standard approach re: lighting is taken (false negative) was also discussed, with Matthew in agreement that the cumulative risk should be considered.	
19/7/2017	SuperAir – David Boundy telecon	SuperAir are the key aerial application contractor who operate in the area (bases at Armidale, Scone & Tamworth) and have been involved in previous consultation for wind farms and also specifically in the Land and Environment Case for GIWF. When asked about the effect on their operation that the turbine height increase would have, David was clear that it will make little difference to them. David considers that the existing approved wind turbines will already prohibit aerial application in many situations. David will only be able to assess whether aerial application is feasible for particular locations, once the turbines have been constructed and all aspects can be viewed (i.e. a case by case assessment taking into account wind direction, terrain, turbulence, visibility, sun glare etc). David has no view on the need for lighting as they do not operate in low visibility conditions. David was of the opinion that all WMT should be marked and lit (day time) – irrespective of whether they were marginally under the required height for lighting. David stated that he has already expressed this view on many occasions with the multiple planning stages that have occurred in the region and feels that the wind farm developers and planning authorities simply ignore the impact that these wind farms will have on the aerial application business, which are already operating on low margins (profit). The cumulative effect of the number of wind farms in the region means that the need to operate at a higher level or with a large lateral margin from the turbines will make aerial application unviable – not safe or economic. When asked about operations at the Aeroplane Landing Areas (ALA's) in the vicinity of the wind farm, David expressed a view that these should not be	Collision with WMT – need for marking / lighting Collision with wind turbine – case by case detailed risk assessment undertaken. Loss of Control due to Turbine turbulence – assessed in task risk assessment.

Date	Organisation / Contact	Discussion Points / Comments	Hazard Identification (HAZID) items
		considered as ALA's as they are only suitable as "Ag strips" requiring a high level of skill to operate safely from them. As far as he was aware there were no "private" operations from any of these Ag strips. David stated that as far as he was aware, SuperAir were the only Aerial Application operator routinely working in the area.	
3/8/2017	Glen Innes Regional Airport / Neil Hansford Director telecon & e-mail	Glen Innes Regional Airport Pty Ltd have approved Development Approvals to construct a commercial flight academy on the airport where it has a 30+30 year lease with a first right option to purchase. Construction is due to commence in November 2017. The capacity is to have 35 aircraft on-line, up to 600 international ab-initio students which will equate to an aircraft movement every 6 minutes when completed at Stage 4. When asked about the impact of the increased turbine height on operations at Glen Innes Airport, Neil was satisfied that as long as the impact assessment indicates no impact on the obstacle free surfaces, that the wind farm is far enough away that it will not affect their operations. Neil provided the recently approved RNAV procedures for the airport and the fact that these will move to the west with future runway changes (200m extension at each end). The flight academy will ensure that their training areas and flight paths / to & from are clear of the wind farm locations. Neil confirmed that the NSW Ambulance Service contractors, Royal Flying Doctor Service perform all night operations on instruments utilising the R-Nav approach and therefore he has no concern for their operations so long as the R-Nav approach isn't compromised by the Glen Innes Wind farm development and the development has perimeter lighting consistent with the requirement placed on the Sapphire Wind Farm development. Neil is mostly concerned for the itinerant recreational VFR pilots (e.g. RAA), whom are not licensed to fly at night and are most likely to "continue on" to try to get to the airport in deteriorating visibility and marginal daylight operations. Neil is concerned that it is inevitable that a collision will occur in such conditions and that	Day VFR Collision with Turbine - Pilot descending in low visibility conditions. Day VFR collision - students Night VFR Collision with Turbine – false negative due to lack of or failed lights. Night VFR – Westpac rescue helicopters performing medical rescue. Loss of Control – Turbulence from wind turbines (vertical & horizontal).

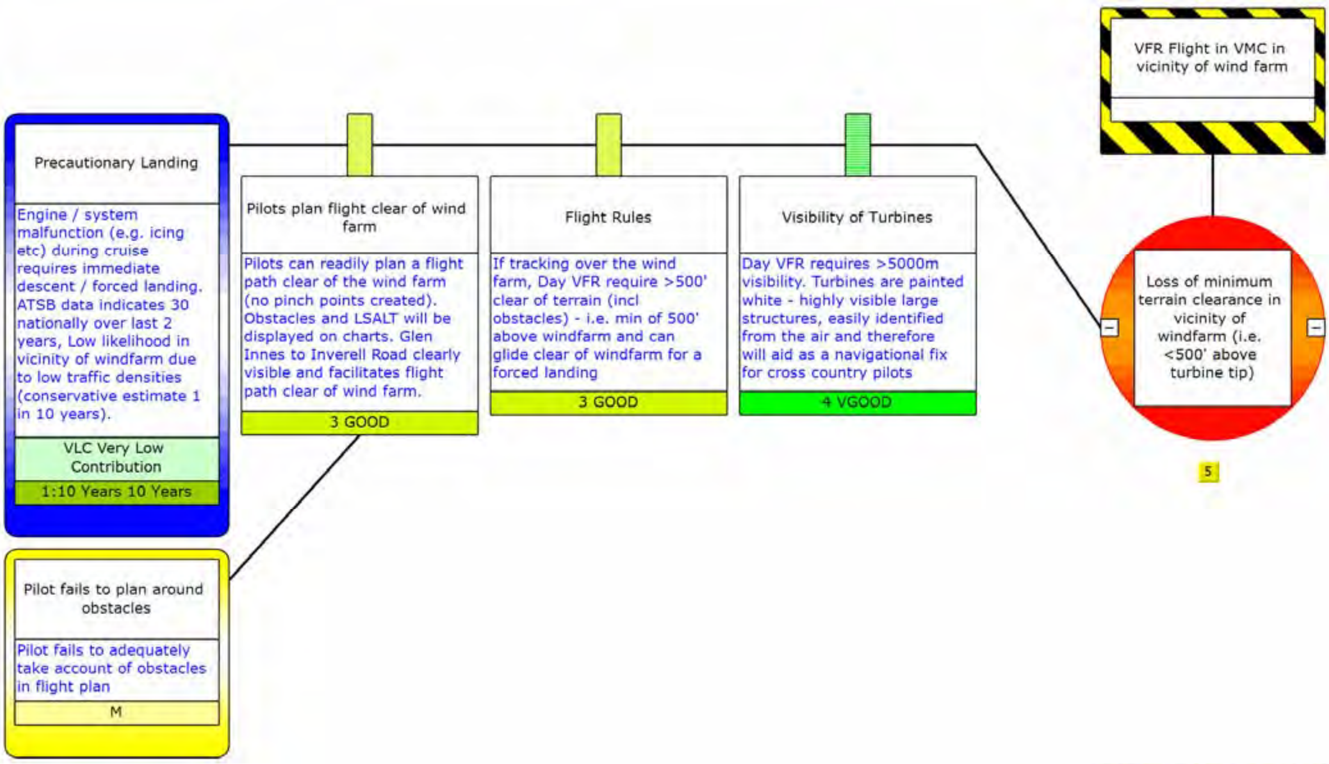
Date	Organisation / Contact	Discussion Points / Comments	Hazard Identification (HAZID) items
		this would also have a detrimental reputational impact on the Glen Inness Airport and flight academy and the reputation overseas of Glen Innes/Inverell being a unique safe training environment for student pilots. It must be noted that overseas students come with zero flying experience. Neil is therefore firmly of the opinion that obstacle collision lighting is required and believes it should follow the same lighting plan as the neighbouring Sapphire Wind Farm whose DA was modified in this regard by NSW Department of Planning. Neil agreed that preventative controls to reduce the likelihood of a pilot descending into a wind farm area in low visibility conditions would be a high priority, but felt that this was almost impossible to achieve in a self-regulating environment (i.e. RAA). Neil agreed that there is the possibility that a false negative could be created if neighbouring wind farms (near) do not follow the same lighting standard – i.e. if planning approval is given for lighting at one wind farm, then night VFR pilots will use them as a navigational aid and that, the absence of lights on another wind farm might falsely indicate to a pilot that they were clear of all turbines. Though obstacles like turbines are shown on the Navigation charts there is no guarantee recreational pilots will consult their charts before flying in the area. It is also imperative that consideration is made of rotary operations at night in medical roles i.e. Westpac Rescue on behalf of NSW Ambulance Service. Similarly, Neil spoke of the importance in having constant monitoring of lighting to ensure that they are working, as a failed light could lead a pilot into a false sense of security (i.e. believe they are clear of obstacles). Neil gave the example of the TV antennae lights on Carpenters Hill (in proximity to Glen Innes airport), which an airport employee checks on a daily basis as part of the Airport Daily Operations Check and is constantly reporting failed lights.	

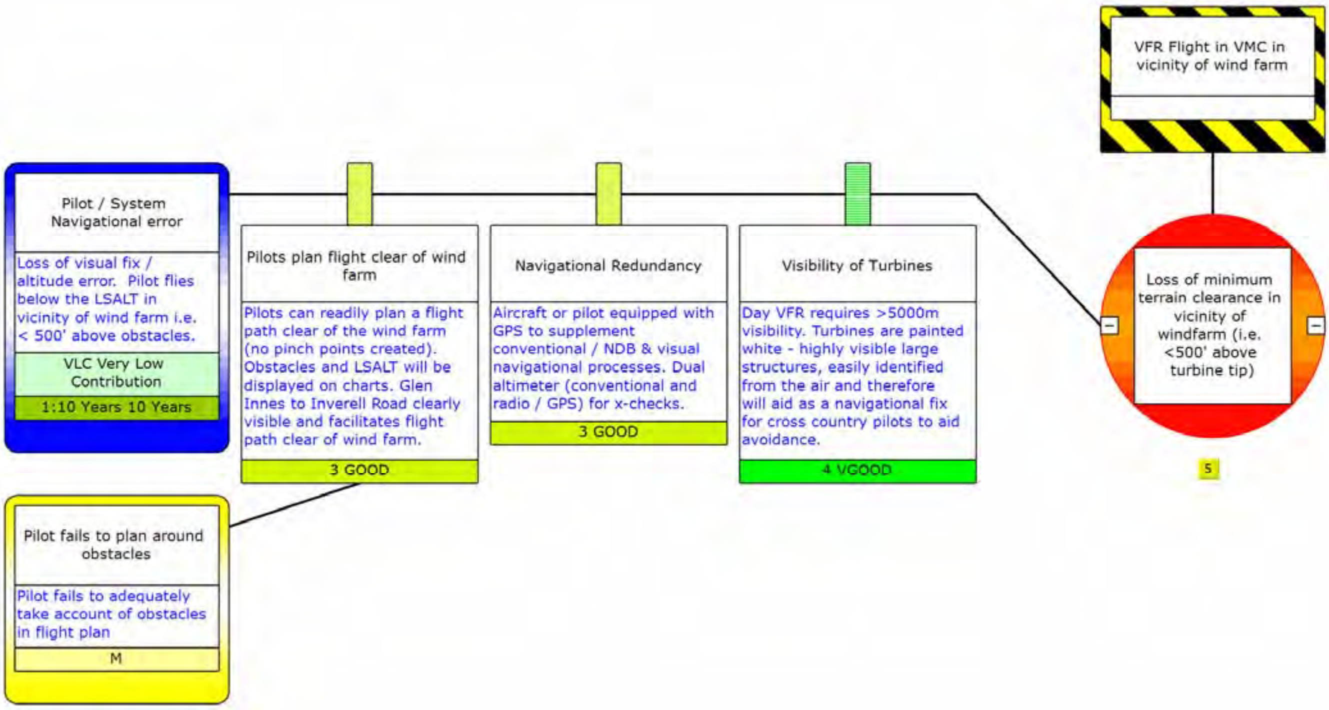
Date	Organisation / Contact	Discussion Points / Comments	Hazard Identification (HAZID) items
		On the subject of wake turbulence generated by wind turbines, Neil was concerned that there was not significant scientific evidence available to indicate the potential vertical rise of wakes and that this needed to be considered in terms of separation requirements. It is accepted that horizontal wake turbulence is out to 600 metres but there is no empirical evidence of vertical wake turbulence where pilots flying under visual flight rules may descend under the 1,000 ft ceiling to get below cloud to land at Glen Innes or Inverell Airports or to transit the area	
Multiple Dates	Glen Innes Council / Graham Price. Telecon & e-mail	Contact with Glen Innes council has been attempted via telephone and e-mail, leaving messages for Graham Price. On 3/8/2017, Greg Doman picked up the call and suggested that an incoming member of staff Malcolm Donally would be well placed for consultation. Greg offered to forward the e-mail previously sent to Graham Price on to Malcolm. To date no response has been received.	
3/8/2017	RAA / Safety	RAA receptionist suggesting e-mailing their safety department for the attention of Janelle. No response received to date.	
3/8/2017	Inverell Aviation	Left a message for Chief Pilot to call back – not yet received. Suggested also talking to Daryl who operates a daily freight run between Inverell and Glen Innes (message left, no response).	
2/8/2017	NSW RFS / Luke Wallace	Luke Wallace in the aviation operations group stated that the RFS would treat the wind turbines as per any other obstacle and perform a detailed risk assessment on a case by case basis. Luke has forwarded questions in general regarding any available RFS policy on fire fighting in proximity to wind farms. No response received in this respect to date.	
3/8/2017	NSW Ambulance Service	After speaking with Stephen Flannagan in the New England regional office, he has forwarded questions via e-mail to relevant persons in the Air ambulance division. No response received to date.	
3/8/2017	RAAA	RAAA main office phone rang out. E-mail enquiry sent via the RAAA website “contact us” form. Automated response only received.	

APPENDIX C. BASELINE FULL BOWTIE CUT-OUTS

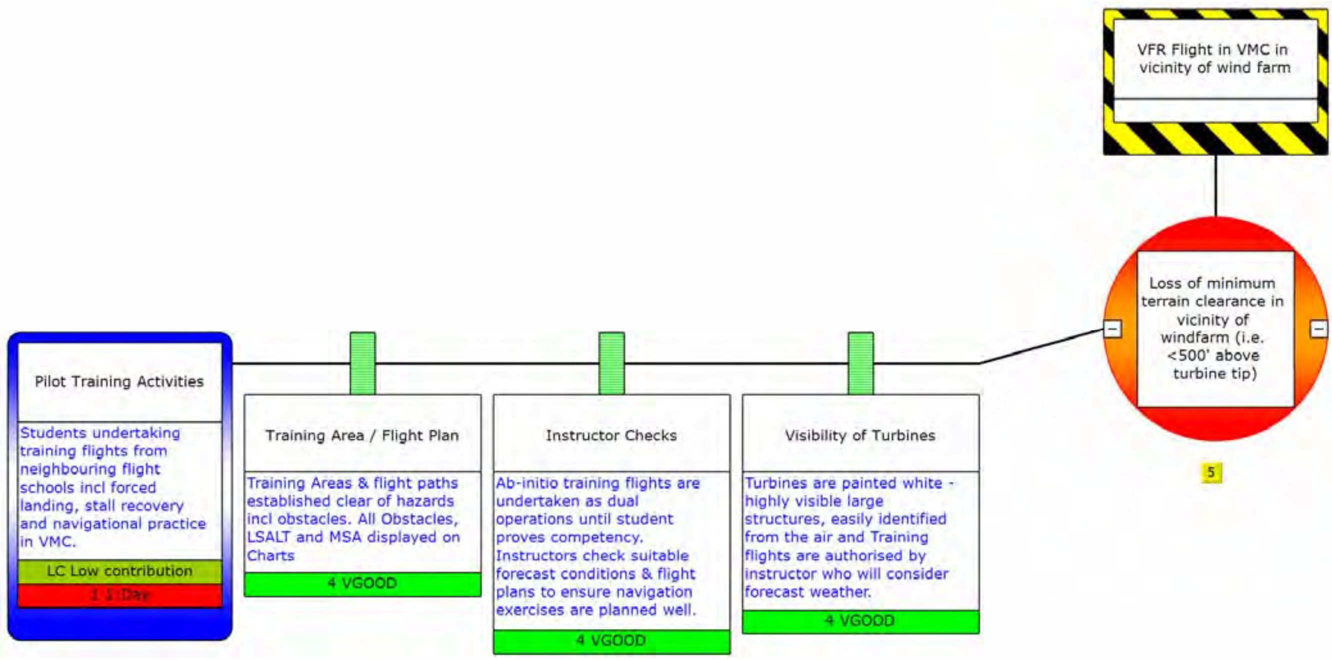
VFR Flight in VMC

Threats

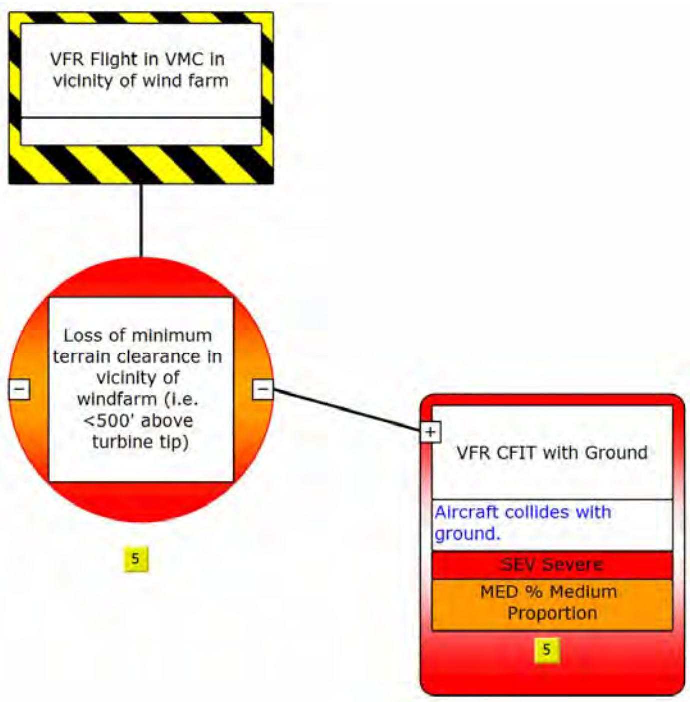


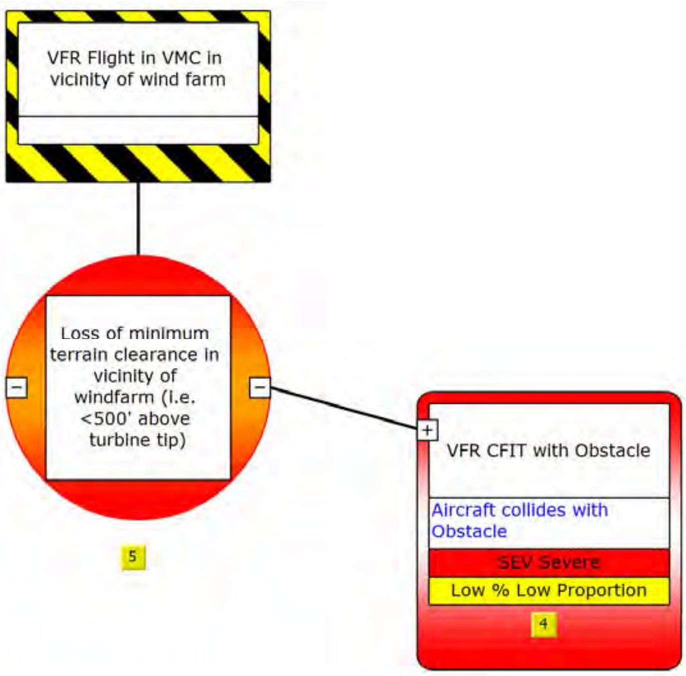


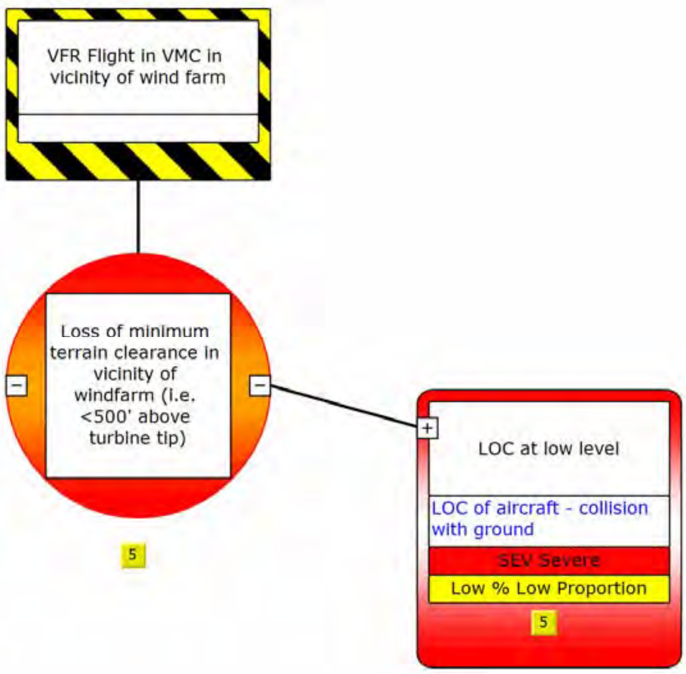
THE AMBIDJI GROUP



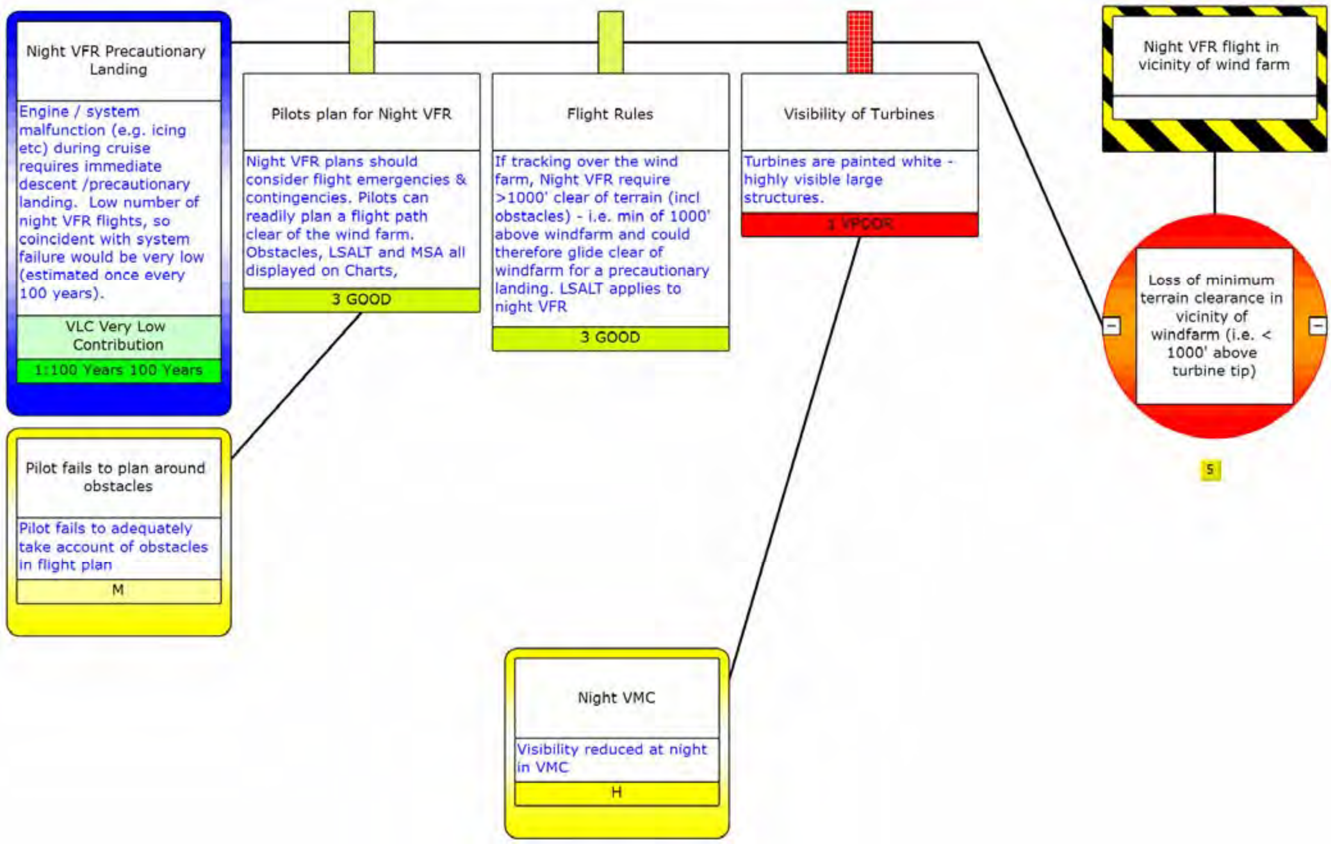
Consequences

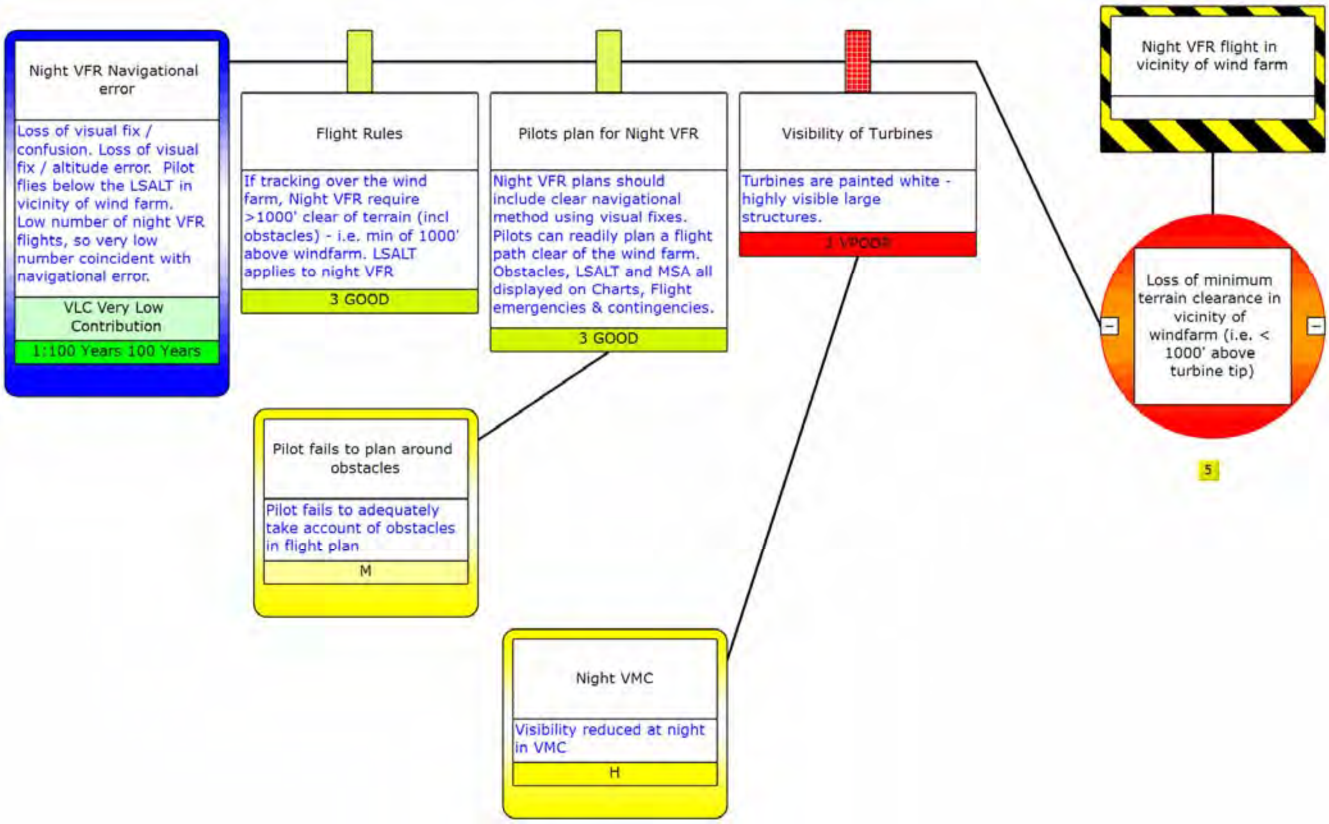


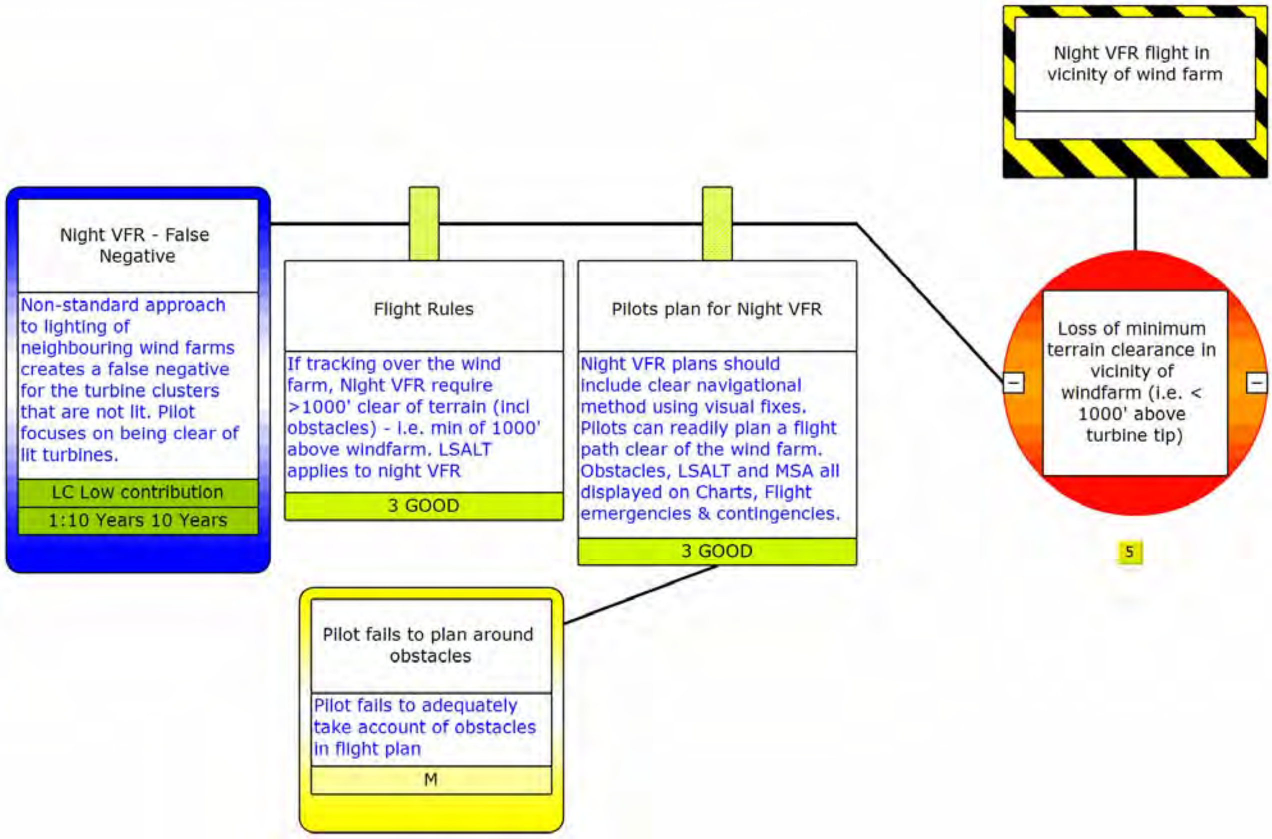

VFR Flight in VMC in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm (i.e. <500' above turbine tip)
5
VFR CFIT with Obstacle
Aircraft collides with Obstacle
SEV Severe
Low % Low Proportion
4


VFR Flight in VMC in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm (i.e. <500' above turbine tip)
5
LOC at low level
LOC of aircraft - collision with ground
SEV Severe
Low % Low Proportion
5

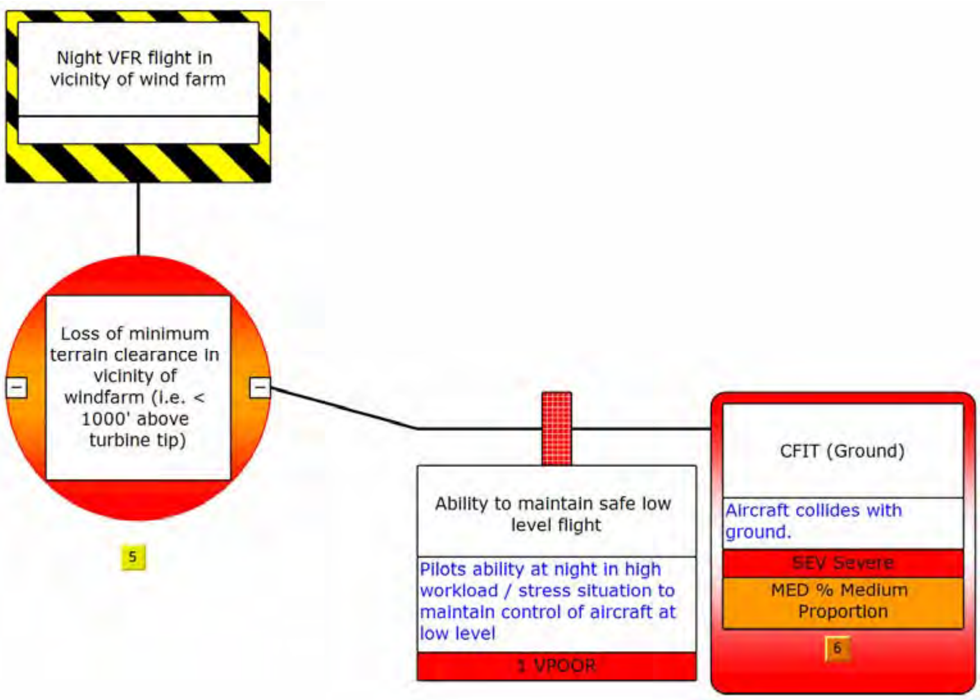
Night VFR flight
Threats

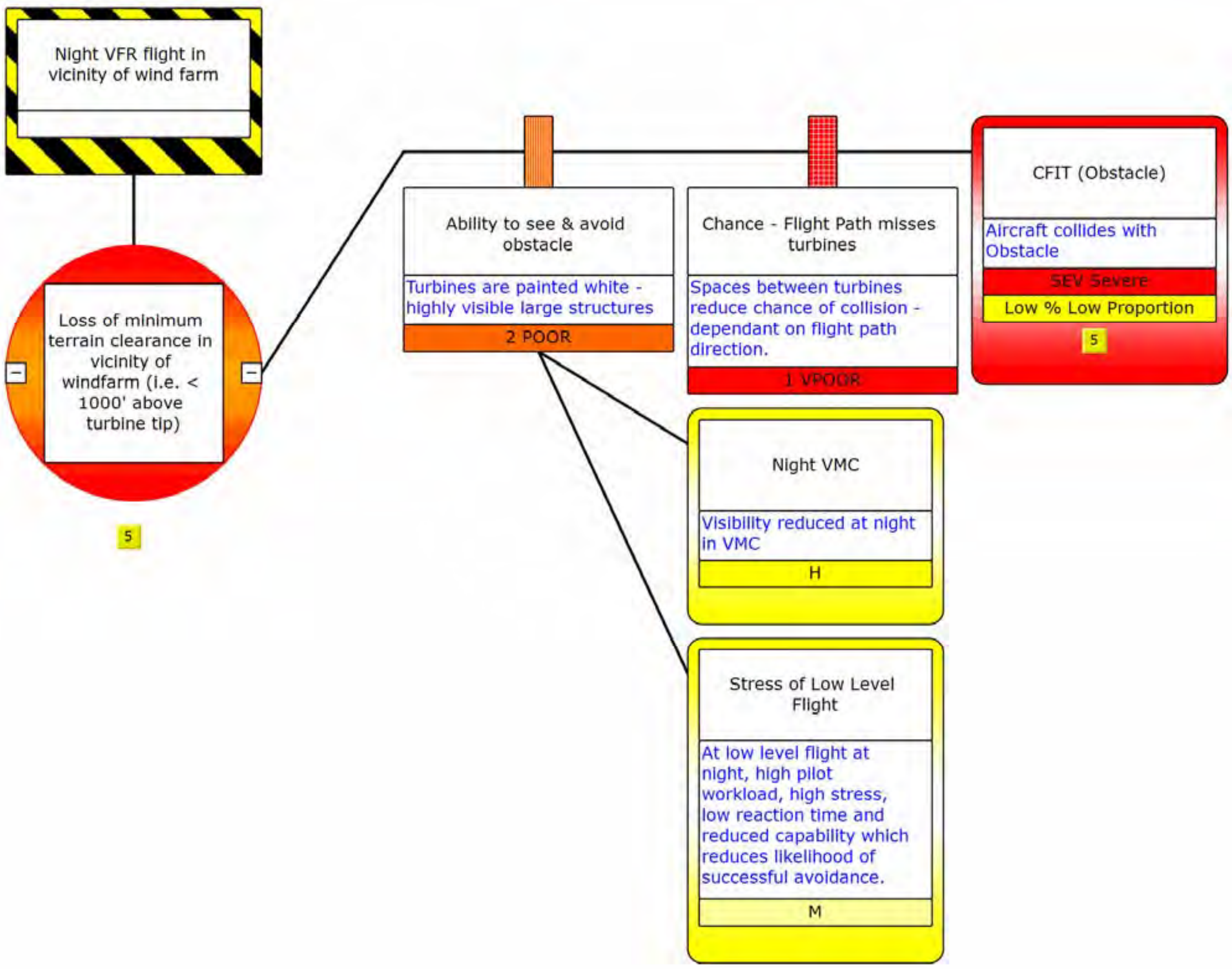


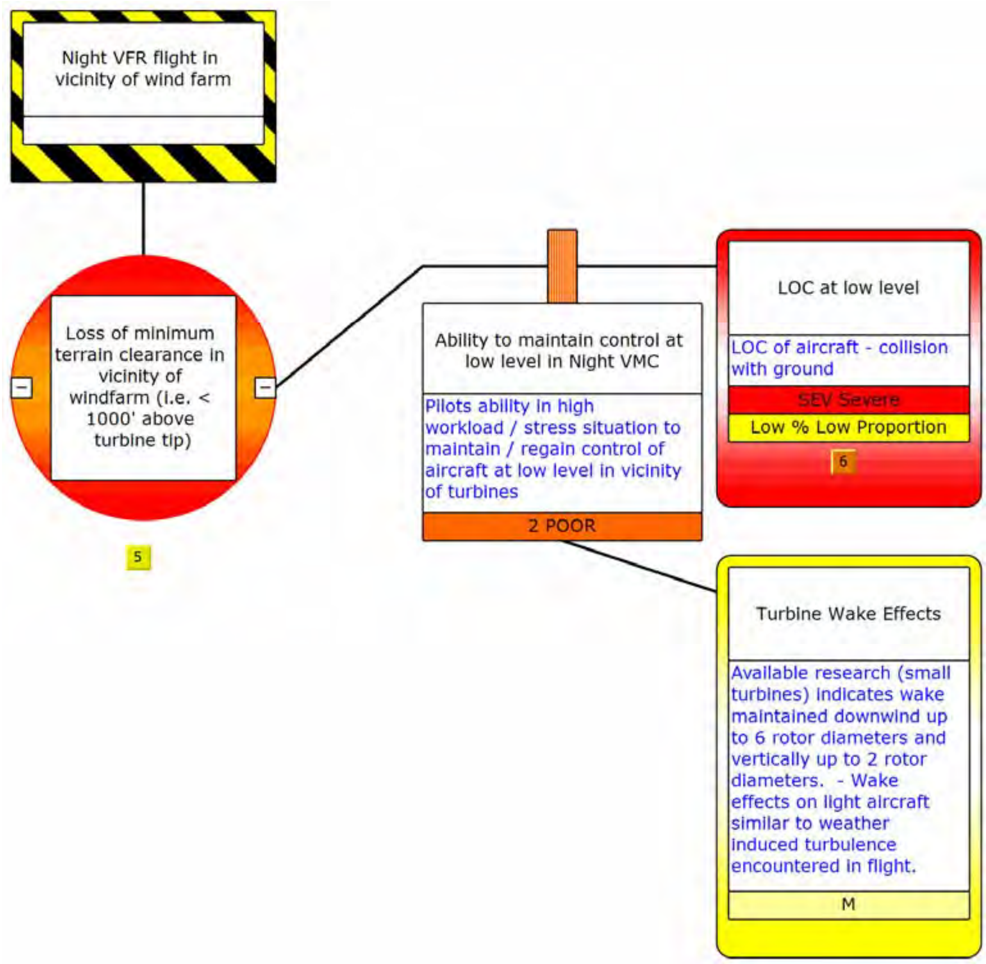




Consequences

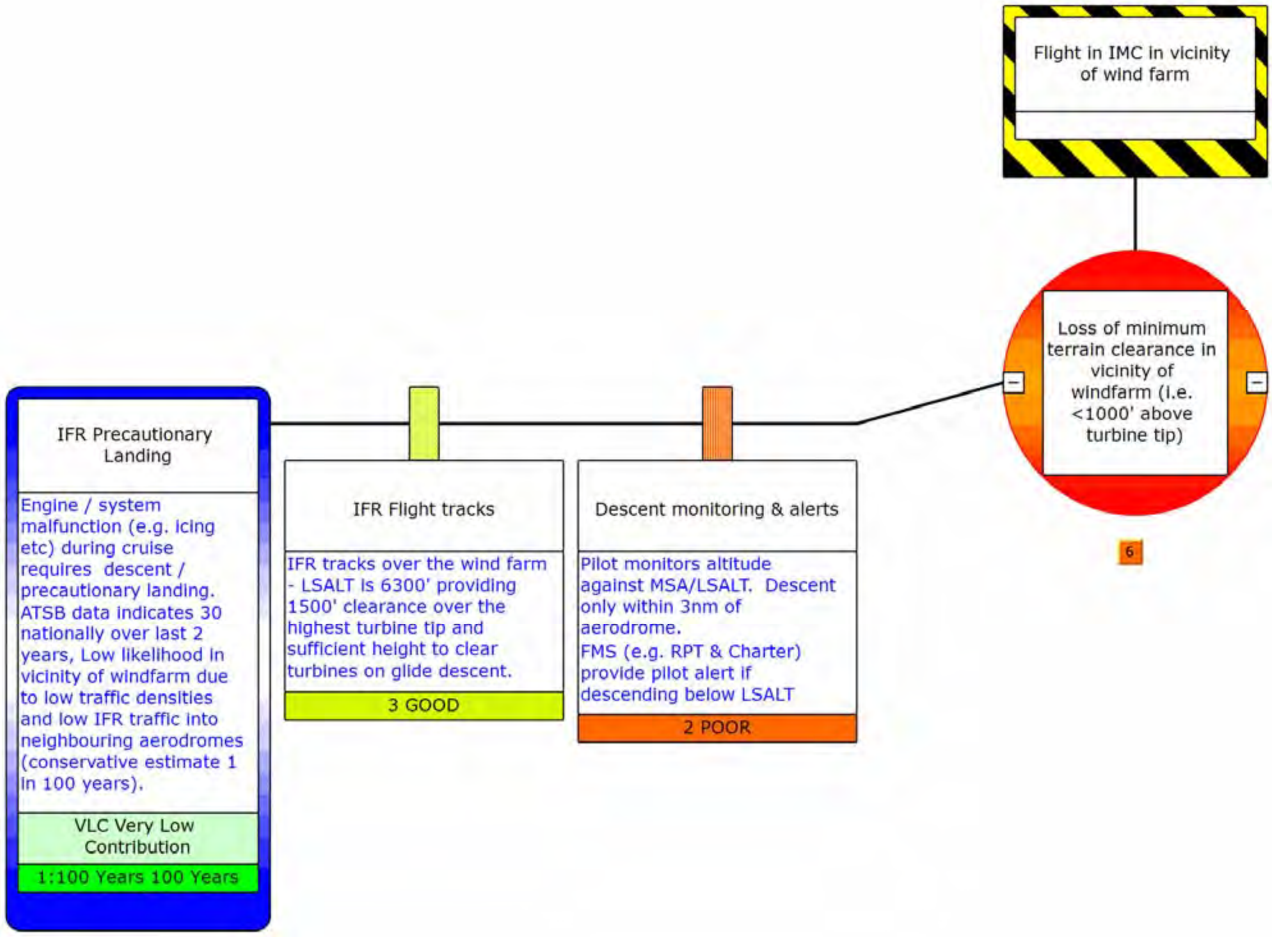

Night VFR flight in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm (i.e. < 1000' above turbine tip)
5
Ability to maintain safe low level flight
Pilots ability at night in high workload / stress situation to maintain control of aircraft at low level
1 VPOOR
CFIT (Ground)
Aircraft collides with ground.
SEV Severe
MED % Medium Proportion
6

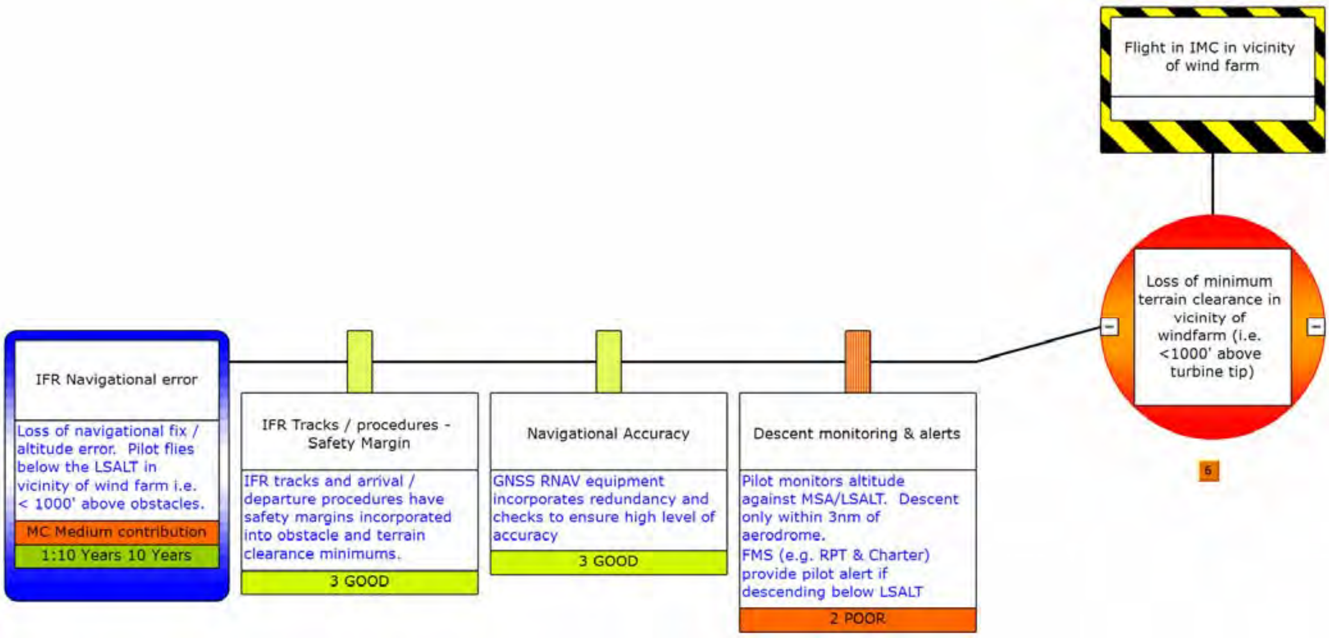

Night VFR flight in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm (i.e. < 1000' above turbine tip)
5
Ability to see & avoid obstacle
Turbines are painted white - highly visible large structures
2 POOR
Chance - Flight Path misses turbines
Spaces between turbines reduce chance of collision - dependant on flight path direction.
1 VPOOR
CFIT (Obstacle)
Aircraft collides with Obstacle
SEV Severe
Low % Low Proportion
5
Night VMC
Visibility reduced at night in VMC
H
Stress of Low Level Flight
At low level flight at night, high pilot workload, high stress, low reaction time and reduced capability which reduces likelihood of successful avoidance.
M

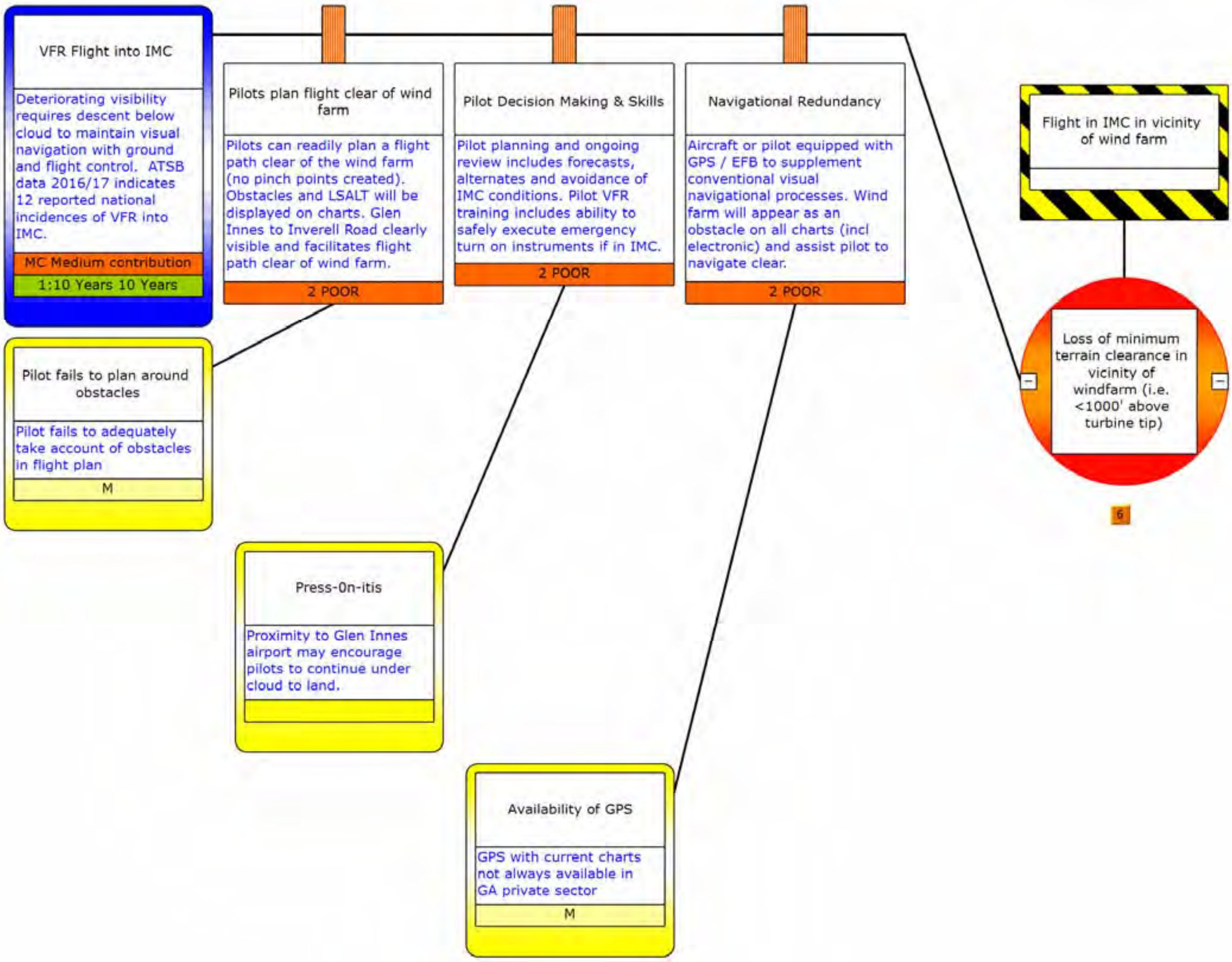

Night VFR flight in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm (i.e. < 1000' above turbine tip)
5
Ability to maintain control at low level in Night VMC
Pilots ability in high workload / stress situation to maintain / regain control of aircraft at low level in vicinity of turbines
2 POOR
LOC at low level
LOC of aircraft - collision with ground
SEV Severe
Low % Low Proportion
6
Turbine Wake Effects
Available research (small turbines) indicates wake maintained downwind up to 6 rotor diameters and vertically up to 2 rotor diameters. - Wake effects on light aircraft similar to weather induced turbulence encountered in flight.
M

Flight in IMC

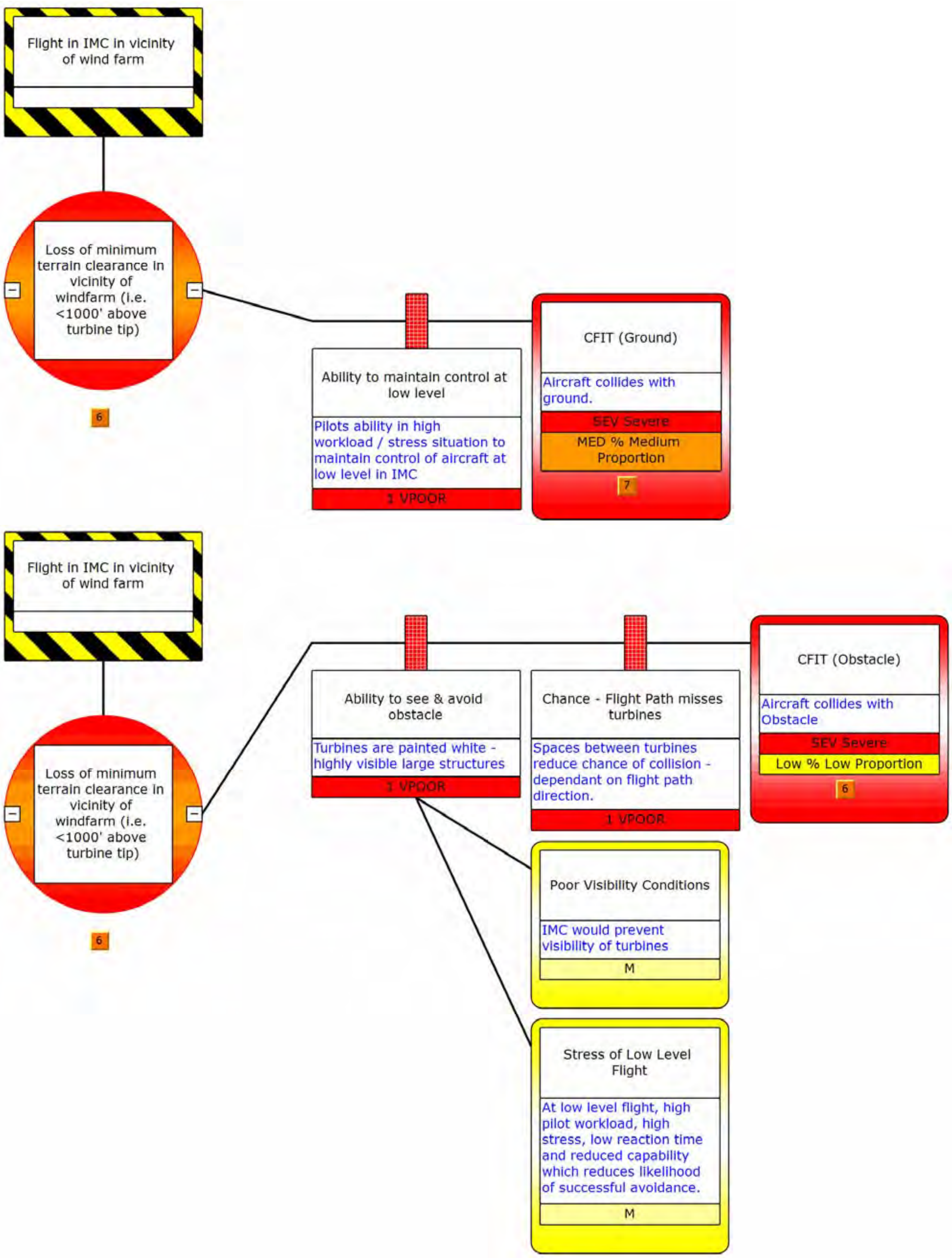
Threats

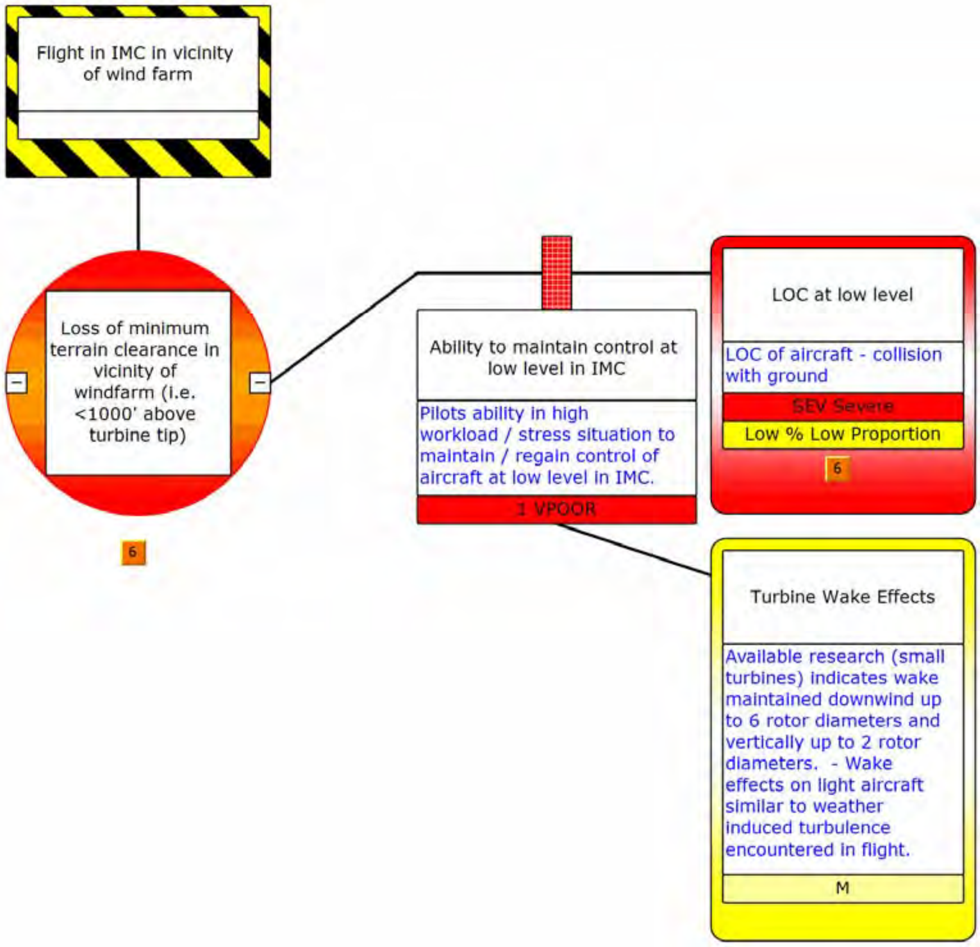






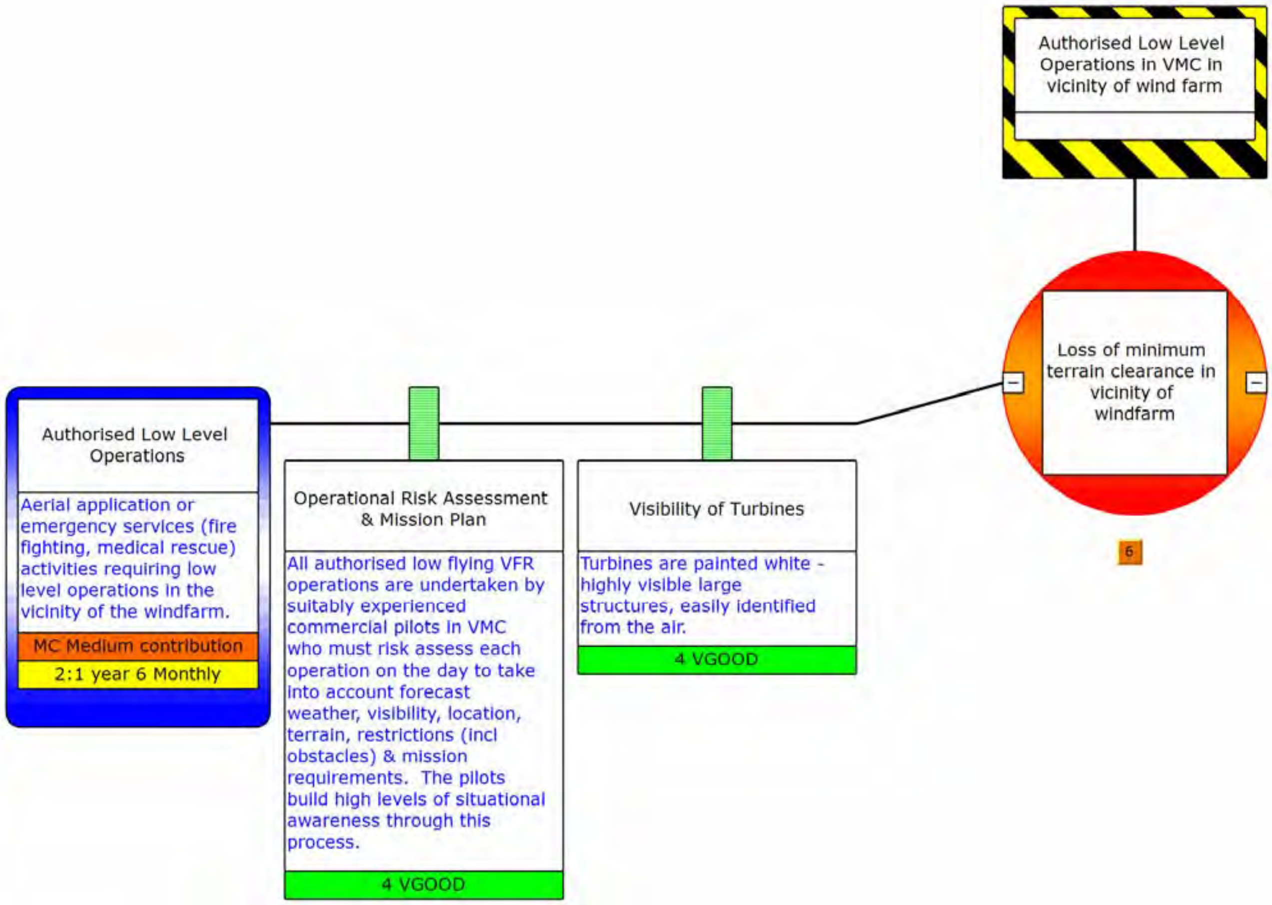
Consequences


Flight in IMC in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm (i.e. <1000' above turbine tip)
6
Ability to maintain control at low level
Pilots ability in high workload / stress situation to maintain control of aircraft at low level in IMC
1 VPOOR
CFIT (Ground)
Aircraft collides with ground.
SEV Severe
MED % Medium Proportion
7
Flight in IMC in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm (i.e. <1000' above turbine tip)
6
Ability to see & avoid obstacle
Turbines are painted white - highly visible large structures
1 VPOOR
Chance - Flight Path misses turbines
Spaces between turbines reduce chance of collision - dependant on flight path direction.
1 VPOOR
CFIT (Obstacle)
Aircraft collides with Obstacle
SEV Severe
Low % Low Proportion
6
Poor Visibility Conditions
IMC would prevent visibility of turbines
M
Stress of Low Level Flight
At low level flight, high pilot workload, high stress, low reaction time and reduced capability which reduces likelihood of successful avoidance.
M

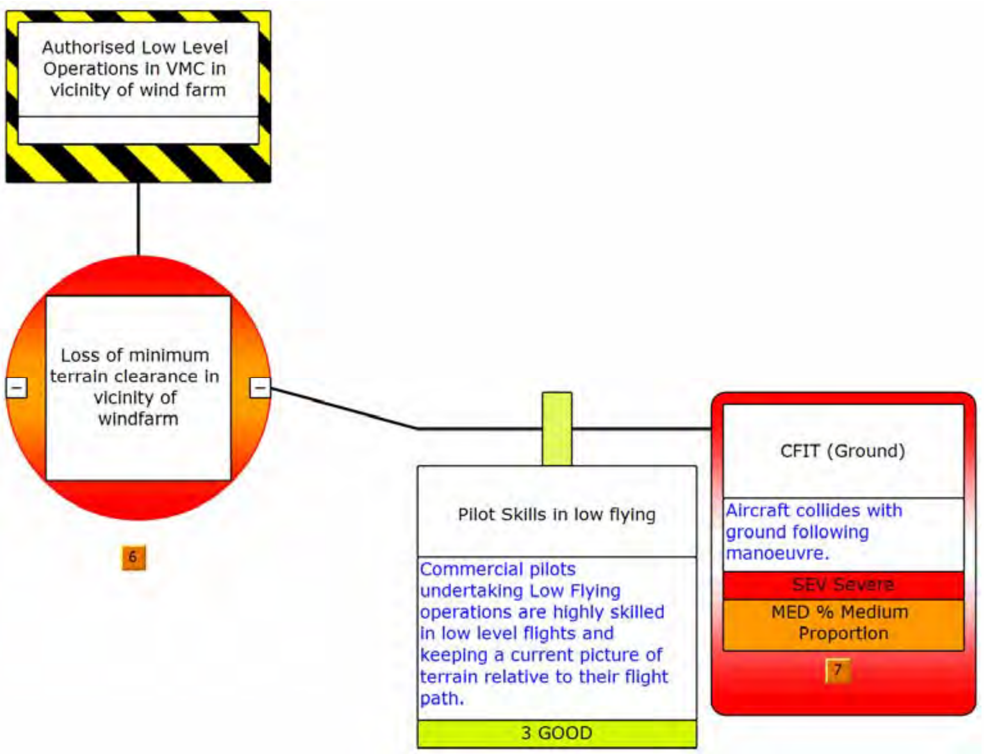

Flight in IMC in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm (i.e. <1000' above turbine tip)
6
Ability to maintain control at low level in IMC
Pilots ability in high workload / stress situation to maintain / regain control of aircraft at low level in IMC.
1 VPOOR
LOC at low level
LOC of aircraft - collision with ground
SEV Severe
Low % Low Proportion
6
Turbine Wake Effects
Available research (small turbines) indicates wake maintained downwind up to 6 rotor diameters and vertically up to 2 rotor diameters. - Wake effects on light aircraft similar to weather induced turbulence encountered in flight.
M

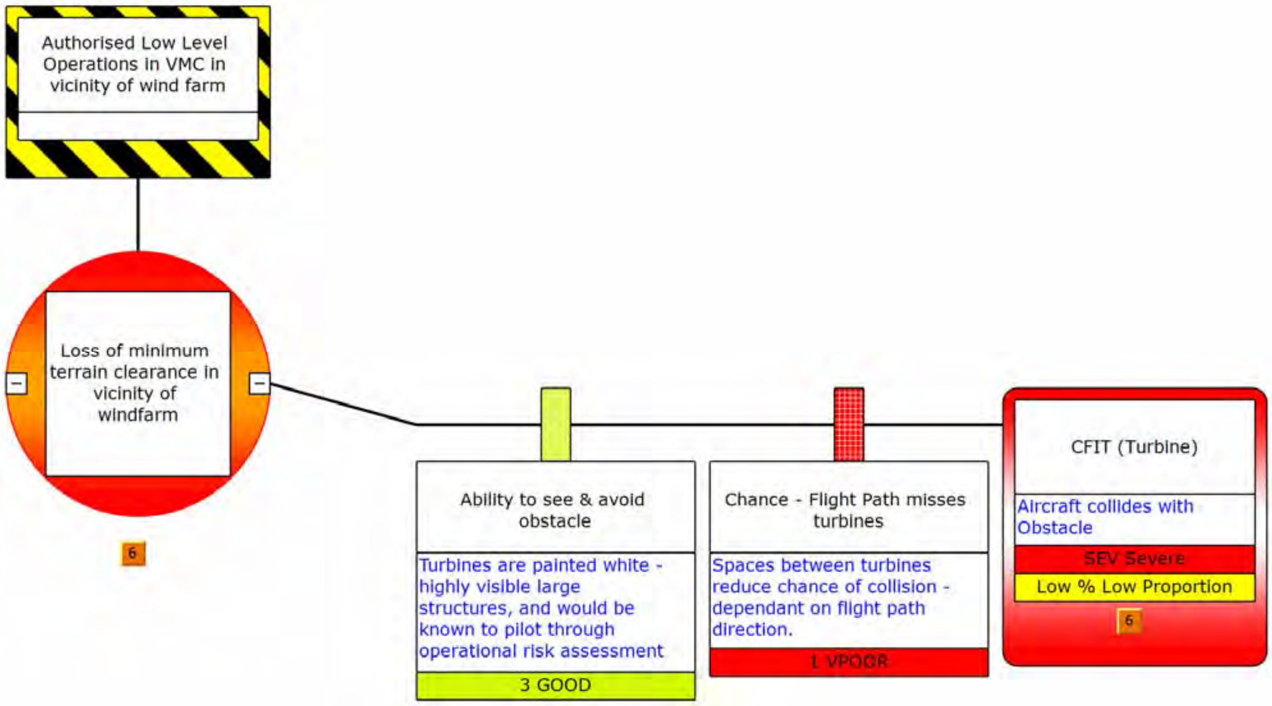
Authorised Low Level Operations

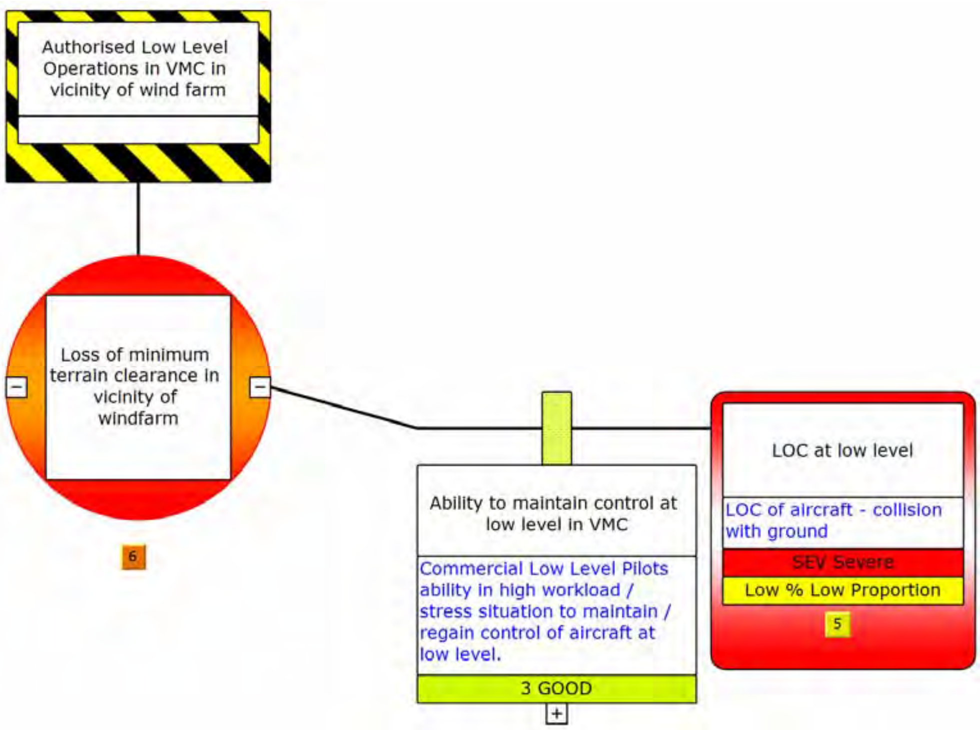
Threats



Consequences

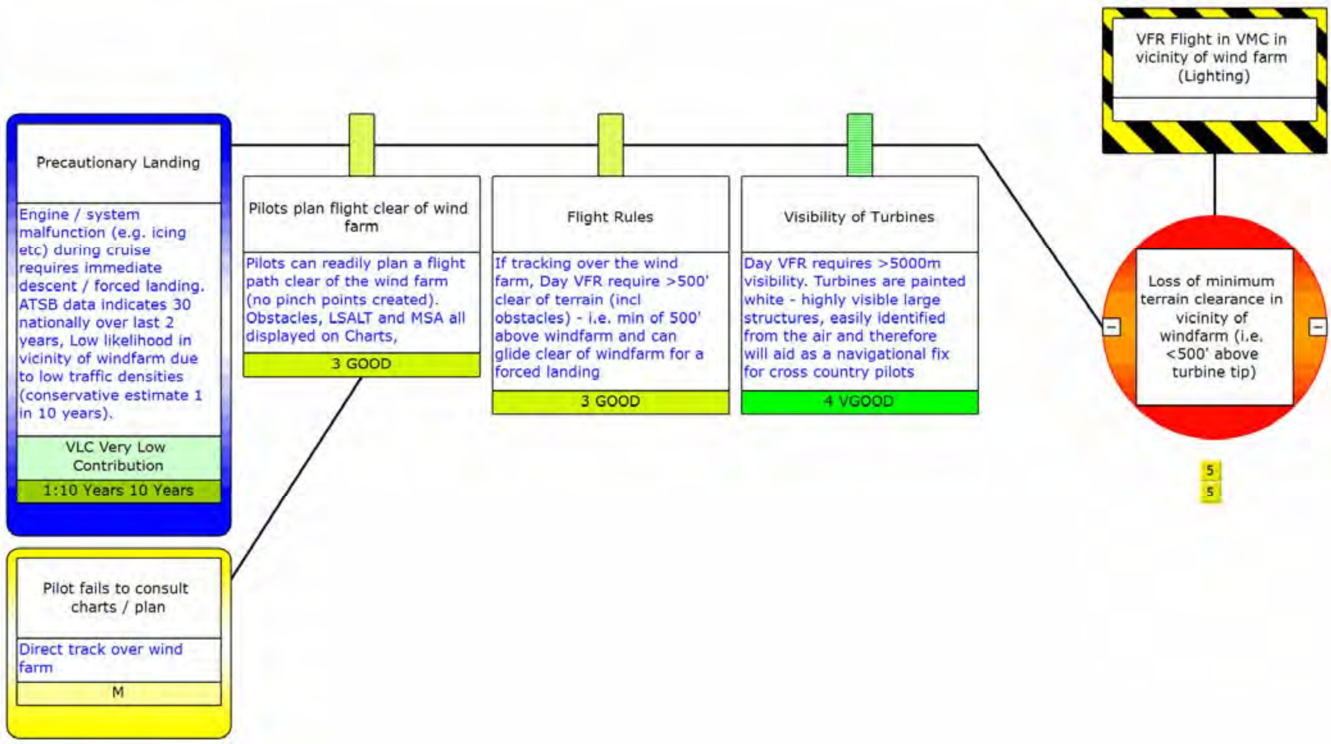

Authorised Low Level Operations in VMC in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm
6
Pilot Skills in low flying
Commercial pilots undertaking Low Flying operations are highly skilled in low level flights and keeping a current picture of terrain relative to their flight path.
3 GOOD
CFIT (Ground)
Aircraft collides with ground following manoeuvre.
SEV Severe
MED % Medium Proportion
7

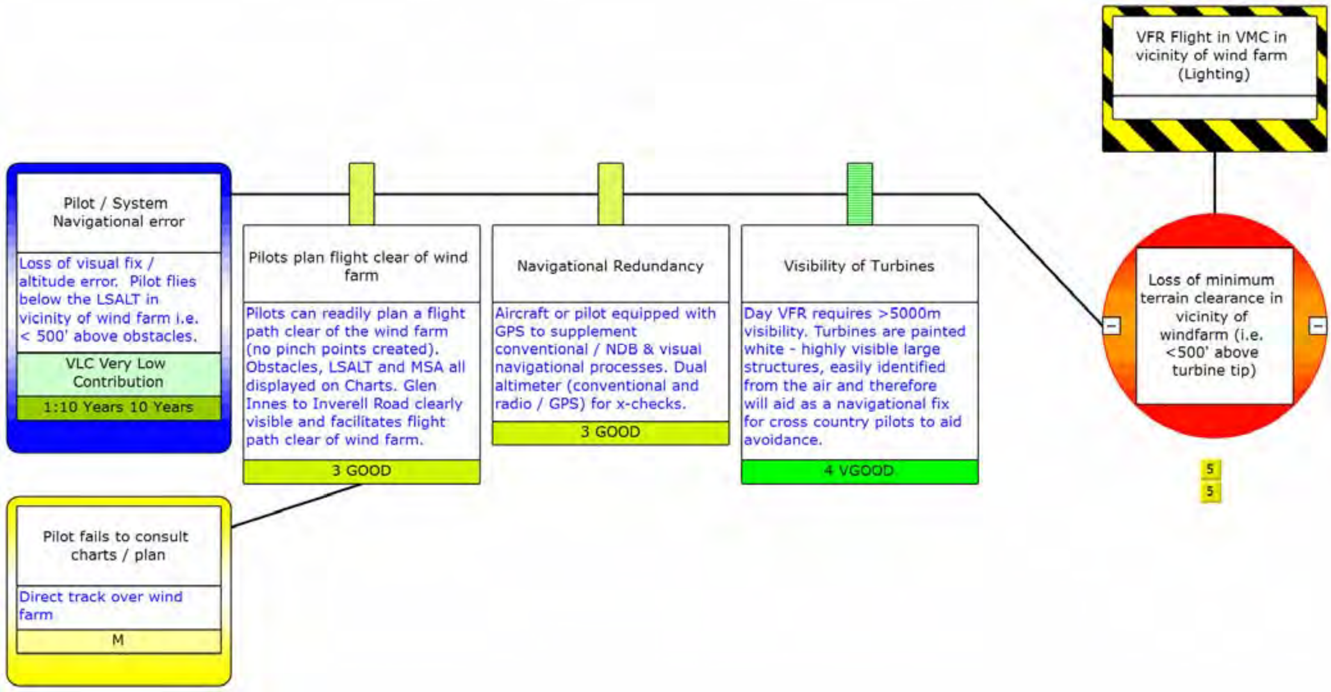

Authorised Low Level Operations in VMC in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm
6
Ability to see & avoid obstacle
Turbines are painted white - highly visible large structures, and would be known to pilot through operational risk assessment
3 GOOD
Chance - Flight Path misses turbines
Spaces between turbines reduce chance of collision - dependant on flight path direction.
1 VPOOR
CFIT (Turbine)
Aircraft collides with Obstacle
SEV Severe
Low % Low Proportion
6

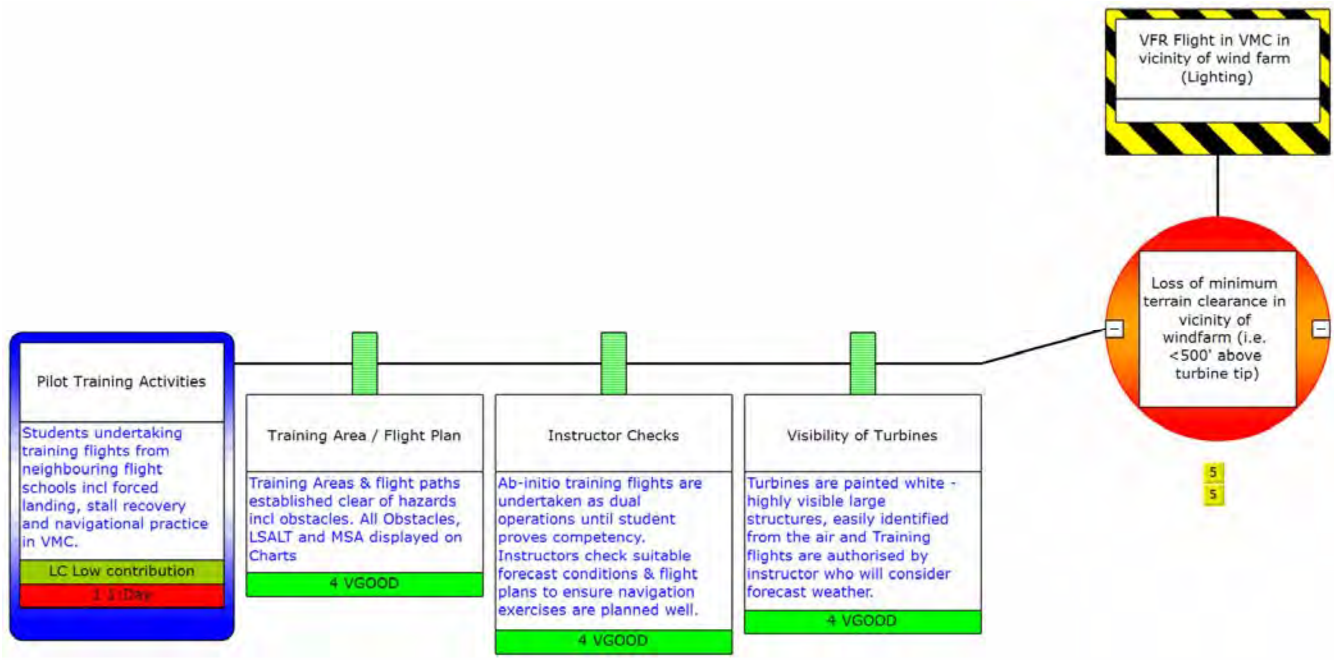

Authorised Low Level Operations in VMC in vicinity of wind farm
Loss of minimum terrain clearance in vicinity of windfarm
6
Ability to maintain control at low level in VMC
Commercial Low Level Pilots ability in high workload / stress situation to maintain / regain control of aircraft at low level.
3 GOOD
LOC at low level
LOC of aircraft - collision with ground
SEV Severe
Low % Low Proportion
5

APPENDIX D. OBSTACLE LIGHTING FULL BOWTIE CUT-OUTS

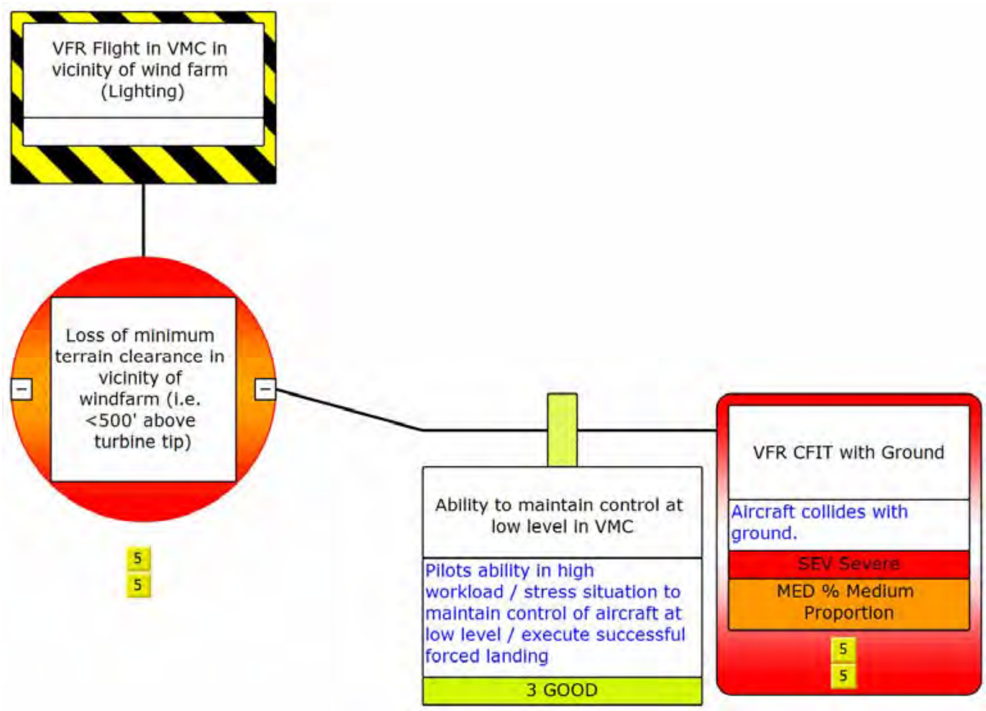
VFR Flight in VMC (Lighting)
Threats



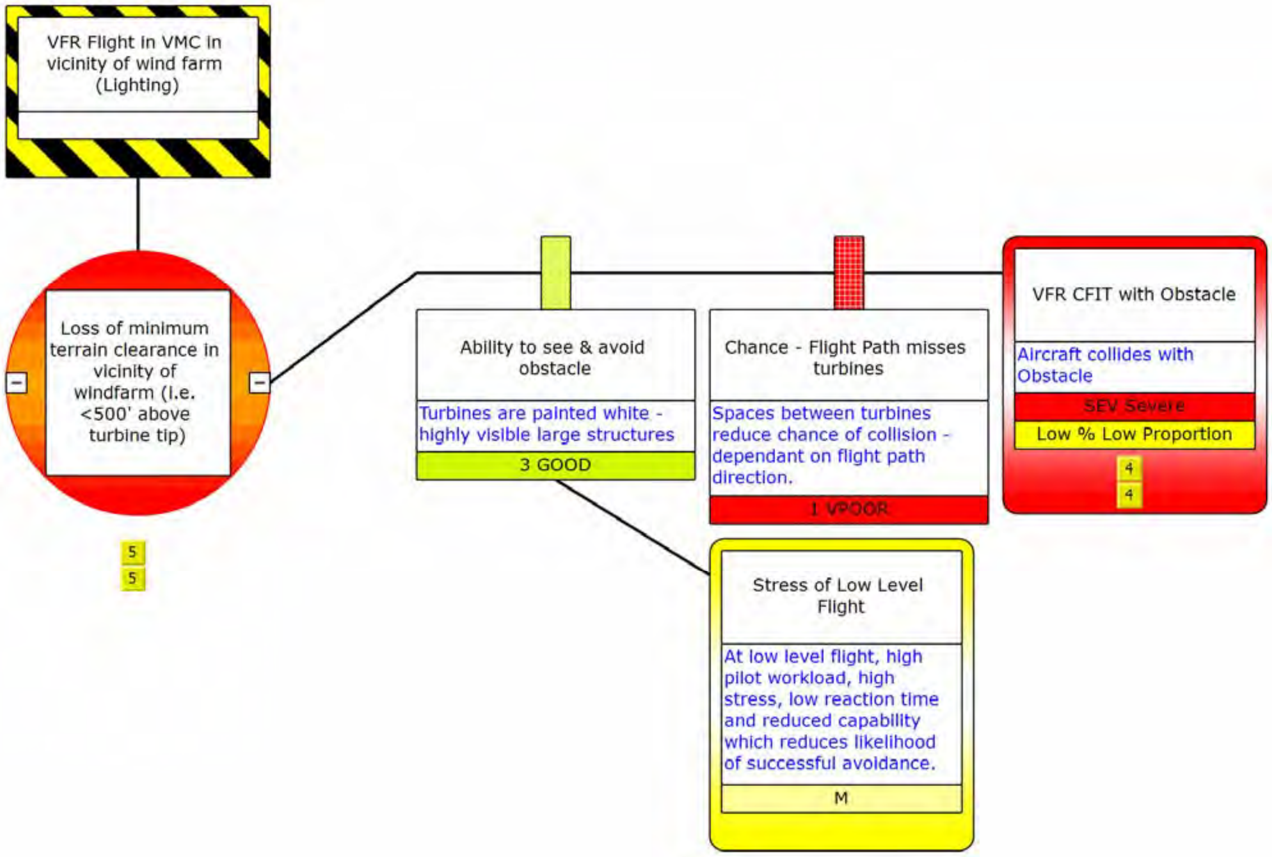




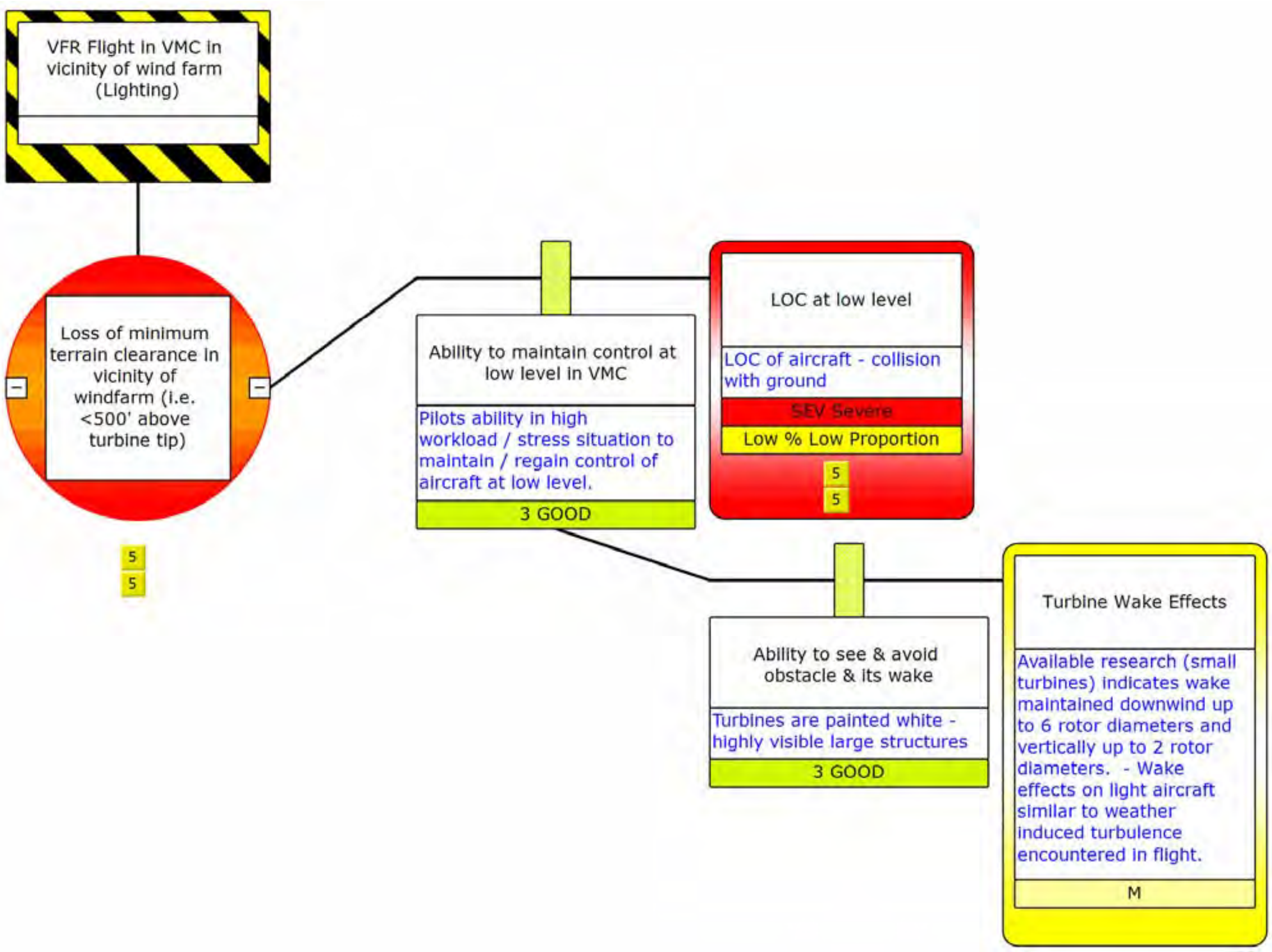
Consequences



THE AMBIDJI GROUP

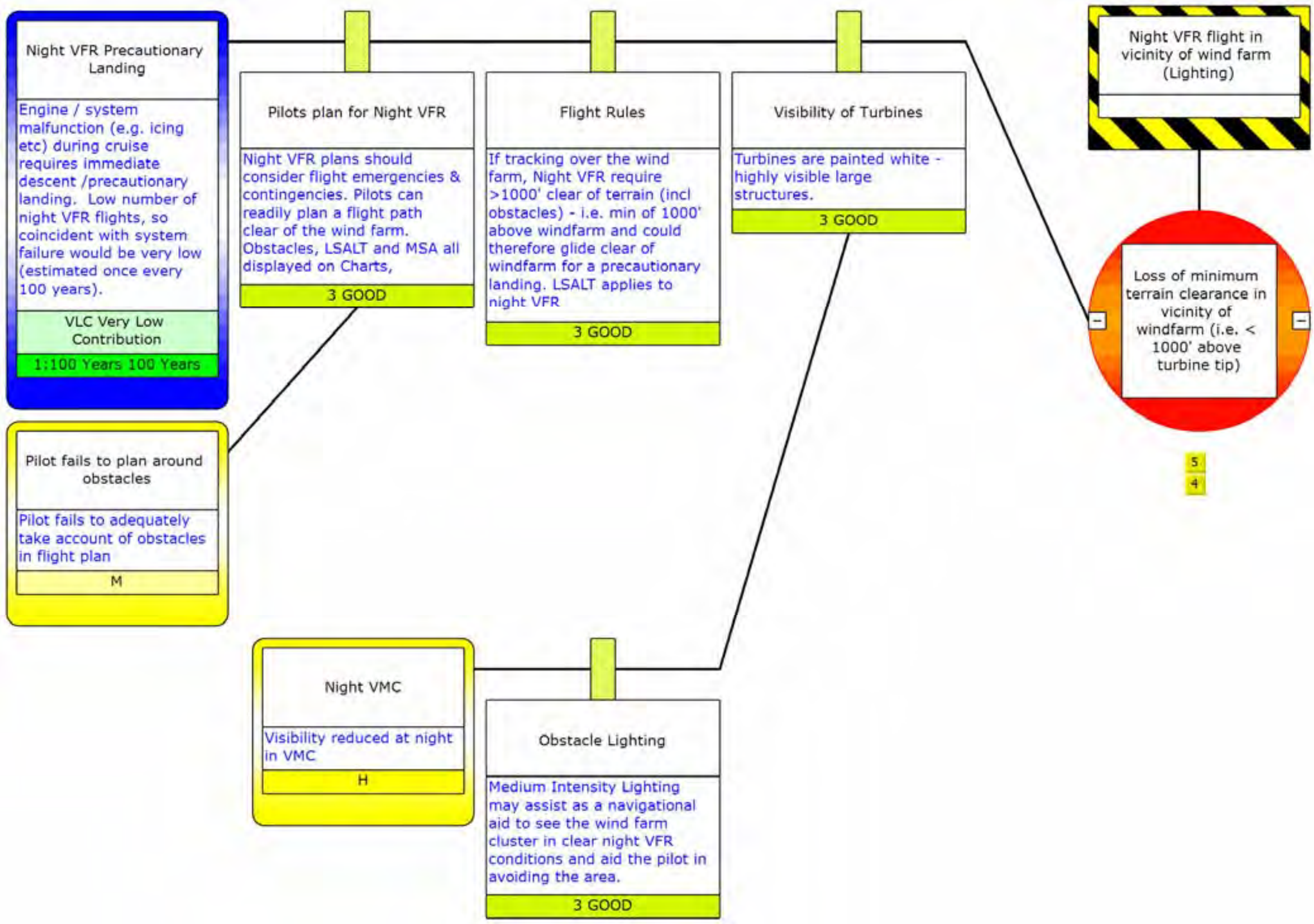


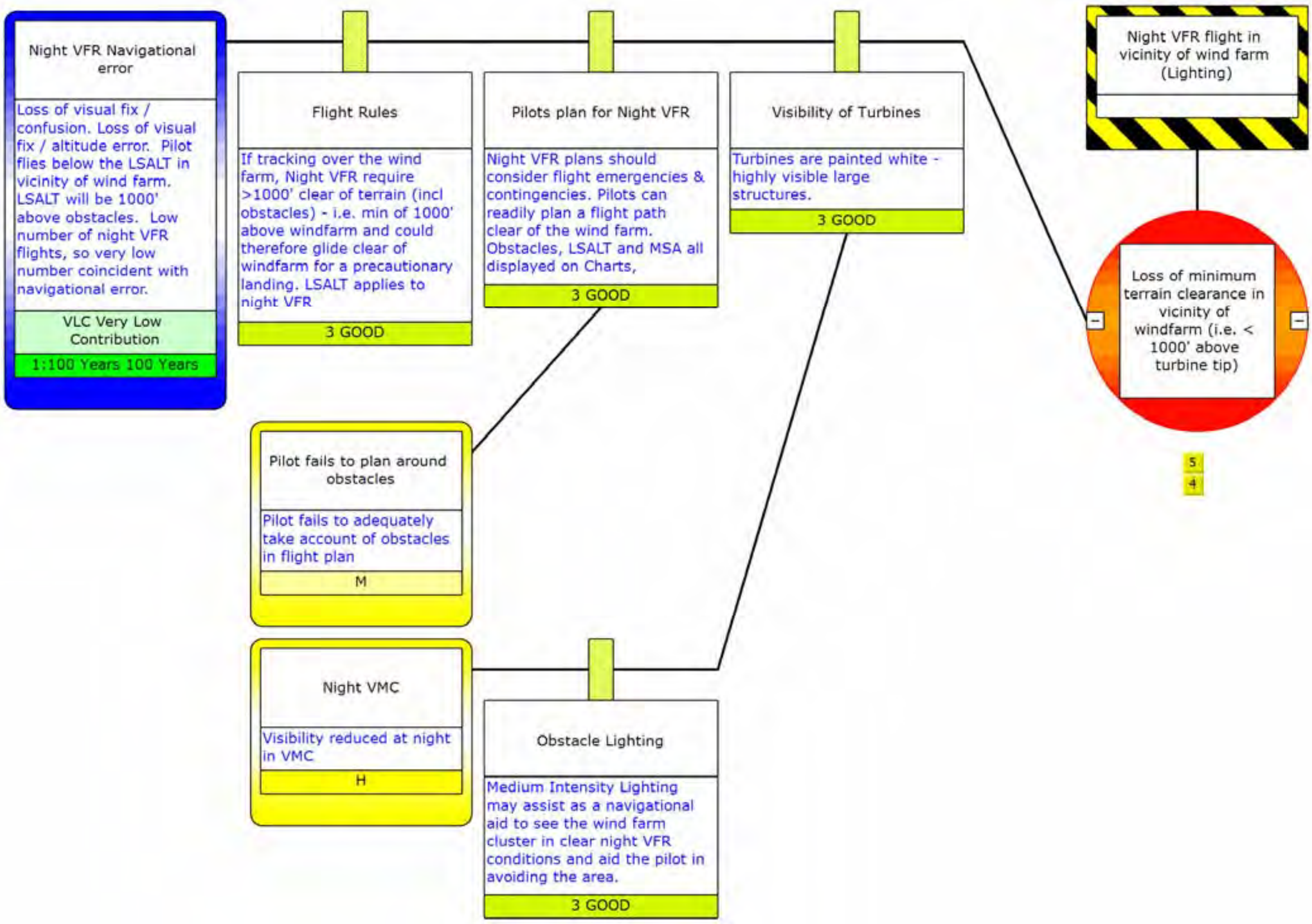
THE AMBIDJI GROUP

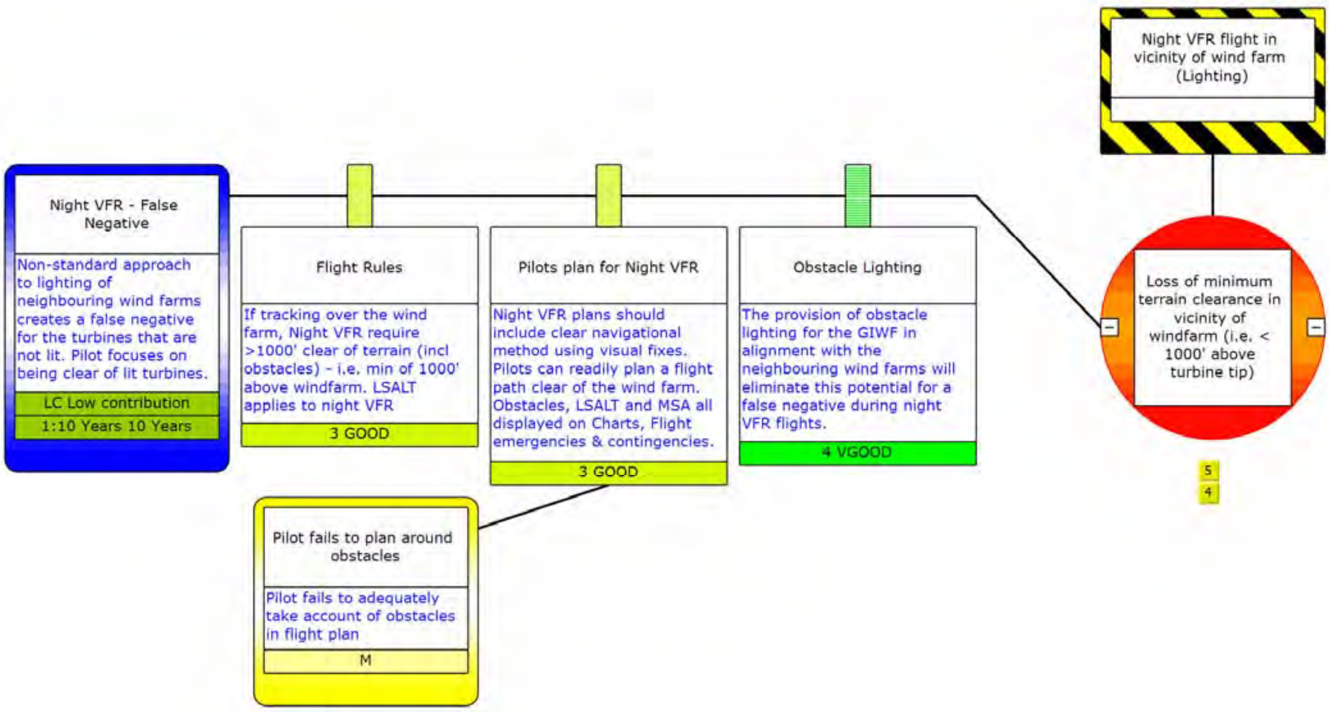


Night VFR flight (Lighting)

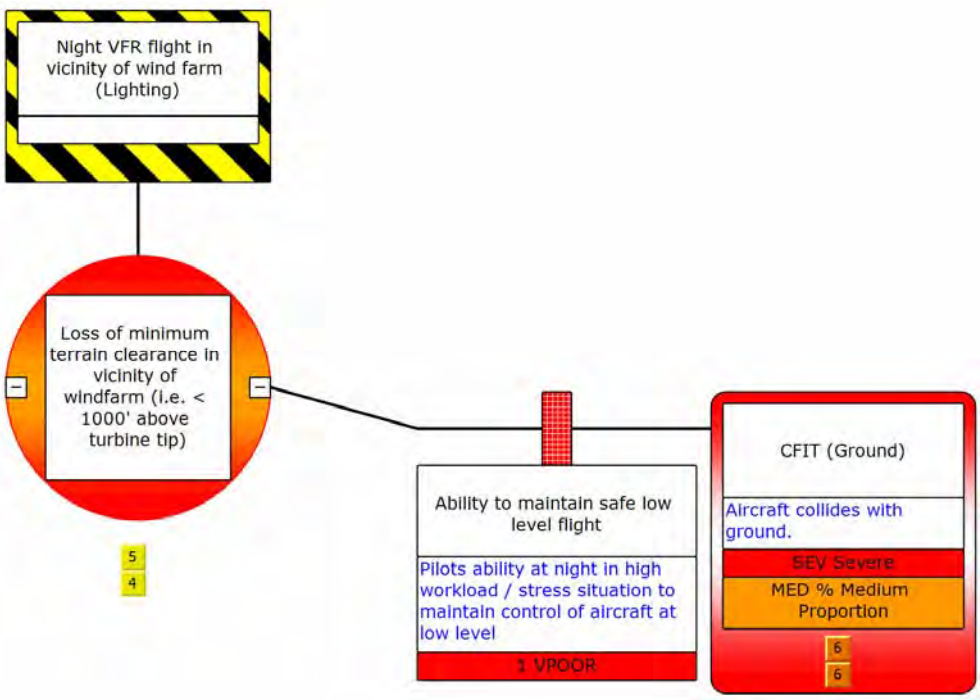
Threats

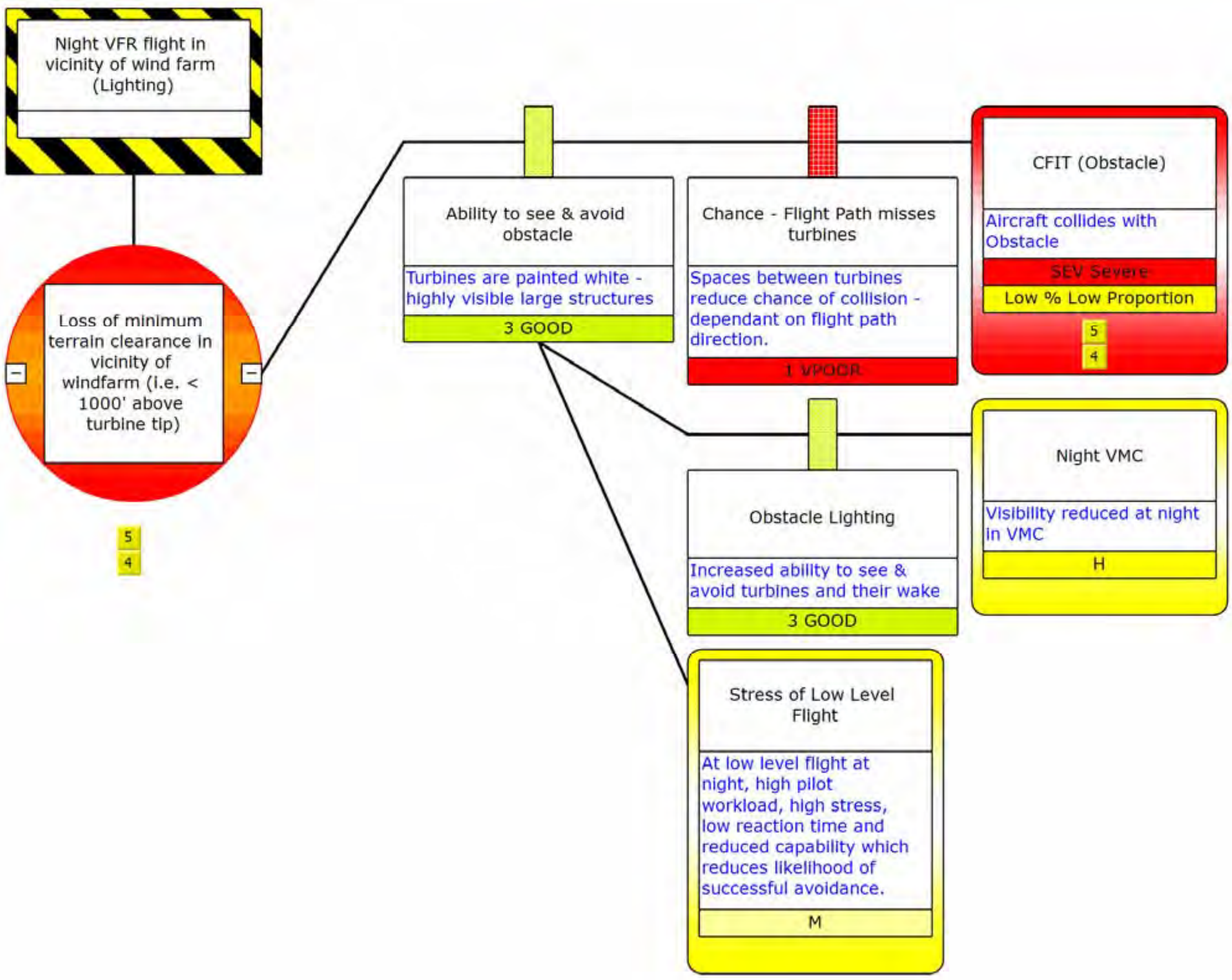


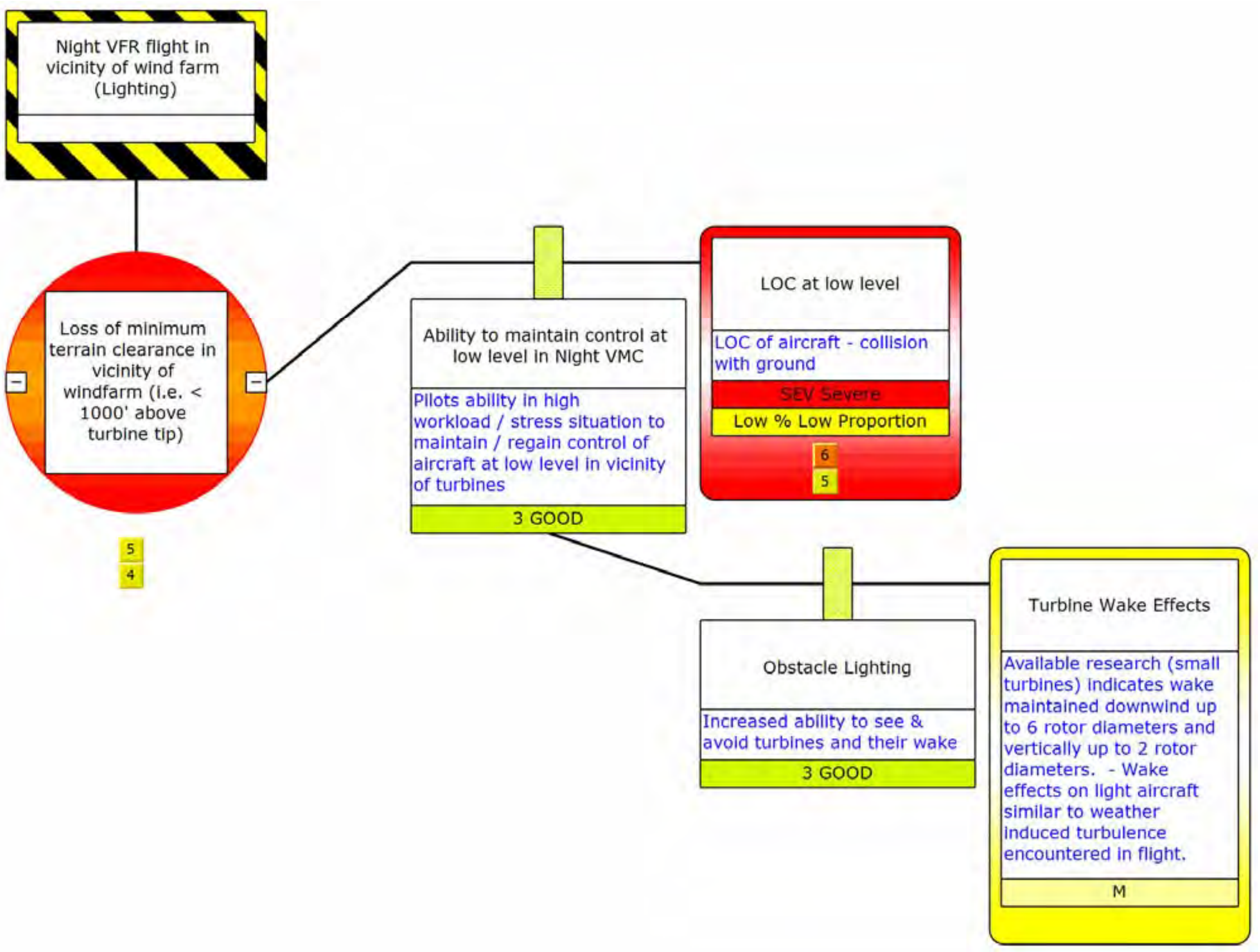




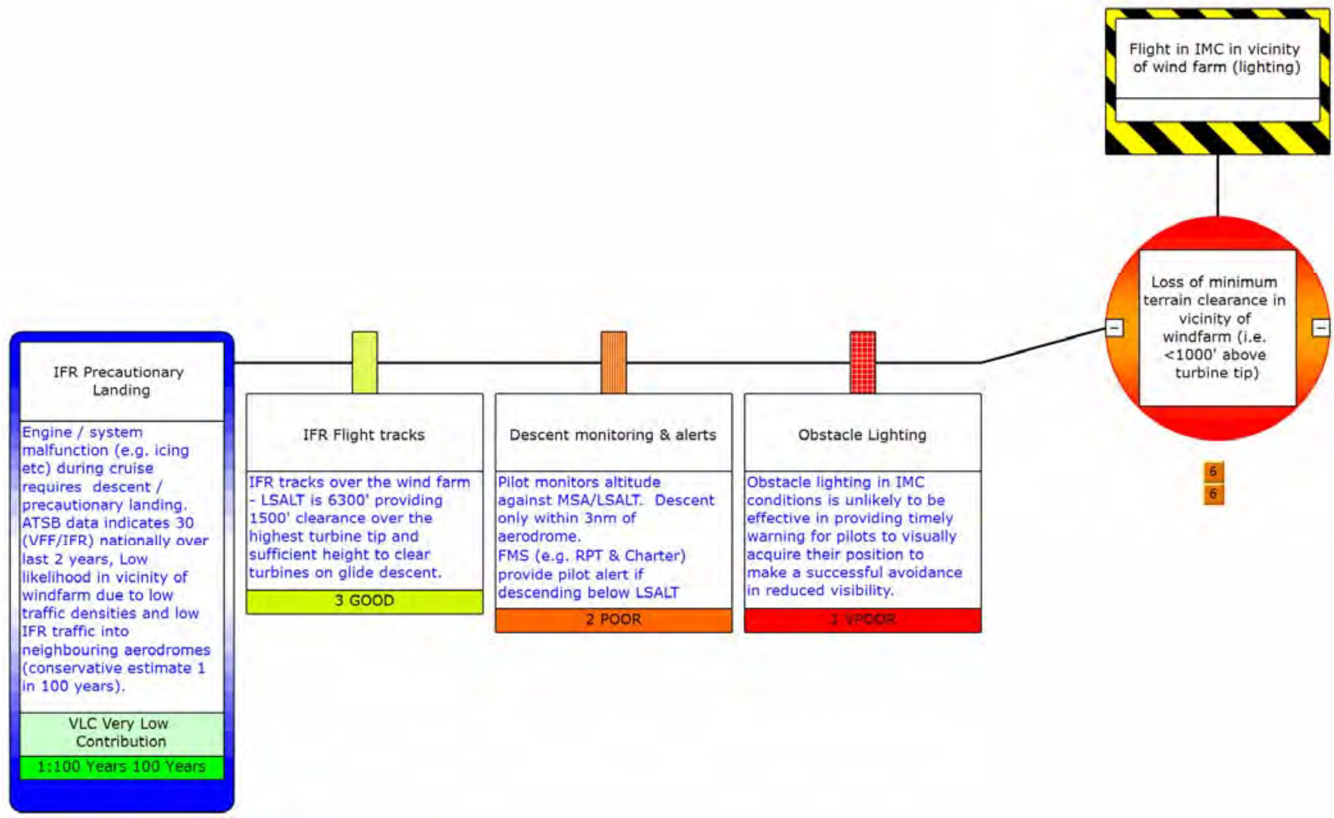
Consequences

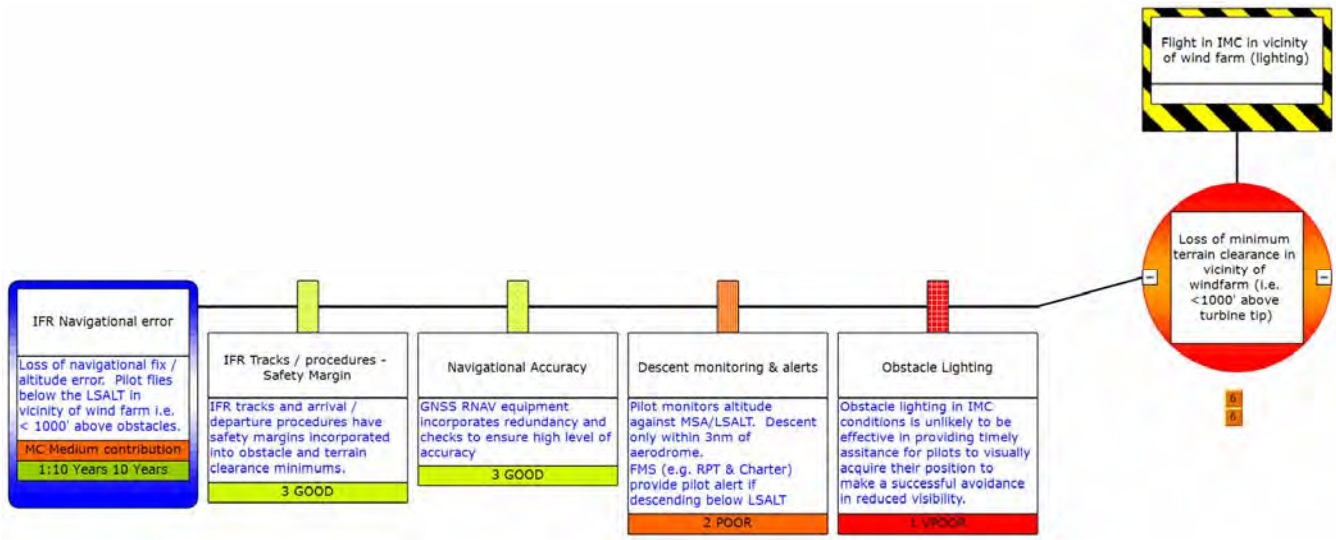

Night VFR flight in vicinity of wind farm (Lighting)
Loss of minimum terrain clearance in vicinity of windfarm (i.e. < 1000' above turbine tip)
5
4
Ability to maintain safe low level flight
Pilots ability at night in high workload / stress situation to maintain control of aircraft at low level
1 VPOOR
CFIT (Ground)
Aircraft collides with ground.
SEV Severe
MED % Medium Proportion
6
6

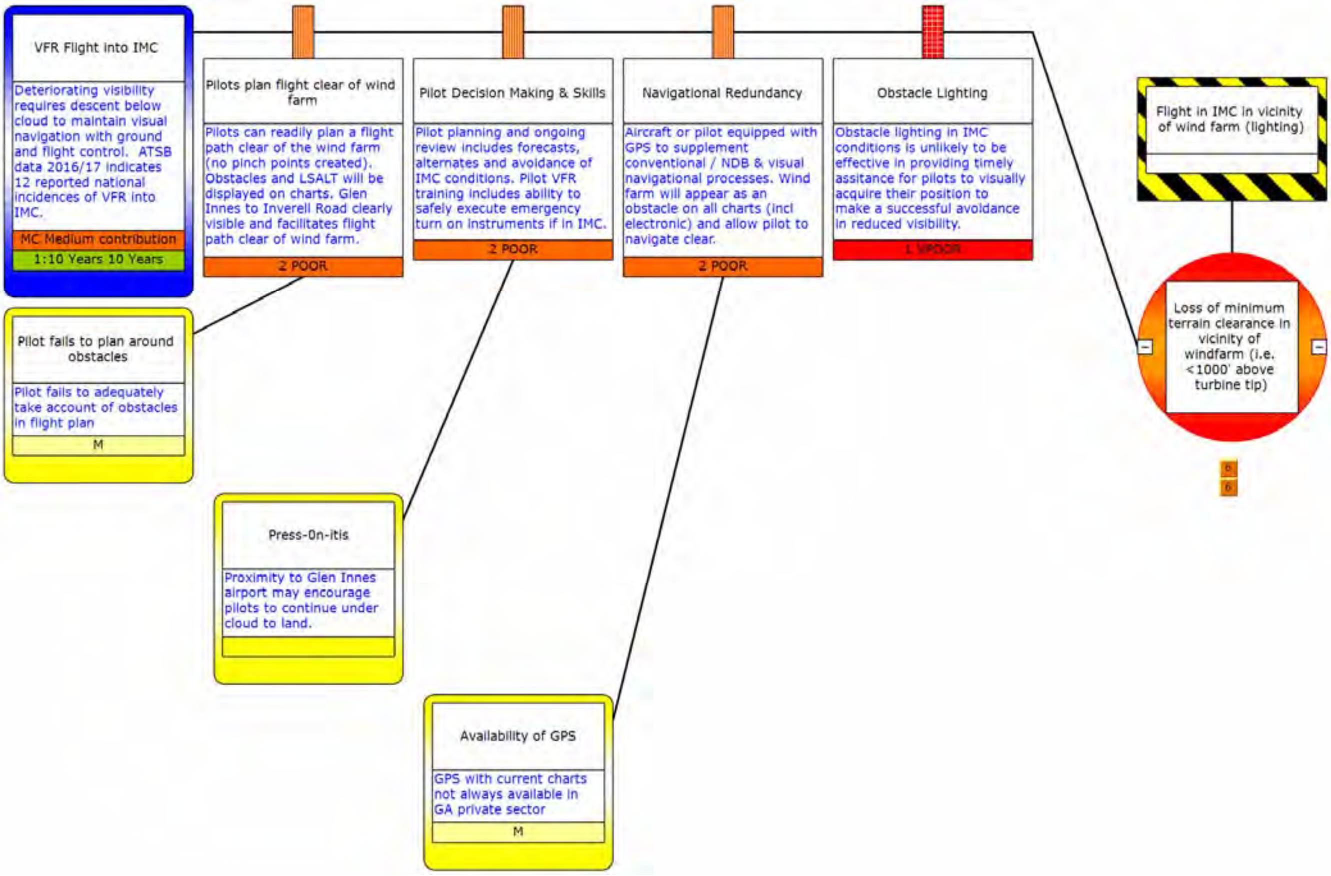

Night VFR flight in vicinity of wind farm (Lighting)
Loss of minimum terrain clearance in vicinity of windfarm (i.e. < 1000' above turbine tip)
5
4
Ability to see & avoid obstacle
Turbines are painted white - highly visible large structures
3 GOOD
Chance - Flight Path misses turbines
Spaces between turbines reduce chance of collision - dependant on flight path direction.
1 VPOOR
CFIT (Obstacle)
Aircraft collides with Obstacle
SEV Severe
Low % Low Proportion
5
4
Obstacle Lighting
Increased ability to see & avoid turbines and their wake
3 GOOD
Night VMC
Visibility reduced at night in VMC
H
Stress of Low Level Flight
At low level flight at night, high pilot workload, high stress, low reaction time and reduced capability which reduces likelihood of successful avoidance.
M


Night VFR flight in vicinity of wind farm (Lighting)
Loss of minimum terrain clearance in vicinity of windfarm (i.e. < 1000' above turbine tip)
5
4
Ability to maintain control at low level in Night VMC
Pilots ability in high workload / stress situation to maintain / regain control of aircraft at low level in vicinity of turbines
3 GOOD
LOC at low level
LOC of aircraft - collision with ground
SEV Severe
Low % Low Proportion
6
5
Obstacle Lighting
Increased ability to see & avoid turbines and their wake
3 GOOD
Turbine Wake Effects
Available research (small turbines) indicates wake maintained downwind up to 6 rotor diameters and vertically up to 2 rotor diameters. - Wake effects on light aircraft similar to weather induced turbulence encountered in flight.
M

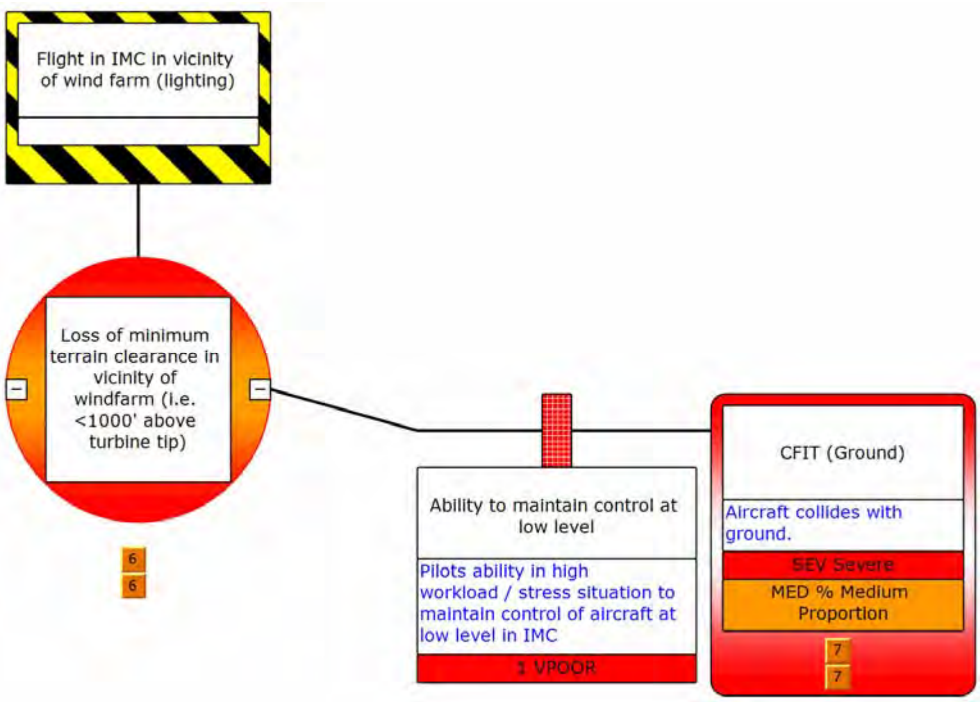
Flight in IMC (lighting)
Threats

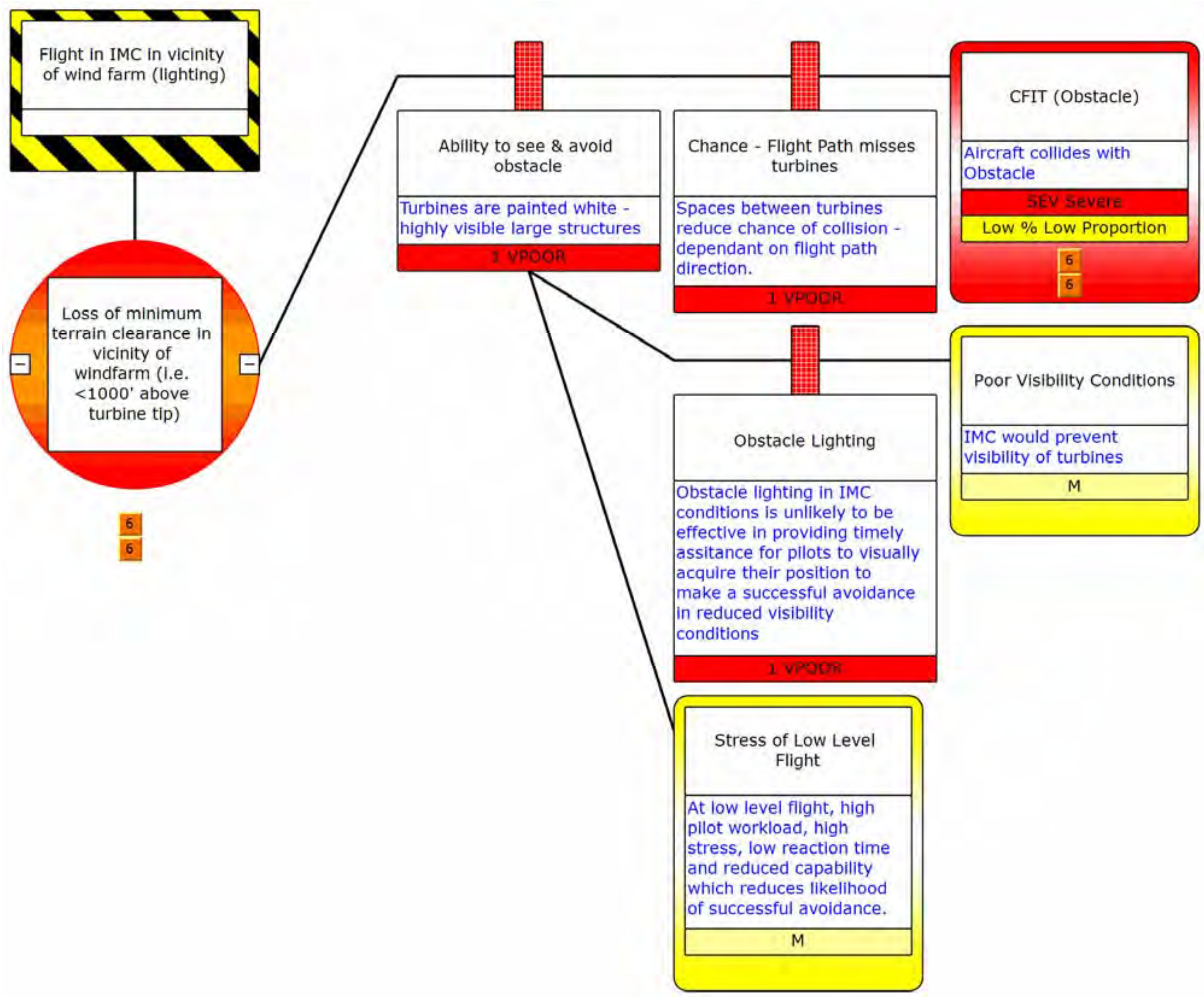




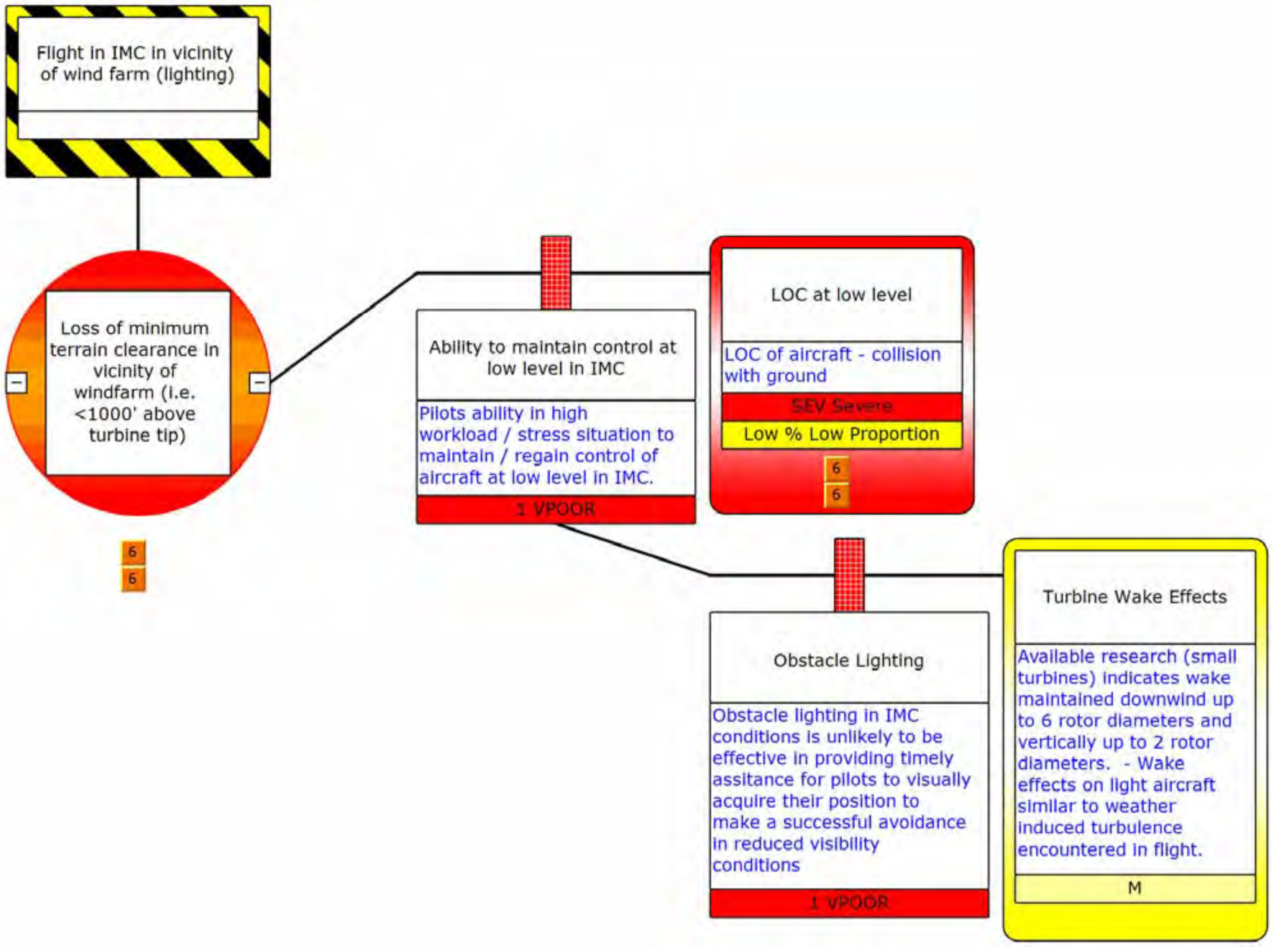


Consequences



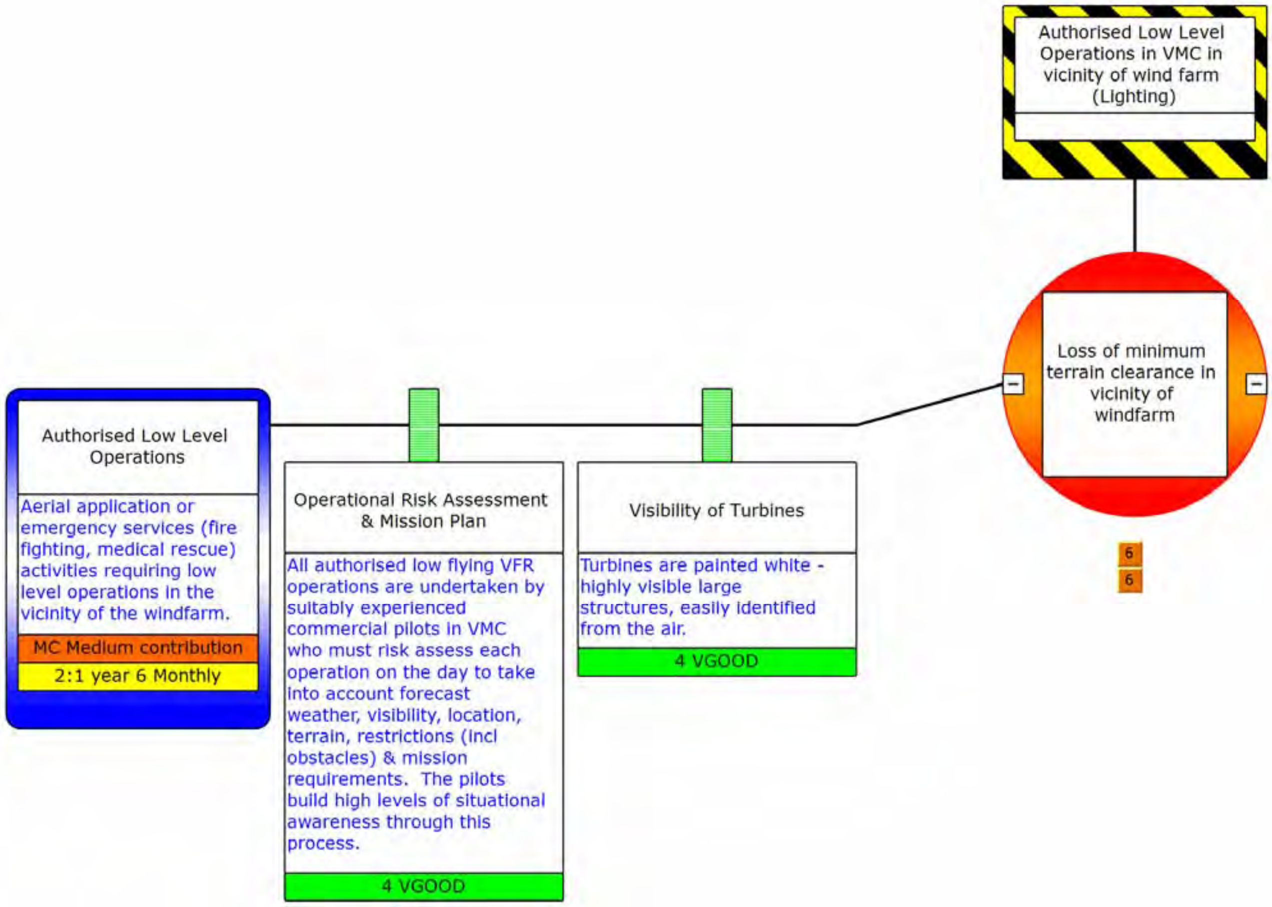

Flight in IMC in vicinity of wind farm (lighting)
Loss of minimum terrain clearance in vicinity of windfarm (i.e. <1000' above turbine tip)
6
6
Ability to see & avoid obstacle
Turbines are painted white - highly visible large structures
1 VPOOR
Chance - Flight Path misses turbines
Spaces between turbines reduce chance of collision - dependant on flight path direction.
1 VPOOR
CFIT (Obstacle)
Aircraft collides with Obstacle
SEV Severe
Low % Low Proportion
6
6
Obstacle Lighting
Obstacle lighting in IMC conditions is unlikely to be effective in providing timely assitance for pilots to visually acquire their position to make a successful avoidance in reduced visibility conditions
1 VPOOR
Poor Visibility Conditions
IMC would prevent visibility of turbines
M
Stress of Low Level Flight
At low level flight, high pilot workload, high stress, low reaction time and reduced capability which reduces likelihood of successful avoidance.
M

THE AMBIDJI GROUP

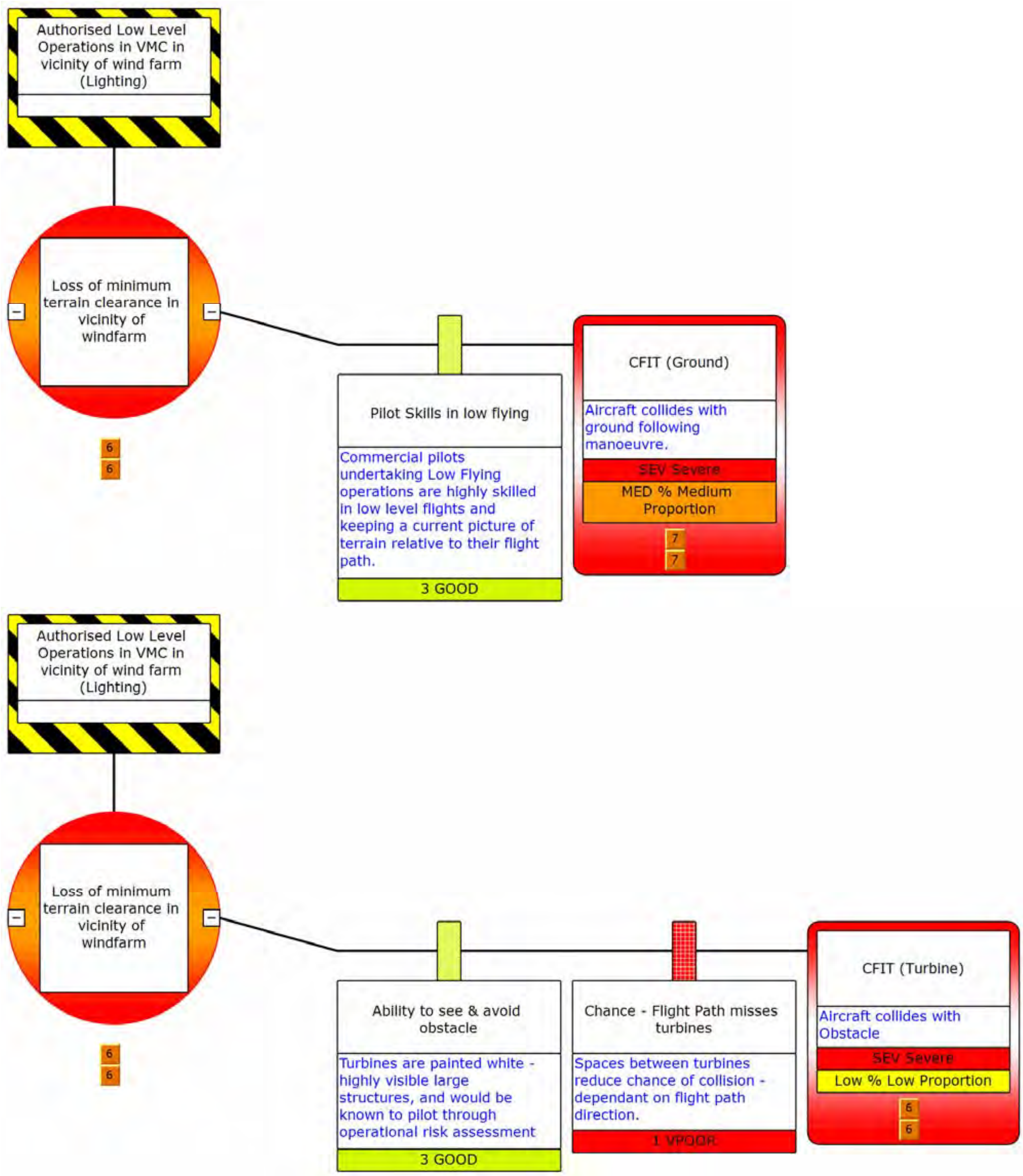


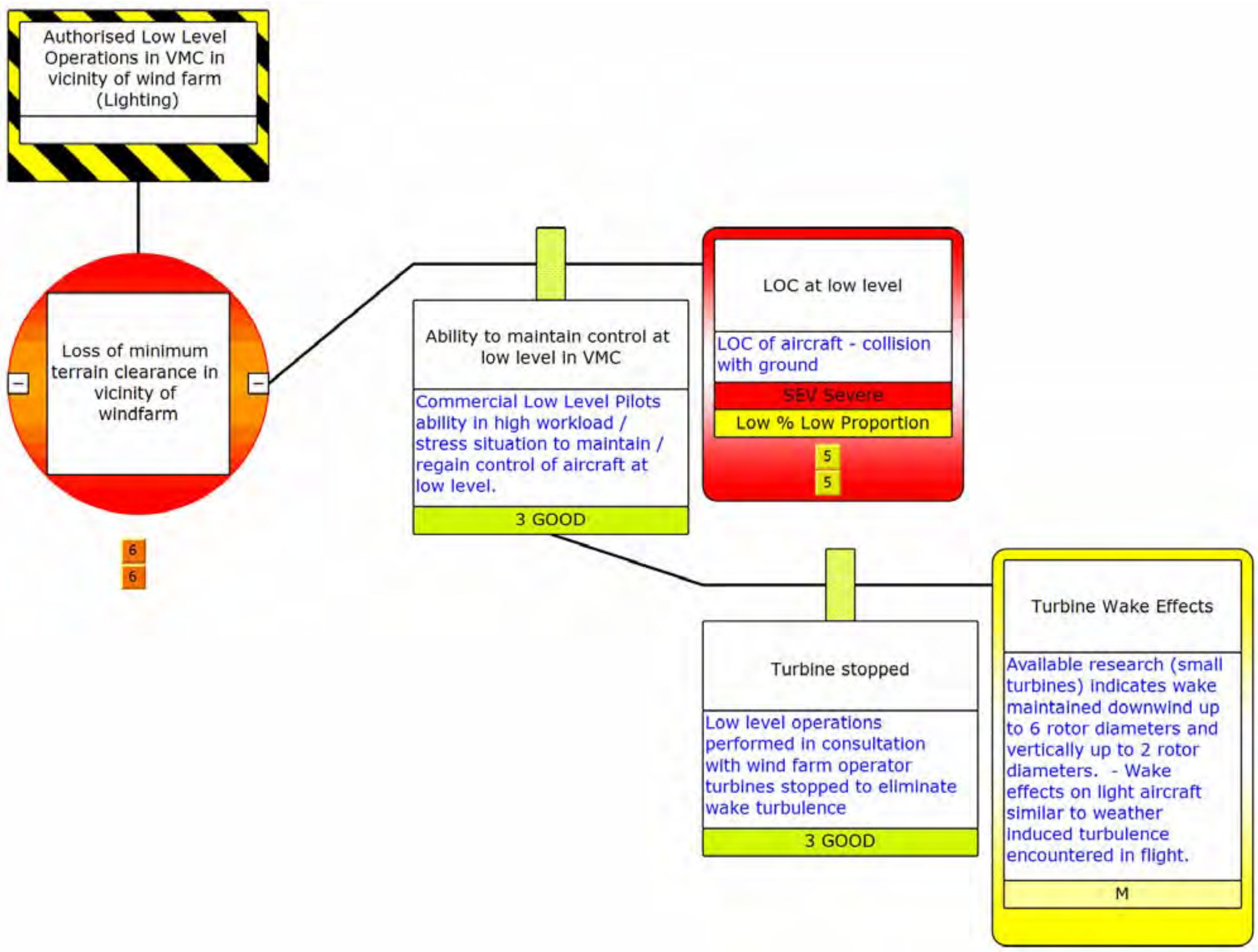
Authorised Low Level Operations in VMC (Lighting)

Threats



Consequences


Authorised Low Level Operations in VMC in vicinity of wind farm (Lighting)
Loss of minimum terrain clearance in vicinity of windfarm
6
6
Pilot Skills in low flying
Commercial pilots undertaking Low Flying operations are highly skilled in low level flights and keeping a current picture of terrain relative to their flight path.
3 GOOD
CFIT (Ground)
Aircraft collides with ground following manoeuvre.
SEV Severe
MED % Medium Proportion
7
7
Authorised Low Level Operations in VMC in vicinity of wind farm (Lighting)
Loss of minimum terrain clearance in vicinity of windfarm
6
6
Ability to see & avoid obstacle
Turbines are painted white - highly visible large structures, and would be known to pilot through operational risk assessment
3 GOOD
Chance - Flight Path misses turbines
Spaces between turbines reduce chance of collision - dependant on flight path direction.
1 VPOOR
CFIT (Turbine)
Aircraft collides with Obstacle
SEV Severe
Low % Low Proportion
6
6


Authorised Low Level Operations in VMC in vicinity of wind farm (Lighting)
Loss of minimum terrain clearance in vicinity of windfarm
6
6
Ability to maintain control at low level in VMC
Commercial Low Level Pilots ability in high workload / stress situation to maintain / regain control of aircraft at low level.
3 GOOD
LOC at low level
LOC of aircraft - collision with ground
SEV Severe
Low % Low Proportion
5
5
Turbine stopped
Low level operations performed in consultation with wind farm operator turbines stopped to eliminate wake turbulence
3 GOOD
Turbine Wake Effects
Available research (small turbines) indicates wake maintained downwind up to 6 rotor diameters and vertically up to 2 rotor diameters. - Wake effects on light aircraft similar to weather induced turbulence encountered in flight.
M

APPENDIX E. EXCERPTS FROM RELEVANT RULES & REGULATIONS

VISUAL FLIGHT RULES

The following information regarding Visual Flight Rules is provided to inform the readers of this report who may not be trained pilots.

It is often stated that aircraft flown in accordance with the VFR can legally fly at 500 feet above the ground. This "fact" is taken from Civil Aviation Regulations 1988 (CAR) Part 11, Division 2 Flight Rules, Regulation 157 – Low Flying.

This regulation is often selectively quoted to indicate that an aircraft can fly at 500ft above the ground, when in fact it is 500ft above the highest point of the ground **and any object on it**. If the wind turbine tip is 625ft above the ground an aircraft must be 500ft above the tip, which is 625 + 500 = 1125ft above the ground. The highest turbine tip in the Glen Innes wind farm is 4745 ft. AHD. For a VFR aircraft to comply with CAR 157 it would need to be at a height of 4745 + 500 = 5245ft AHD. For aviation purposes height above AHD is known as altitude. Consequently, a VFR aircraft would need to be flying at an altitude of 500ft over the wind turbines to comply with this regulation.

The primary regulation for Visual Flight Rules is CAR 171 – VFR Flight, which at sub regulation 2) states "Where an aircraft cannot be flown in accordance with the Visual Flight Rules, the pilot in command shall comply with the Instrument Flight Rules contained in Division 4 of this Part, or land at the nearest suitable aerodrome."

CAR 172 FLIGHT VISIBILITY AND DISTANCE FROM CLOUD

1) The pilot in command of an aircraft must not conduct a VFR flight at a height of, or less than 2000ft above ground or water if:

a. The pilot is not able to navigate by reference to the ground or water; and

b. CASA has not directed that the flight may be conducted at a height of 2000ft or less.

Penalty 50 penalty points.

2) Subject to sub regulation 4), the pilot in command must not conduct a VFR flight if:

a. The flight visibility during that flight is not equal to or greater than the applicable distance determined by CASA; and

b. The vertical and horizontal distances from cloud are not equal to or greater than the applicable distances determined by CASA

Penalty 50 penalty points.

2AA) An offence against sub regulation 1) or 2) is an offence of strict liability.

2A) CASA may determine applicable distances for the purpose of sub regulation 2)

2B) CASA must notify the distances determined under sub regulation 2A) in AIP or NOTAMS

3) When determining applicable distances, CASA may do so by reference to class of airspace

4) In spite of sub regulation 2) the pilot in command of an aircraft may conduct a special VFR flight if:

a. Air traffic control gives permission for the flight; and

b. The flight is conducted in accordance with any special conditions to which the permission is subject,

5) In this regulation: *special VFR flight* means a VFR flight:

a. Conducted in a control zone; or

b. Conducted in a control area next to a control zone for the purpose of entering or leaving the zone;

When the flight visibility or distances from cloud are less that the applicable distances determined under sub regulation 2).

174B VFR FLIGHTS AT NIGHT

1) The pilot in command of an aircraft must not fly the aircraft at night under the VFR at a height of less than 1000ft above the highest obstacle located within 10nm of the aircraft in flight if it is not necessary for take-off or landing.

Penalty 25 penalty points

2) The pilot in command of a single engine aircraft must not fly the aircraft at night under the VFR if the flight is not one of the following operations:

a. Private operations;

b. Aerial work operations;

c. Charter operations that do not involve the carrying of passengers for hire or reward;

d. Charter operations that involve the carrying of passengers for hire or reward if:

i. The operator is approved in writing by CASA to conduct he operations; and

ii. The operations are conducted in a turbine powered aeroplane approved in writing by CASA for the operations.

Penalty 25 penalty points

3) An offence against sub regulation 1) or 2) is an offence of strict liability

4) It is a defence to a prosecution under sub regulation 1) if CASA gave permission for the flight.

CAR 157 LOW FLYING7

1) The pilot in command of an aircraft must not fly the aircraft over:

a. Any city, town or populous area at a height lower than 1000ft; or

b. Any other area at a height lower than 500ft.

Penalty 50 penalty units

[7] https://www.legislation.gov.au/Details/F2015C00993/Html/Volume_3#_Toc438213033 last accessed 1 April 2016.

2) An offence against sub regulation 1) is an offence of strict liability

3) A height specified in sub regulation 1) is the height above the highest point of the terrain and any object on it, within a radius of:

a. In the case of an aircraft other than a helicopter – 600 metres; or

b. In the case of a helicopter – 300 metres;

from a point on the terrain vertically below the aircraft.

3A) Paragraph 1) a) does not apply in respect of a helicopter flying at a designated altitude with an access lane details of which have been published in the AIP or NOTAMs for use by helicopters arriving or departing from a specified place.

4) Sub regulation 1) does not apply if:

a. Through the stress of weather or any other unavoidable cause it is essential that a lower height be maintained; or

b. The aircraft is engaged in private operations or aerial work operations, being operations that require low flying, and the owner or operator of the aircraft has received from CASA either a general permit for all flights or a specific permit for the particular flight to be made at a lower height while engaged in such operations; or

c. The pilot of the aircraft is receiving flight training in low-level operations or aerial applications operations within the meaning of Part 61 of CASR; or

d. The pilot of the aircraft is engaged in a baulked approach procedure, or the practice of such procedure under the supervision of a flight instructor or a check pilot; or

e. The aircraft is flying in the course of actually taking off or landing at an aerodrome; or

f. The pilot of the aircraft is engaged in:

i. A search; or

ii. A rescue; or

iii. Dropping supplies;

In a search and rescue operation; or

g. The aircraft is a helicopter:

i. Operated by, of for the purposes of the Australian Federal Police or the police force of a State or Territory; and

ii. Engaged in law enforcement operations; or

h. The pilot of the aircraft is engaged in an operation which requires the dropping of packages or other articles or substances in accordance with directions issued by CASA.

Sub regulation 4) a) provides for the pilot, who through poor airmanship has ‘pressed on’ into marginal VMC, to extricate themselves from an unsafe situation. Refer to CAR 171 sub regulation 2) below for what a pilot is required to do if they cannot proceed in accordance with the VFR.

The Visual Flight Rules are shown in Civil Aviation Regulations 1988 (CAR) Part 12

Division 3[8].

CAR 171 VFR FLIGHT

1) A flight conducted in accordance with the provisions of this Division is classed as a flight under the Visual Flight Rules.
2) Where an aircraft cannot be flown in accordance with the Visual Flight Rules, the pilot in command shall comply with the Instrument Flight Rules contained in Division 4 of this Part, or land at the nearest suitable aerodrome.

   Penalty 25 penalty points
3) An offence against sub regulation 2) is an offence of strict liability.

[8] https://www.legislation.gov.au/Details/F2015C00993/Html/Volume_3#_Toc438213061 last accessed 1 April 2016.

APPENDIX F. OBSTACLE LIGHTING CHARACTERISTICS

Aeronautical obstacle lighting is required to meet specified operational and performance characteristics as defined in the following documents:

- CASA Manual of Standards (MoS) Part 139 – Aerodromes; and
- NASF Guideline D) – "Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers"

A summary of these requirements is provided below.[9]

MoS Part 139 Section 9.4.2, Types of Obstacle Lighting and Their Use, defines the types of obstacle lighting requirements; Low Intensity, Medium Intensity and High Intensity.

For Obstacles above 45m (but below 150m) AGL the requirement is for Medium Intensity Obstacle Lighting.

Definition: Medium intensity lighting can be one of three types:

- Flashing White Light;
- Flashing Red Light (known as a hazard beacon); and
- Steady Red Light – may be used where there is opposition to the use of a flashing red light, for example in environmentally sensitive locations.

MoS Pt 139: Characteristics of Medium Intensity Lights (Summary)

- Frequency of flashes is to be between 20 and 60 flashes per minute;
- Peak effective intensity is to be 2,000 +/- 25% cd with a vertical distribution as follows:
- Vertical beam spread is to be 3° minimum (beam spread is defined as the angle between two directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity)
- At -1° elevation, the intensity is to be 50% minimum and 75% maximum of lower tolerance value of the peak intensity.
- At 0° elevation, the intensity is to be 100% minimum of the lower tolerance value of the peak intensity.

CASA Advisory Circular AC139-18(0)

Although this Advisory Circular has been withdrawn by CASA it has been advised that the technical recommendations still apply. In the case of Wind Farms, AC139-18(0) defined the required obstacle lighting characteristics as follows:

- Two flashing red medium intensity obstacle lights should be provided;
- Light fixtures to be mounted sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and at a horizontal separation to

[9] This summary is considered to provide a comprehensive overview of obstacle lighting requirements. However, it is recommended that the proponents of Sapphire Wind Farm fully familiarize themselves with the requirements when conducting their detailed obstruction lighting and system design.

ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction;

- Both lights should flash simultaneously;
- Characteristics of the obstacle lights should be in accordance with MoS Pt 139;
- All obstacle lights on a wind farm are to be synchronised so that they flash simultaneously; and
- An appropriate monitoring, reporting and maintenance procedure is to be established to ensure outages are detected, reported and rectified.

The requirements of AC139-18(0) have been superseded by the NASF Guidelines

Visual Impact Minimisation

It may be necessary to allow for minimisation of the visual impact on the environment. Some shielding may be installed provided it does not compromise the operational effectiveness of the obstruction lighting.

Shielding may be provided to restrict the downward component of light to either, or both, of the following:

- Such that no more than 5% of the nominal intensity is emitted at or below 5° below the horizontal
- Such that no light is emitted at or below 10° below the horizontal.

Minimisation of reflected light from the turbine blades may be also catered for. A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the blades of light from obstacle lights, without compromising the daytime conspicuity of the overall turbine.

Obstacle light fittings are commercially available that minimise visual impact and accord with CASA performance and operating requirements.

Obstacle Lighting Operating Requirements

Where two lights are mounted on a nacelle, dynamic shielding or light extinction of one light at a time, for the period that a blade is passing in front of the light, is permissible providing that at all times at least one light can be seen, without interruption, from every angle in the azimuth.

Obstacle lights should operate at night, and at times of reduced visibility. All obstacle lights on a wind farm should be turned on simultaneously and off simultaneously.

Where obstacle lighting is provided, it is necessary to establish a monitoring, reporting and maintenance procedure to ensure outages, including loss of synchronisation, are detected, reported and rectified.

APPENDIX G. GLOSSARY

To facilitate the understanding of aviation terminology used in this report, the following is a glossary of terms and acronyms that are commonly used in aeronautical impact assessments and similar aeronautical studies. A full list of terms and abbreviations used in this report is included in this Appendix. It should be noted that, within aviation, the International standard unit for altitude is feet (ft.) and distance is nautical mile (nm).

AC (Advisory Circulars) are issued by CASA and are intended to provide recommendations and guidance to illustrate a means, but not necessarily the only means, of complying with the *Regulations*.

Aeronautical study is a tool used to review aerodrome and airspace processes and procedures to ensure that safety criteria are appropriate.

AHD (Australian Height Datum) is the datum to which all vertical control for mapping is to be referred. The datum surface is that which passes through mean sea level at the 30 tide gauges and through points at zero AHD height vertically below the other basic junction points.

AIP (Aeronautical Information Publication) is a publication promulgated to provide operators with aeronautical information of a lasting character essential to air navigation. It contains details of regulations, procedures and other information pertinent to flying and operation of aircraft. In Australia, the AIP may be issued by CASA or Airservices Australia.

Air routes exist between navigation aid equipped aerodromes or waypoints to facilitate the regular and safe flow of aircraft operating under Instrument Flight Rules (IFR).

Airservices Australia is the Australian government-owned corporation providing safe and environmentally sound air traffic management and related airside services to the aviation industry.

Altitude is the vertical distance of a level, a point or an object, considered as a point, measured from mean sea level.

AMSL (Above Mean Sea Level) is the elevation (on the ground) or altitude (in the air) of any object, relative to the average sea level datum. In aviation, the ellipsoid known as World Geodetic System 84 (WGS 84) is the datum used to define mean sea level.

ATC (Air Traffic Control) service is a service provided for the purpose of:

a. preventing collisions:
   1. between aircraft; and
   2. on the maneuvering area between aircraft, vehicles and obstructions; and
b. expediting and maintaining an orderly flow of air traffic.

CASA (Civil Aviation Safety Authority) is the Australian government authority responsible under the *Civil Aviation Act 1988* for developing and promulgating appropriate, clear and concise aviation safety standards. As Australia is a signatory to the ICAO *Chicago Convention,* CASA adopts the standards and recommended practices established by ICAO, except where a difference has been notified*.*

CASR (Civil Aviation Safety Regulations) are promulgated by CASA and establish the regulatory framework *(Regulations)* within which all service providers must operate.

Civil Aviation Act 1988 (the Act) establishes the CASA with functions relating to civil aviation, in particular the safety of civil aviation and for related purposes.

ICAO (International Civil Aviation Organization) is an agency of the United Nations which codifies the principles and techniques of international air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth. The ICAO Council adopts standards and recommended practices concerning air navigation, its infrastructure, flight inspection, prevention of unlawful interference, and facilitation of border-crossing procedures for international civil aviation. In addition, the ICAO defines the protocols for air accident investigation followed by transport safety authorities in countries signatory to the Convention on International Civil Aviation, commonly known as the *Chicago Convention*. Australia is a signatory to the *Chicago Convention.*

IFR (Instrument Flight Rules) are rules applicable to the conduct of flight under IMC. IFR is established to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals. It is also referred to as, "a term used by pilots and controllers to indicate the type of flight plan an aircraft is flying," such as an IFR or VFR flight plan.

IMC (Instrument Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, less than the minimum specified for visual meteorological conditions.

LSALT (Lowest Safe Altitudes) are published for each low-level air route segment. Their purpose is to allow pilots of aircraft that suffer a system failure to descend to the LSALT to ensure terrain or obstacle clearance in IMC where the pilot cannot see the terrain or obstacles due to cloud or poor visibility conditions. It is an altitude that is at least 1,000 feet above any obstacle or terrain within a defined safety buffer region around a particular route that a pilot might fly.

MOS (Manual of Standards) comprises specifications *(Standards)* prescribed by CASA, of uniform application, determined to be necessary for the safety of air navigation.

NASAG (National Airports Safeguarding Advisory Group) set up in May 2010 to implement the Australian Government's National Aviation Policy White Paper, *Flight Path to the Future* initiatives relating to safeguarding airports and surrounding communities from inappropriate development. NASAG comprises representatives from state and territory planning and transport departments, the Civil Aviation Safety Authority (CASA), Airservices Australia, the Department of Defence and the Australian Local Government Association (ALGA) and is chaired by the Department of Infrastructure and Regional Development (DIRD).

NASF (National Airports Safeguarding Framework) is the set of guidelines, adopted in July 2012, developed by NASAG to safeguard airports and surrounding communities.

NOTAMs (Notices to Airmen) are notices issued by the NOTAM office containing information or instruction concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to persons concerned with flight operations.

Obstacles - All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

OLS (Obstacle Limitation Surfaces) are a series of planes associated with each runway at an aerodrome that defines the desirable limits to which objects may project into the airspace around the aerodrome so that aircraft operations may be conducted safely.

PANS-OPS (Procedures for Air Navigation Services - Aircraft Operations) is an Air Traffic Control term denominating rules for designing instrument approach and departure procedures. Such procedures are used to allow aircraft to land and take off under Instrument Meteorological Conditions (IMC) or Instrument Flight Rules (IFR). ICAO document 8168-

OPS/611 (volumes 1 and 2) outlines the principles for airspace protection and procedure design which all ICAO signatory states must adhere to. The regulatory material surrounding PANS-OPS may vary from country to country.

PANS-OPS Surfaces - Similar to an Obstacle Limitation Surface, the PANS-OPS protection surfaces are imaginary surfaces in space which guarantee the aircraft a certain minimum obstacle clearance. These surfaces may be used as a tool for local governments in assessing building development. Where buildings may (under certain circumstances) be permitted to penetrate the OLS, they cannot be permitted to penetrate any PANS-OPS surface, because the purpose of these surfaces is to guarantee pilots operating under IMC an obstacle free descent path for a given approach.

Prescribed airspace is an airspace specified in, or ascertained in accordance with, the Regulations, where it is in the interests of the safety, efficiency or regularity of existing or future air transport operations into or out of an airport for the airspace to be protected. The prescribed airspace for an airport is the airspace above any part of either an OLS or a PANS OPS surface for the airport and airspace declared in a declaration relating to the airport.

Regulations (Civil Aviation Safety Regulations)

VFR (Visual Flight Rules) are rules applicable to the conduct of flight under VMC. VFR allow a pilot to operate an aircraft in weather conditions generally clear enough to allow the pilot to maintain visual contact with the terrain and to see where the aircraft is going. Specifically, the weather must be better than basic VFR weather minima. If the weather is worse than VFR minima, pilots are required to use instrument flight rules.

VMC (Visual Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, equal or better than specified minima

APPENDIX H. ABBREVIATIONS

Abbreviations used in this report, and the meanings assigned to them for the purposes of this report are detailed in the following table:

Abbreviation	Meaning
AC	Advisory Circular (document support CASR 1998)
ACFT	Aircraft
AD	Aerodrome
AHD	Australian Height Datum
AHT	Aircraft height
AIP	Aeronautical Information Publication
Airports Act	Airports Act 1996, as amended
AIS	Aeronautical Information Service
ALA	Aircraft Landing Area
Alt	Altitude
AMSL	Above Minimum Sea Level
A(PofA)R	Airports (Protection of Airspace) Regulations, 1996 as amended
APARs	Airports (Protection of Airspace) Regulations, 1996 as amended
ARP	Aerodrome Reference Point
AsA	Airservices Australia
ATC	Air Traffic Control(ler)
ATM	Air Traffic Management
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
Cat	Category
DAP	Departure and Approach Procedures (charts published by AsA)
DER	Departure End of (the) Runway
DEVELMT	Development
DME	Distance Measuring Equipment
Doc nn	ICAO Document Number nn
DIRD	Department of Infrastructure and Regional Development. (Formerly Department of Infrastructure and Transport)
DoIT	Department of Infrastructure and Transport. Also called “Infrastructure”. (Formerly Department of Infrastructure, Transport, Regional Development and Local Government (DITRDLG) and previously the Department of Transport and Regional Services (DoTARS))
DITRDLG	See DoIT above
DOTARS	See DITRDLG above
ELEV	Elevation (above mean sea level)
ENE	East North East
ERSA	Enroute Supplement Australia
FAF	Final Approach Fix

Abbreviation	Meaning
FAP	Final Approach Point
ft.	feet
GA	General Aviation
GNSS	Global Navigation Satellite System
GP	Glide Path
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IHS	Inner Horizontal Surface, an Obstacle Limitation Surface
ILS	Instrument Landing System
ISA	International Standard Atmosphere
km	kilometres
kt	Knot (one nautical mile per hour)
LAT	Latitude
LLZ	Localizer
LONG	Longitude
LSALT	Lowest Safe Altitude
m	metres
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MGA94	Map Grid Australia 1994
MOC	Minimum Obstacle Clearance
MOS	Manual of Standards, published by CASA
MSA	Minimum Sector Altitude
SSR	Monopulse Secondary Surveillance Radar
MVA	Minimum Vector Altitude
NASAG	National Airports Safeguarding Advisory Group
NASF	National Airports Safeguarding Framework
NDB	Non Directional Beacon
NE	North East
NM or nm	Nautical Mile (= 1.852 km)
nnDME	Distance from the DME (in nautical miles)
NNE	North North East
NOTAM	NOtice To AirMen
OAS	Obstacle Assessment Surface
OCA	Obstacle Clearance Altitude
OCH	Obstacle Clearance Height
OHS	Outer Horizontal Surface
OIS	Obstacle Identification Surface
OLS	Obstacle Limitation Surface
PANS-OPS	Procedures for Air Navigation Services – Aircraft Operations, ICAO Doc 8168
PRM	Precision Runway Monitor
PROC	Procedure
PSR	Primary Surveillance Radar

Abbreviation	Meaning
QNH	An altimeter setting relative to height above mean sea level
Rnnn	Restricted Airspace – promulgated in AIP as R with 3 numbers
REF	Reference
RL	Relative Level
RNAV	aRea NAVigation
RNP	Required Navigation Performance
RPA	Rules and Practices for Aerodromes — replaced by the MOS Part 139 — Aerodromes
RPT	Regular Public Transport
RWY	Runway
SFC	Surface
SID	Standard Instrument Departure
SOC	Start Of Climb
SSR	Secondary Surveillance Radar
STAR	Standard ARrival
TAR	Terminal Area Radar
TAS	True Air Speed
THR	Threshold (Runway)
TNA	Turn Altitude
TODA	Take-Off Distance Available
VFR	Visual Flight Rules
V_n	aircraft critical Velocity reference
VOR	Very high frequency Omni directional Range

Appendix E

Visual Impact Assessment

Glen Innes Wind Farm Modification 4

VISUAL IMPACT ASSESSMENT

Prepared for:

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Prepared by:

GREEN BEAN DESIGN
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June 2017

DOUCMENT CONTROL

Item	Detail
Project Name:	**Glen Innes Wind Farm Modification 4**
Report Title:	**Visual Impact Assessment**
Project Number:	**17-235**
Version Number:	**v2**
Status:	**Final**
Author:	**Andrew Homewood**, Registered Landscape Architect, AILA *Graduate Diploma Landscape Management, Bachelor Science (Dual Honours)* *Landscape Design and Archaeology, National Diploma Horticulture*
Date:	**27 June 2017**

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Table 1 Glossary

Term	Definition
Cumulative effects	The summation of effects that result from changes caused by a development in conjunction with other past, present or reasonably foreseeable actions.
Magnitude	A combination of the scale, extent and duration of an effect.
Mitigation	Measures, including any processes, activity or design to avoid, reduce, remedy or compensate for adverse landscape and visual effects of a development project.
Residual visual effect	Observable difference between the approved GIWF Mod-2 project and the proposed Mod-4 amendments.
Sensitivity	Susceptibility of a receiver to a specific type of change.
Swept area	Circular area defined by the rotational path of the rotor blades.
Visibility	A relative determination at which the proposal can be discerned and described.
Visual amenity	The value of a particular area or view in terms of what is seen.
Visual envelope	Extent of potential visibility to or from a specific area or feature.
Visual Impact Assessment	A process of applied professional and methodical techniques to assess and determine the extent and nature of change to the composition of existing views that may result from a development.
View location	A place or situation from which a proposed development may be visible.
Visual receiver	Individual and/or defined groups of people who have the potential to be impacted.
Visual significance	A measure of visual effect culminating from the degree of magnitude and receiver sensitivity.
Zone of Visual Influence Diagram	A map, usually digitally produced, showing areas of land within which wind turbines are theoretically visible.

Executive summary

Green Bean Design Pty Ltd has been commissioned by Glen Innes Windpower Pty Ltd , to prepare a Visual Impact Assessment report for the Glen Innes Wind Farm proposed Modification-4 Application. The Application is for an amendment of development consent in accordance with Section 75W of the Environment Planning and Assessment Act 1979.

The GIWF Mod-2 and Mod-3 consolidated development consent (dated January 2016) permits the construction and operation of up to 25 wind turbines to a maximum 150 metre tip height. This VIA has been prepared to assess the potential visual effect of the GIWF proposed Mod-4 amendments which include an increased:

- hub height to 110 metres (24% taller)
- rotor dimeter to 140 metres (15% longer)
- swept area to 15,394 metres squared (32% larger) and
- tip height to a maximum 180m.

The total number of wind turbines would remain at 25 in accordance with the Consolidated Development Consent, January 2016.

The wind turbine locations have undergone minor micro-siting adjustments. The maximum decrease in distance between dwelling and wind turbine is around 66 metres. The maximum increase in distance between dwelling and wind turbine is around 43 metres. The proposed micro-siting adjustments are not expected to result in any changes to the magnitude and significance of visual effect as previously determined in the Mod-2 VIA.

The Zone of Visual Influence Diagrams (**Figures 2** and **3)** demonstrate the area of land within which the GIWF Mod-2 and Mod-4 would be theoretically visible (as well as overall number of wind turbines being visible), would be very similar to each other. Further analysis has determined that no more than two to three Mod-4 wind turbine hubs and tips would be visible from any residential dwelling within 3 kilometres of the GIWF Mod-4 wind turbines.

The installation of ancillary wind farm infrastructure would not result in unacceptable levels of visual impact from surrounding key receiver locations.

This VIA included an assessment of twenty-three residential dwellings within 3 km of a GIWF proposed Mod-4 wind turbine. The overall assessment of visual effects associated with the GIWF proposed Mod-4 wind turbines is summarised as Low to Negligible. The GIWF Mod-4 wind turbine is not considered to be of a magnitude that would significantly increase visual effects associated with the approved GIWF Mod-2 development. Key differences in the approved GIWF Mod-2 and proposed Mod-4 are illustrated in **Figures 4, 5** and **6**.

Twenty-three wire frame model diagrams have been prepared to illustrate the location and extent of wind turbines within the approved GIWF Mod-2 and Mod-4 wind turbine layouts.

The proposed amendments to the approved GIWF Mod-2 would result in a low level of visual magnitude and an unchanged visual rating in accordance with the approved GIWF Mod-2 project. The proposed amendments would not introduce elements that are prominent or out of character with the approved GIWF Mod-2 project, and the potential for the proposed Mod-4 wind turbines to result in any additional significant cumulative visual effects is considered to be low.

1 Introduction

Green Bean Design Pty Ltd (GBD) has been commissioned by Glen Innes Windpower Pty Ltd (the Proponent) to prepare a Visual Impact Assessment (VIA) report for the Glen Innes Wind Farm (GIWF) proposed Modification-4 Application (Mod-4).

This VIA has been prepared to compare the potential visual effect of the proposed GIWF Mod-4 project with the visual ratings determined and approved for the GIWF Mod-2 project. The approved GIWF Mod-2 visual ratings have been extracted from the Glen Innes Wind Farm DA Approval Modification Visual Assessment Report, Aurecon December 2013.

The comparison between the approved GIWF Mod-2 and proposed Mod-4 projects has been used to determine if any of the approved GIWF Mod-2 visual ratings applied to view locations within 3 kilometres of the approved GIWF are subject to an increased level of visual effect as a result of the proposed Mod-4 works. This VIA has not undertaken as assessment to verify the visual ratings determined in the approved GIWF Mod-2 application.

GBD confirm the following information has been provided by the Proponent, or procured by GBD, for consideration and/or incorporation into this VIA:

- the Mod-4 wind turbine layout (generally conforming with the approved Mod-2 layout)
- location and description of proposed Mod-4 wind turbines
- Zone of Visual Influence (ZVI) diagrams
- wireframe models illustrating the approved GIWF Mod-2 wind turbines and the proposed Mod-4 wind turbines and layout
- Glen Innes Wind Farm Project Approval and Consolidated Conditions of Consent January 2016 and
- Glen Innes Wind Farm DA Approval Modification Visual Assessment Report, Aurecon December 2013.

2 Report structure

2.1 Report structure

This VIA report been structured into ten parts as follows:

Table 2 – Report structure

Report section	Description
Section 1 Report structure	This section provides a description of the report structure
Section 2 Project information provided to GBD	Identifies the information provided to, or sourced by, GBD in order to undertake the VIA
Section 3 Methodology	This section sets out the methodology employed in the VIA preparation
Section 4 Approved Glen Innes Mod-2 Wind Farm and proposed Mod-4 amendments	This section describes the key differences in wind turbine layout and design criteria between the approved Mod-2 and proposed Mod-4 amendments
Section 5 Zone of Visual Influence (ZVI) diagrams	This section identifies the area of land surrounding the wind farm from which wind turbines, or portions of wind turbine structures, may be theoretically visible
Section 6 Ancillary structures	This section describes infrastructure associated with the wind farm other than the wind turbines
Section 7 Assessment of visual effects	This section describes the assessment and determination of residual visual effects between the approved Mod-2 and proposed Mod-4 amendments
Section 8 Wire frame models	This section describes and presents wire frame models prepared for the GIWF Mod-4 VIA
Section 9 Review of Consolidated Conditions of Consent	This section identifies the GIWF Consolidated Conditions of Consent relevant to visual amenity and confirms their applicability to the proposed Mod-4 amendments

Table 2 – Report structure

Report section	Description
Section 10 Conclusion	Conclusions are drawn on the overall impact of the proposed GIWF Mod-4 within the surrounding viewshed.

3 Methodology

3.1 Introduction

The GIWF proposed Mod-4 methodology included the following activities:

- desktop study reviewing the approved GIWF original application, the approved Mod-2 and proposed Mod-4 layouts
- preparation of ZVI diagrams
- assessment of significance of residual visual effects and
- preparation of wire frame models and illustrative figures.

3.2 Desktop study

A desktop study was carried out to review the approved GIWF application and approved Mod-2 Visual Assessment Report.

The desktop review included a review of the approved project layout and surrounding landscape. This was carried out by reference to topographic maps as well as aerial photographs of the surrounding landscape. Topographic maps and aerial photographs were also used to confirm the locations and categories of potential view locations to be reviewed.

3.3 ZVI diagrams

ZVI Diagrams were prepared to illustrate the theoretical visibility of the approved GIWF Mod-2 wind turbines (tip height at 150 metres) and proposed Mod-4 wind turbines (tip height at 180 metres). The ZVI Diagrams are illustrated in **Figures 2** and **3**.

3.4 Residual visual effects

The GIWF Mod-4 residual visual effects on surrounding receiver locations would result from a combination of the Mod-4 wind turbine visibility (beyond that of the approved Mod-2 project) and the characteristics of the landscape between, and surrounding, the receiver locations and the wind farm. The potential degree of visibility and resultant visual effect in addition to the approved Mod-2 visual effect, would be partly determined by a combination of factors such as:

- category and type of situation from which people could view the wind farm (examples of view location categories include residents or motorists)
- visual sensitivity of view locations surrounding the wind farm
- distance of visual effect (between view locations and the wind farm) and
- duration of time people could view the wind farm from any particular static or dynamic view location.

3.5 Wire frame models

Wire frame models have been prepared from twenty-three residential dwelling locations including the residential dwellings assessed in the approved GIWF Mod-2 Visual Assessment Report. The wire frame models illustrate and contrast the approved GIWF Mod-2 and the proposed Mod-4 wind turbine and layout. The wireframe models are illustrated in **Figures 7** to **48**. The wire frame models also illustrate the location of the approved Stage 1 and Stage 2 White Rock Wind Farm wind turbine locations.

4 Approved GIWF Mod-2 and proposed Mod-4 amendment

4.1 Approved GIWF Mod-2 design

The approved GIWF permits construction and operation of up to 25 wind turbines and the installation of wind turbines to a maximum tip height of 150 metres.

4.2 Proposed GIWF Mod-4 design

The GIWF Mod-4 design would include:

- up to 25 wind turbines
- a hub height increase to 110 metres
- an increase in blade length to a maximum 68.5 metres
- an increase in rotor diameter up to 140 metres and
- an increase of the blade tip height up to 180 metres.

Table 3 outlines the differences in the approved GIWF Mod-2 and proposed Mod-4 wind turbine design criteria.

Table 3: Approved Mod-2 and proposed Mod-4 design criteria

	Hub height	Rotor diameter	Tip height	Total number
Approved GIWF Mod-2 wind turbine	89 m	122 m	150 m	25
GIWF Mod-4 proposed wind turbine	110 m	140 m	180 m	25
Difference	+21 m	+18 m	+30 m	0
Percentage difference	+24%	+15%	+20%	0%

Table 4: Approved Mod-2 and proposed Mod-4 swept area

	Rotor diameter	Swept area
Approved GIWF Mod-2 wind turbine	122 m	11,960 m^2
Proposed GIWF Mod-4 wind turbine	140 m	15,394 m^2
Difference	+30 m	+3,434 m^2
Percentage difference	+20%	+32%

The approved GIWF Mod-2 and proposed Mod-4 amended wind turbine layouts are illustrated in **Figure 1**.

4.3 Approved GIWF Mod-2 and proposed Mod-4 design distance and hub visibility

The proposed Mod-4 wind turbine layout and design would result in some minor changes to distances between residential dwellings and wind turbines, as well as the number of wind turbine hubs visible from residential dwellings surrounding the wind farm site. **Table 5** identifies residential dwellings within 3 kilometres of a proposed Mod-4 wind turbine and associated changes in wind turbine distances and hub visible.

Table 5: Distance and hub height changes

Residential dwelling (Refer **Figure 1**)	Approved Mod-2 distance to closest wind turbine (m)	Proposed Mod-4 distance to closest wind turbine (m)	Difference in distance (m)	Approved Mod-2 wind turbine hubs and tips visible. (Tips in brackets)	Proposed Mod-4 wind turbine hubs visible	Difference in number of hubs and tips visible. (Tips in brackets)	Approved Mod-2 Visibility Rating
Furracabad Station	2,980	2,962	-18	5 (10)	7 (12)	+2 (+2)	Moderate
Klossie	2,135	2,120	-15	4 (10)	7 (12)	+3 (+2)	Moderate
Green House	1,899	1,881	-18	5 (8)	7 (8)	+2 (0)	Moderate
Green Valley	2,514	2,523	+9	15 (18)	17 (18)	+2 (0)	Moderate
Nullagai	2,115	2,130	+15	1 (3)	1 (5)	0 (+2)	Moderate
Ilparran A	1,535	1,525	-10	11 (14)	11 (16)	0 (+2)	High
Wandsworth	2,429	2,455	+26	13 (16)	15 (19)	+2 (+3)	Moderate
Minamurra C	2,456	2,477	+21	22 (25)	23 (25)	+1 (0)	High
Minamurra A	2,246	2,266	+20	21 (23)	23 (25)	+2 (+2)	High
Cherry Tree	1,852	1,886	+34	13 (15)	14 (15)	+1 (0)	High
Highfields	1,419	1,458	+39	14 (17)	17 (17)	+3 (0)	High
Minamurra B	2,012	2,032	+20	20 (21)	21 (23)	+1 (+2)	High
Ilparran B	1,306	1,326	+20	8 (10)	10 (11)	+2 (+1)	High
Lombardy	2,157	2,157	0	12 (15)	13 (15)	+1 (0)	High
Kalanga C	2,349	2,319	-30	21 (25)	23 (25)	+2 (0)	High
Kalanga A	2,162	2,131	-31	19 (25)	21 (25)	+2 (0)	High
Mayvona	1,051	1,051	0	8 (8)	8 (8)	0 (0)	High
Kalanga B	2,310	2,267	-43	21 (25)	24 (25)	+3 (0)	High

Table 5: Distance and hub height changes

Residential dwelling (Refer **Figure 1**)	Approved Mod-2 distance to closest wind turbine (m)	Proposed Mod-4 distance to closest wind turbine (m)	Difference in distance (m)	Approved Mod-2 wind turbine hubs and tips visible. (Tips in brackets)	Proposed Mod-4 wind turbine hubs visible	Difference in number of hubs and tips visible. (Tips in brackets)	Approved Mod-2 Visibility Rating
Balaclava A	2,904	2,838	-66	22 (25)	24 (25)	+2 (0)	Moderate
Glengarry	2,817	2,812	-5	2 (4)	3 (4)	+1 (0)	Moderate
Girrahween	2,074	2,117	+43	12 (14)	12 (22)	0 (+8)	High
Rivoli	1,849	1,827	-22	3 (4)	4 (5)	+1 (+1)	Moderate
Wattle Vale	1,903	1,936	+33	15 (22)	18 (25)	+3 (+3)	High

4.4 Magnitude of visual effects

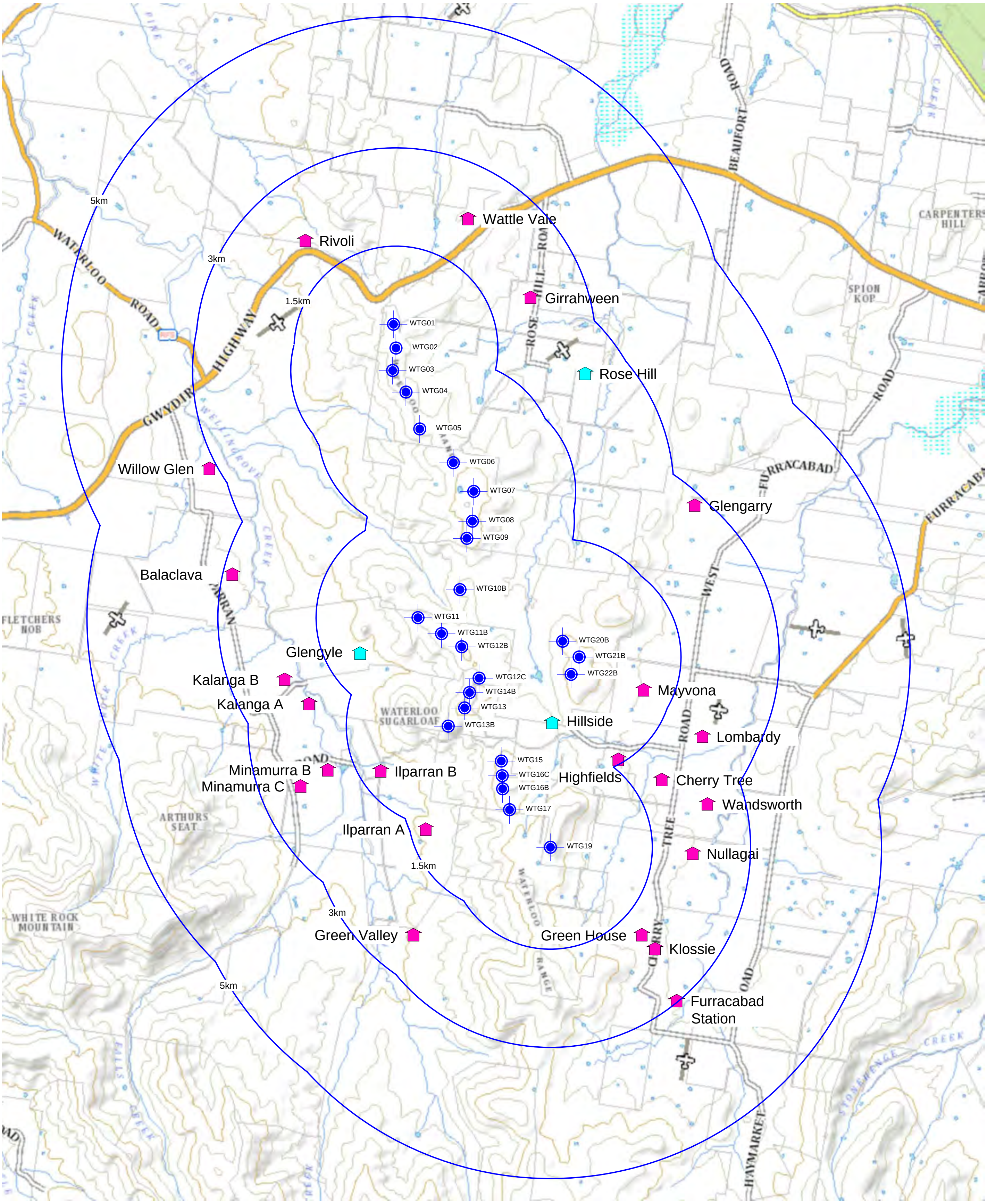
The determination of residual visual effects resulting from the GIWF proposed Mod-4 wind turbines would result primarily from observable differences between the approved Mod-2 and the proposed Mod-4 wind turbines. Observable differences would include:

- views toward wind turbines (hubs and blade tips) where previously screened by landform and
- a change in distance between a receiver location and wind turbine.

Table 5 indicates that the proposed Mod-4 wind turbines would result in:

- up to four residential dwellings with views toward an additional three wind turbine hubs
- up to fifteen residential dwellings with views toward an additional two or less wind turbine hubs
- up to four residential dwellings with views toward no additional wind turbine hubs
- the greatest decrease in distance between wind turbine and residential dwelling would be 66 metres (Balaclava A and wind turbine ID 11) and
- the greatest increase in distance between a wind turbine and residential dwelling would be 43 metres (Girrahween and wind turbine ID 01).

Views toward additional wind turbine hubs (and tips) are not considered to result in a magnitude of visual effect which is greater than the magnitude of visual effect associated with the approved GIWF Mod-2 project. The minor changes to distances are within general allowances provided for micro-siting wind turbines and are not considered to result in a magnitude of visual effect which is greater than the magnitude of visual effect associated with the approved GIWF Mod-2 project



Legend

Approved GIWF Mod-2 and proposed Mod-4 wind turbine (indicative location)

Associated residential dwelling within 3km of an approved Mod-2 and proposed Mod-4 wind turbine

Non associated residential dwelling within 3km of approved Mod-2 and proposed Mod-4 wind turbine

0km 1.5km

Figure 1 GIWF Approved Mod-2 and proposed Mod-4 layout

Glen Innes Wind Farm Mod 4
Visual Impact Assessment

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5 Zone of Visual Influence Diagrams

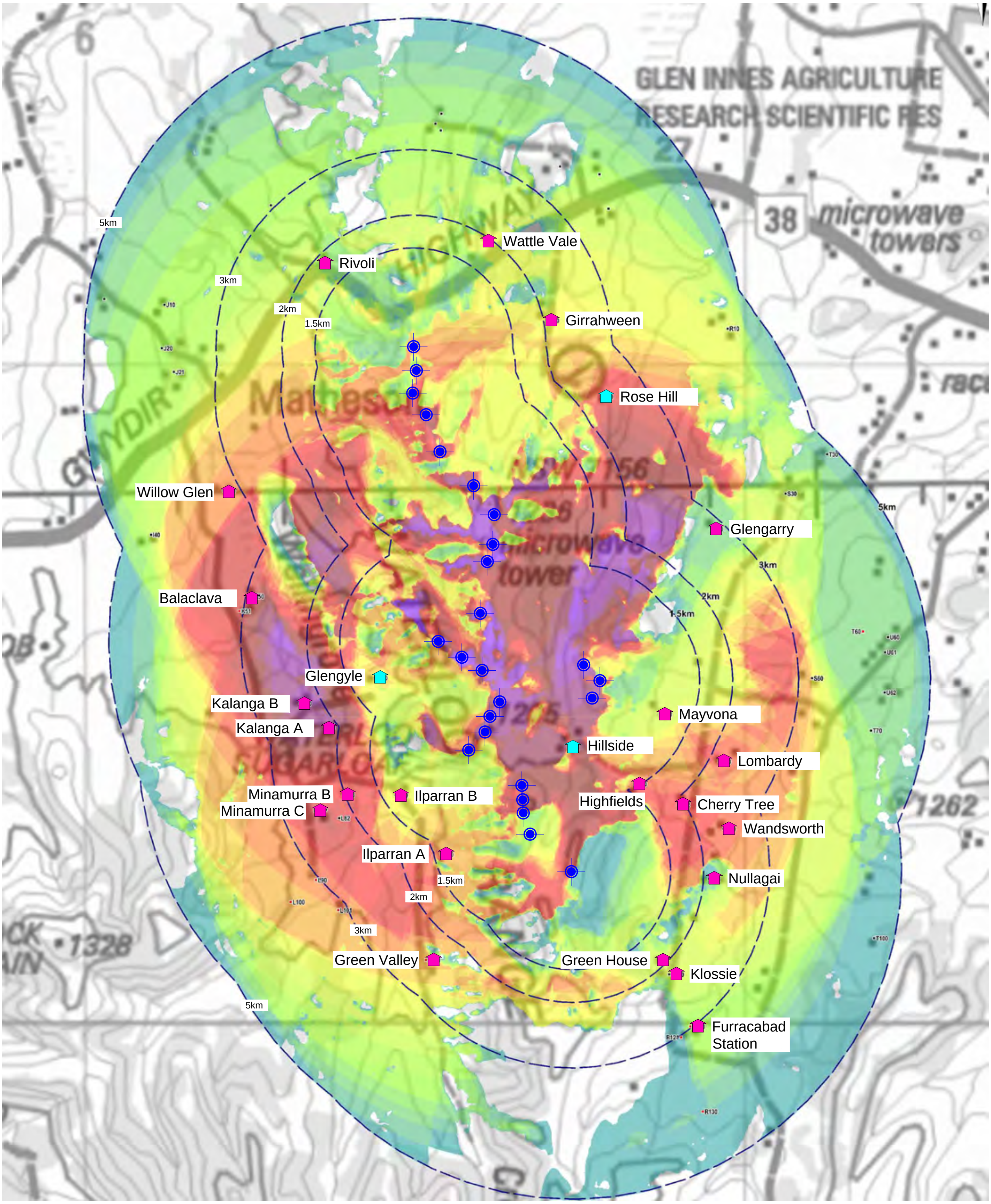
5.1 Introduction

Within the recognised limitations of Zone of Visual Influence (ZVI) diagrams, the overall extent of approved GIWF Mod-2 and proposed Mod-4 wind turbine visibility covers a very similar extent within 5 kilometres of the landscape surrounding the approved GIWF Mod-2 wind farm.

Figures 2 and **3** illustrate the theoretical visibility of the approved GIWF Mod-2 (at 150 metre tip height) and proposed Mod-4 (at 180m tip height) wind turbines.

The similarity in theoretical wind turbine visibility demonstrates the influence of local topographical features on views toward the approved GIWF Mod-2 and proposed Mod-4 wind turbines. The ZVI diagrams also illustrate that the proposed Mod-4 wind turbines would have a very limited increase in visual effects across the approved GIWF Mod-2 viewshed.

Whilst the overall extent of wind turbine visibility would be contained by topography for both the approved GIWF Mod-2 and the proposed Mod-4 wind turbines, the number of wind turbines visible from receiver locations within the wind farm viewshed is likely to be subject to a minor increase. However, when compared to the approved GIWF Mod-2 wind turbines, the increase in wind turbine visibility would be largely restricted to the upper sections (hubs and rotors) of wind turbine structures, rather than whole wind turbines.



Legend

Zone of Visual Influence
(Tips Visible)

0
1-5
6-10
11-15
16-20
21-25

Approved GIWF Mod-2 and proposed Mod-4 wind turbine (indicative location)

Associated residential dwelling within 3km of an approved Mod-2 and proposed Mod-4 wind turbine

Non associated residential dwelling within 3km of approved Mod-2 and proposed Mod-4 wind turbine

0km 1km

Figure 2 GIWF Mod-2 ZVI Diagram approved tip of blade at 150 metres

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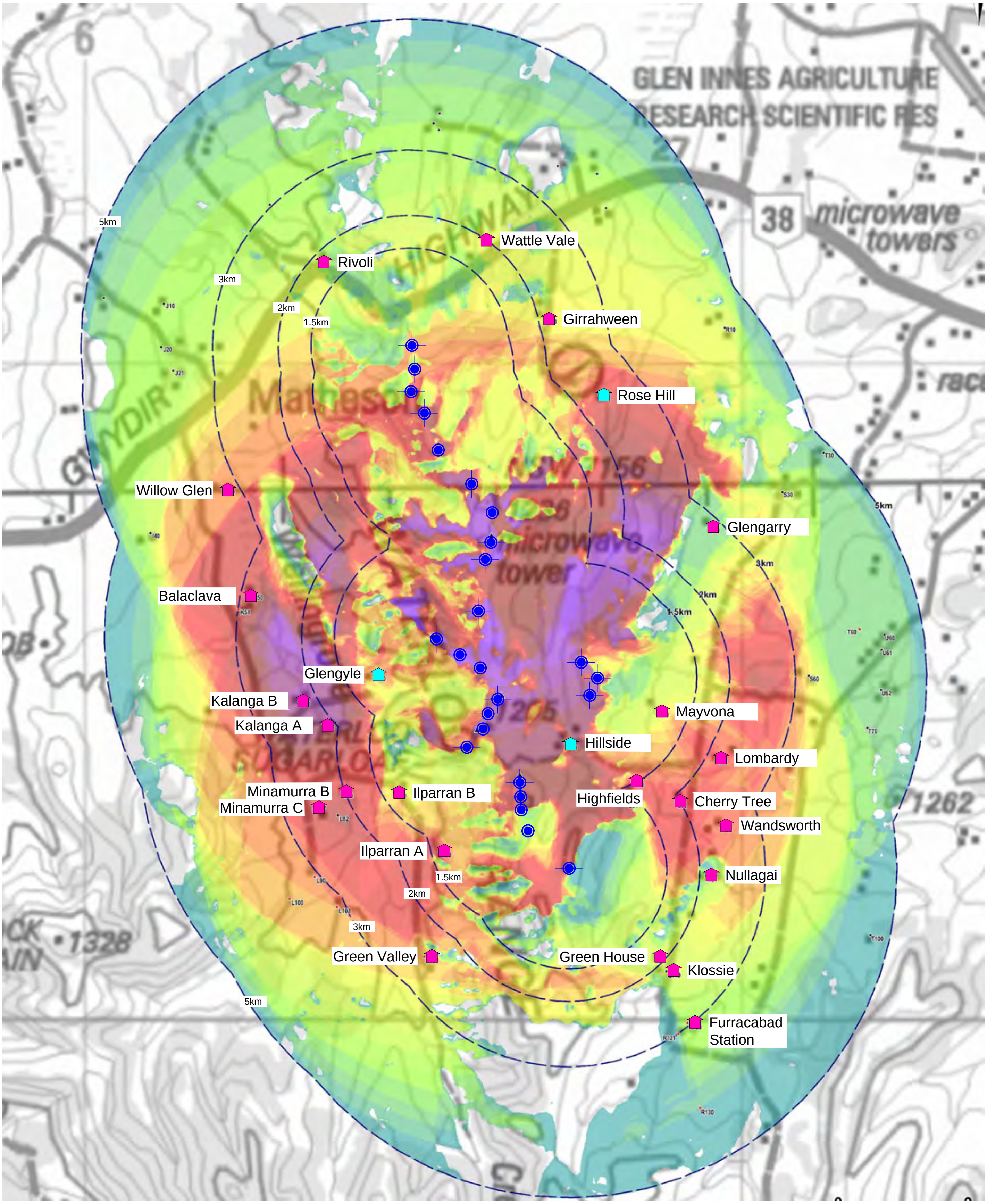
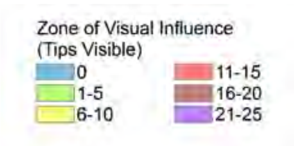


Legend



Approved GIWF Mod-2 and proposed Mod-4 wind turbine (indicative location)

Associated residential dwelling within 3km of an approved Mod-2 and proposed Mod-4 wind turbine

Non associated residential dwelling within 3km of approved Mod-2 and proposed Mod-4 wind turbine

Figure 3 GIWF Mod-4 ZTV Diagram proposed tip of blade at 180 metres

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6 Ancillary structures

6.1 Introduction

The approved GIWF Mod-2 identifies a range of ancillary structures which include:

- wind monitoring masts
- on-site access tracks
- substation
- overhead powerline and
- control and operation facilities building.

The proposed Mod-4 wind farm would not result in any fundamental change to the majority of approved Mod-2 ancillary structures and would not result in any additional visual impacts to those outlined in the approved Mod-2 application.

7 Visual effects

7.1 Introduction

Whilst the proposed GIWF Mod-4 wind turbines would extend above the approved Mod-2 wind turbine height, this VIA has determined that the overall scale of the proposed Mod-4 wind turbines at a 5-kilometre (and over) view distance would not result in an order of visual magnitude that is significantly above the visual magnitude of the approved Mod-2 wind turbines. A comparison of the GIWF Mod-2 and proposed Mod-4 wind turbines is illustrated in **Figure 4**.

It is also noted that the proposed GIWF Mod-4 wind turbines would be consistent with the approved Mod-2 wind turbines with regard to their visual form, design, pattern and colour. The location of associated and non-associated residential dwellings within 3 kilometres of the proposed Mod-4 wind turbine layout is illustrated in **Figure 1**.

The degree of visual magnitude is illustrated in **Figures 5** and **6**. **Figure 5** illustrates the elevated angle of view (toward tip height) for the approved Mod-2 and proposed Mod-4 amended wind turbines from a view distance of 2 kilometres and 5 kilometres respectively. **Figure 5** illustrates that the proposed Mod-4 wind turbine would include an additional and approximate half degree view angle above the approved Mod-2 with 150 metre tip of blade wind turbine from a 2-kilometre view distance. The additional view angle from a view distance of 5 kilometres would be an additional and approximate half degree (34 minutes) increase in view angle.

Figure 6 illustrates the perceived and relative height difference between the approved Mod-2 150 metre tip height wind turbine and the proposed Mod-4 180 metre tip height wind turbine. At a view distance of 5 kilometres the approved Mod-2 and proposed Mod-4 wind turbines would be perceived at less than half the height of the proposed Mod-4 wind turbine when viewed at a distance of 2 kilometres. The relatively small increase in view angle toward the proposed Mod-4 wind turbine tip height, at a view distance of 5 kilometres (and beyond) is considered unlikely to result in a level of visual magnitude greater than the approved wind turbines.

Within the parameters of normal human vision, the proposed Mod-4 wind turbines are not considered to give rise to an increased level of visual magnitude over and above that determined for the approved GIWF Mod-2 project.

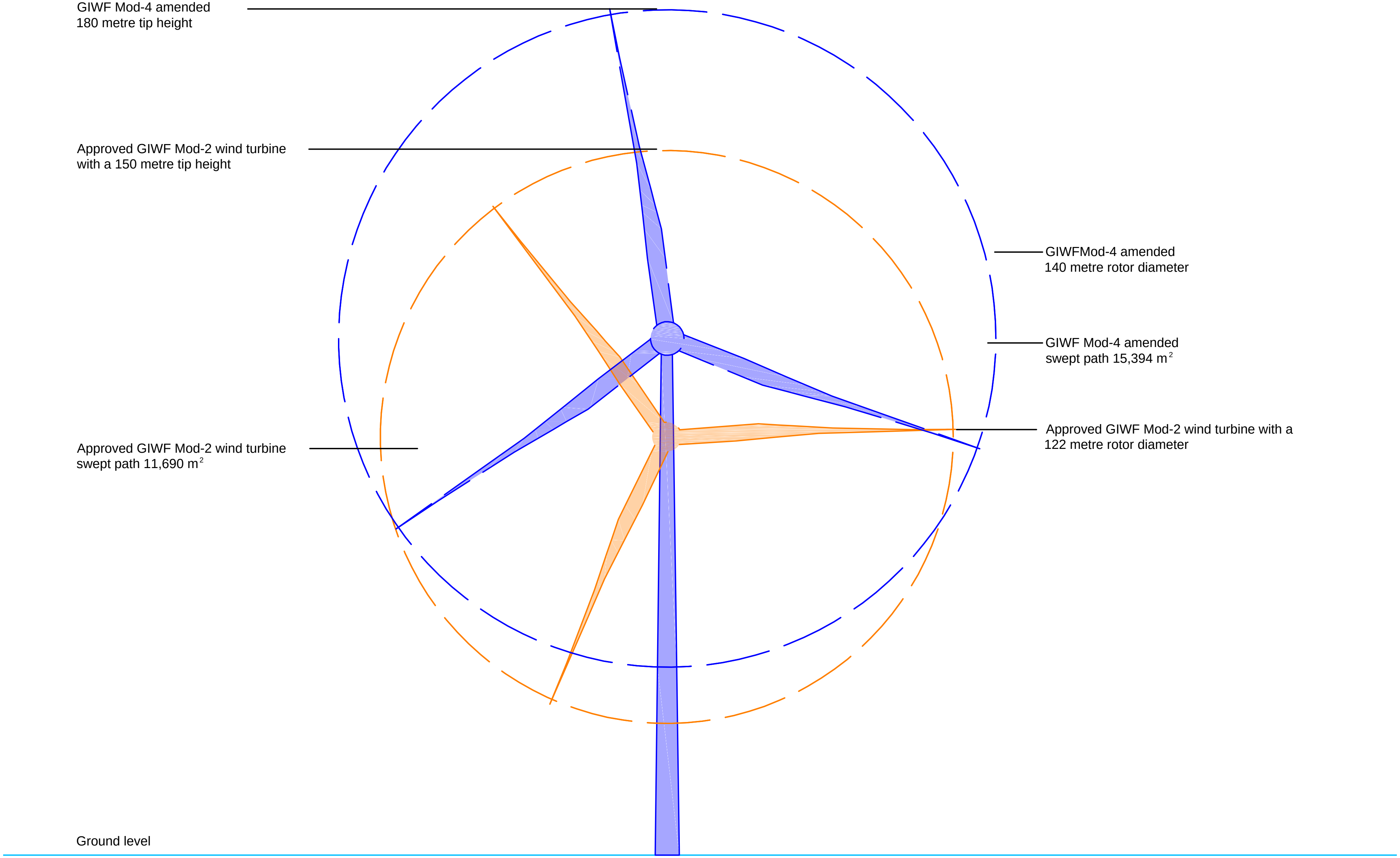

Figure 4- Approved GIWF Mod-2 and proposed Mod-4 wind turbine comparison

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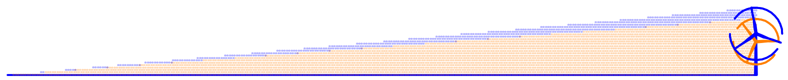
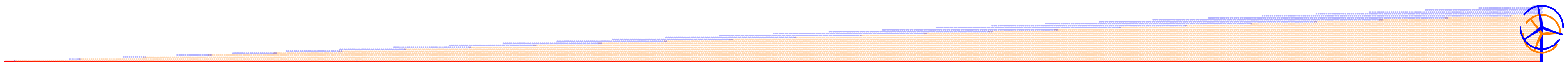
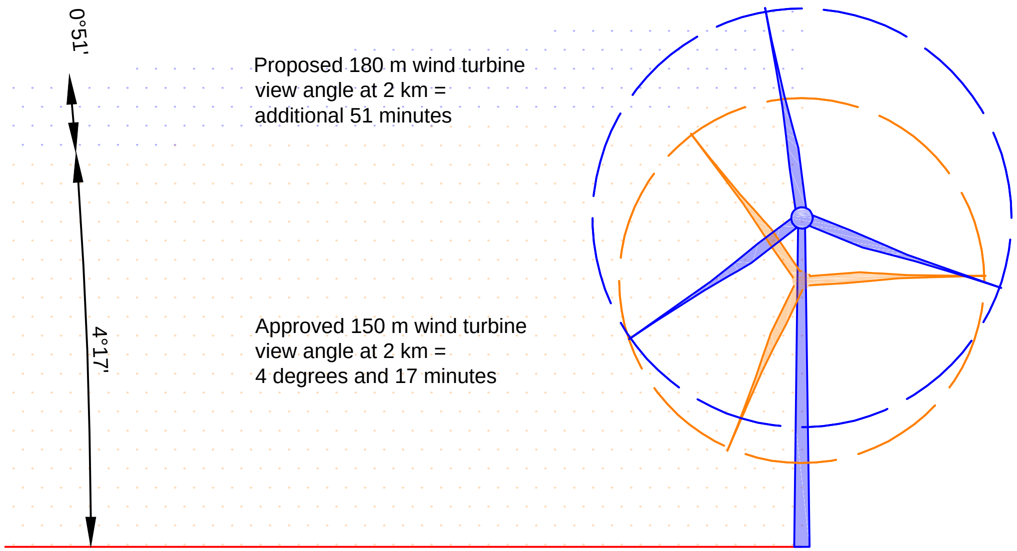
Orange line = view line toward tip height of approved Mod-2 wind turbine (150 metres)
Blue line = view line toward tip height of proposed Mod-4 wind turbine (180 metres)



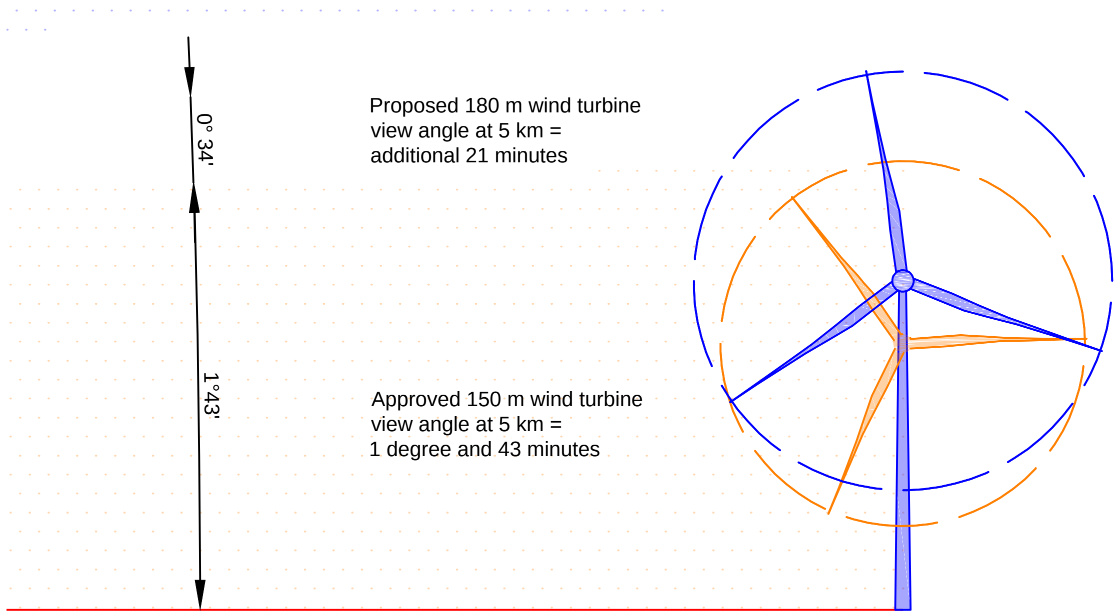
Comparative height of approved GIWF Mod-2 and proposed Mod-4 wind turbine from a 2 km view distance



Comparative height of approved GIWF Mod-2 and proposed Mod-4 wind turbine from a 5 km view distance



View angle toward approved GIWF Mod-2 and proposed Mod-4 wind turbine tip of blade from a 2 km view distance



View angle toward approved GIWF Mod-2 and proposed Mod-4 wind turbine tip of blade from a 5 km view distance

Figure 5 - Approved GIWF Mod-2 and proposed Mod-4 wind turbine view angle comparison

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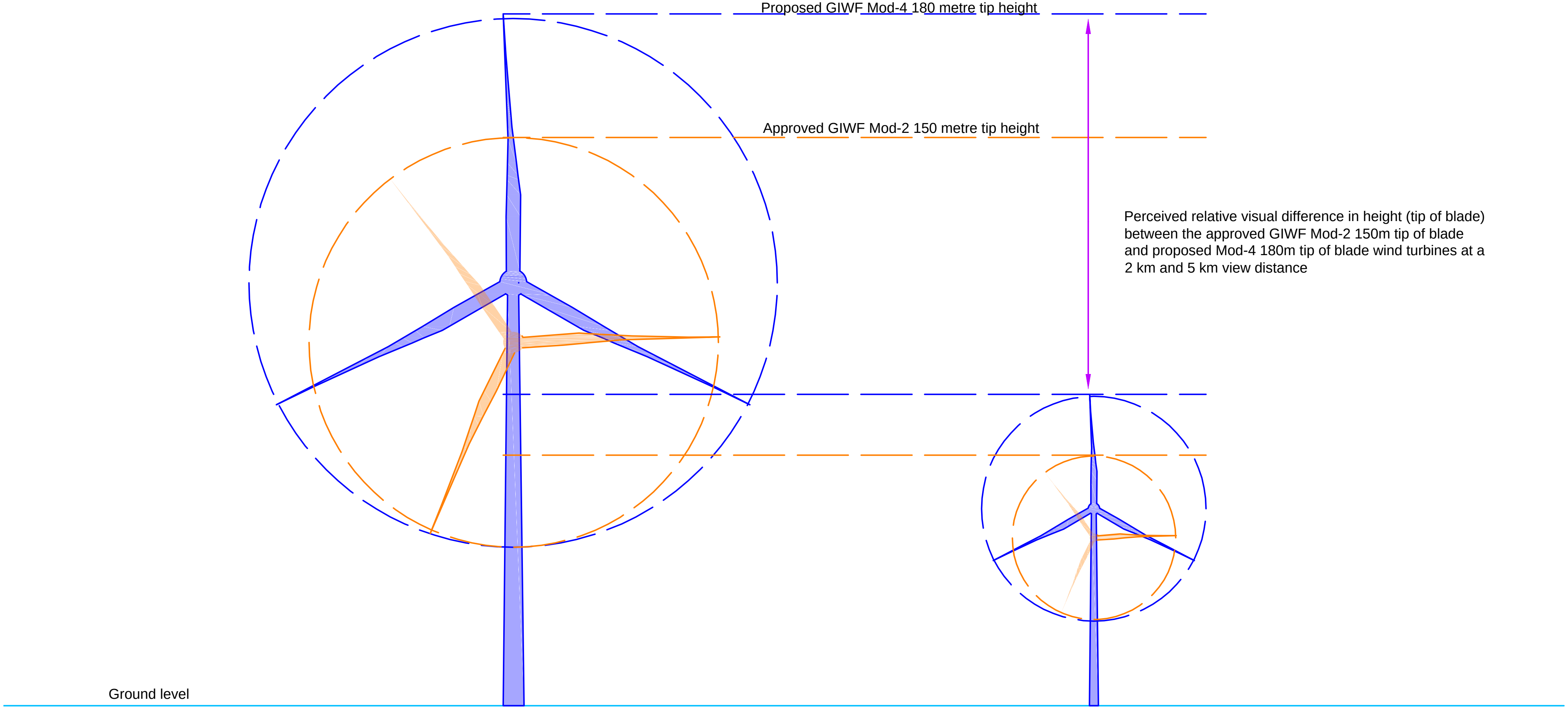

Perceived relative visual scale between approved Mod-2 150 m high wind turbine and proposed GIWF Mod-4 180 m high wind turbine at 2 km view distance

Perceived relative visual scale between approved GIWF Mod-2 150 m high wind turbine and proposed Mod-4 180 m high wind turbine at 5 km view distance

Figure 6 - Approved GIWF Mod-2 and proposed Mod-4 wind turbine comparison at 2 km and 5 km view distance

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Visual Impact Assessment

For the purpose of this VIA the magnitude of visual effect takes account of the scale of the change in the view with respect to the loss or addition of features in the view and changes in its composition or contrast with the landscape, including the proportion of the view occupied by the proposed Mod-4 wind turbine relative to the approved GIWF Mod-2 wind turbine.

For the purpose of this VIA **Table 6** out ratings and definitions associated with the magnitude of visual effects.

Table 6 – Magnitude of visual effect

Visual effect	Magnitude
Amendments to the approved GIWF Mod-2 project would result in a major and prominent visual effect and introduce elements that contrast, or are not in character with the approved GIWF Mod-2 project.	High
Amendments to the approved GIWF Mod-2 project would result in a partial visual effect and introduce elements which may be prominent, but not completely out of character with the approved GIWF Mod-2 project.	Medium
Amendments to the approved GIWF Mod-2 project would result in minor visual effects and introduce elements which are not prominent or out of character with the approved GIWF Mod-2 project.	Low
Amendments to the approved GIWF Mod-2 project would result in a very minor visual effect and introduce elements which are not prominent or uncharacteristic of the approved GIWF Mod-2 project. There would likely be 'no change' to the approved GIWF Mod-2 visual effect.	Negligible

7.3 Visual effect matrix

Table 7 sets out the assessment of visual effects from residential dwellings up to 3 kilometres from the approved GIWF Mod-2 project. The locations of residential dwellings included in this VIA are illustrated in **Figure 1**.

Whilst the assessment includes a determination of visual effects from dwellings, it also takes into account any curtilage surrounding each dwelling which may be considered an extension to the dwelling for domestic or social activities. The criteria set out in **Table 6** are noted against each dwelling, with a visual effect rating determined against the matrix in **Table 7**.

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
Residential dwellings within 3 km of approved Glen Innes Wind Farm Mod-2 turbine					
Furracabad Station	Non-associated residential dwelling	2,962	Moderate	The observable scale of change would be limited by distance between the dwelling and closest proposed GIWF Mod-4 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 wind turbine layout and the surrounding landscape. Mature trees alongside the driveway and to the north west of the dwelling would filter some views toward the proposed Mod-4 wind turbines. Magnitude Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Klossie	Non-associated residential dwelling	2,120	Moderate	The observable scale of change would be limited by distance between the dwelling and closest proposed GIWF Mod-4 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
				cover beyond the dwelling would filter some views toward the proposed Mod-4 wind turbines. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	
Green House	Non-associated residential dwelling	1,881	Moderate	The observable scale of change would be limited by distance between the dwelling and closest proposed GIWF Mod-4 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree cover beyond the dwelling would filter some views toward the proposed Mod-4 wind turbines. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Green Valley	Non-associated residential dwelling	2,523	Moderate	The observable scale of change would be limited by distance between the dwelling and closest proposed GIWF Mod-4 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
				wind turbine layout and the surrounding landscape. A small grouping of mature trees to the north of the dwelling would filter some views toward the proposed Mod-4 wind turbines from the dwelling. Magnitude Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	
Nullagai	Non-associated residential dwelling	2,130	Moderate	The observable scale of change would be partially limited by distance between the dwelling and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Ilparran A	Non-associated residential dwellings	1,525	High	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
				development and the surrounding landscape. Scattered tree planting beyond the dwelling will filter some views toward the proposed Mod-4 wind turbines. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	
Wandsworth	Non-associated residential dwellings	2,455	Moderate	The observable scale of change would be partially limited by distance between the dwelling and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Minamurra C	Non-associated residential dwelling	2,477	High	The observable scale of change would be partially limited by distance between the dwelling and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development.	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
				Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	
Minamurra A	Non-associated residential dwelling	2,266	High	The observable scale of change would be partially limited by distance between the dwelling and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Cherry Tree	Non-associated residential dwellings	1,886	High	The observable scale of change would be partially limited by distance between the dwelling and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
Highfields	Non-associated residential dwellings	1,458	High	The observable scale of change would be partially limited by distance between the dwelling and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Minamurra B	Non-associated residential dwellings	2,032	High	The observable scale of change would be partially limited by distance between the dwelling and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Ilparran B	Non-associated potential dwelling site	1,326	High	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition	Unchanged from approved GIWF

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
	without DA Approval			or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree planting beyond the dwelling will filter some views toward the proposed Mod-4 wind turbines. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Mod-2 Visual Rating
Lombardy	Non-associated residential dwelling	2,157	High	The observable scale of change would be noticeable between the dwelling and closest approved GIWF Mod-2 wind turbine. There would be limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree planting surrounding the dwelling would also screen and filter some views toward both approved Mod-2 and proposed Mod-4 wind turbines. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
Kalanga C	Non-associated residential dwellings	2,319	High	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree planting beyond the dwelling will filter some views toward the proposed Mod-4 wind turbines. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Kalanga A	Non-associated residential dwellings	2,131	High	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree planting beyond the dwelling will filter some views toward the proposed Mod-4 wind turbines.	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
				Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	
Mayvona	Non-associated residential dwellings	1,051	High	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Kalanga B	Non-associated residential dwelling	2,267	High	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree planting beyond the dwelling will filter some views toward the proposed Mod-4 wind turbines.	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
				Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	
Balaclava A	Non-associated residential dwellings	2,838	Moderate	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree planting beyond the dwelling will filter some views toward the proposed Mod-4 wind turbines. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Glengarry	Non-associated residential dwellings	2,812	Moderate	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
				planting beyond the dwelling will filter some views toward the proposed Mod-4 wind turbines. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	
Girrahween	Non-associated residential dwellings	2,117	High	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating
Rivoli	Non-associated residential dwellings	1,827	Moderate	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Scattered tree	Unchanged from approved GIWF Mod-2 Visual Rating

Table 7 – Visual effect matrix (Refer **Figure 1** for non-associated residential dwelling locations)

Receiver location/s	Category of receiver location	Approximate distance to proposed GIWF Mod-4 wind turbine (m)	Approved GIWF Mod-2 Visual Rating*	Description and Magnitude of GIWF Mod-4 amended visual effect	GIWF Mod-4 Visual Rating
				planting beyond the dwelling will filter some views toward the proposed Mod-4 wind turbines. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	
Wattle Vale	Non-associated residential dwellings	1,936	High	The observable scale of change would be limited by distance between the dwellings and closest approved GIWF Mod-2 wind turbine. There would be very limited change in the composition or contrast between the approved Mod-2 and proposed Mod-4 development and the surrounding landscape. Magnitude rating Low – resulting in no change to the approved GIWF Mod-2 visual impact rating.	Unchanged from approved GIWF Mod-2 Visual Rating

* Approved GIWF Mod-2 Visual Rating as determined by Aurecon (Visual Assessment Report Rev 2 18 December 2013)

7.4 Summary of visual effects

The Visual Effects Matrix includes twenty-three residential dwellings within 3 kilometres of a GIWF proposed Mod-4 wind turbine.

The overall assessment of the magnitude of visual effects associated with the GIWF proposed Mod-4 wind turbines is summarised as Low. The scale of change in the wind turbine structures, whilst noticeable from proximate residential view locations would not result in a degree of change significantly above the visibility of the approved GIWF Mod-2 wind turbines.

7.5 Cumulative visual effects

A consideration of potential cumulative visual effects between the Glen Innes, White Rock and Sapphire Wind Farms was detailed in the White Rock Wind Farm Landscape and Visual Assessment Report V8 March 2011 (LVIA).

The LVIA concluded that sequential views between the Sapphire, White Rock and Glen Innes Wind Farms would occur for motorists travelling along the Gwydir Highway, as well as a small number of local roads although the journey between the wind farms would include a range of views extending toward and beyond turbines within each project. The extent and overall visibility of turbines would be influenced by the direction of travel relative to the alignment of wind turbines as well as the relatively short travel time along the highway and local road network alongside and between the wind farm turbines.

Visibility between the Glen Innes and White Rock wind turbines would occur from residential dwellings north and north east of the White Rock Wind Farm and south to south east of the GIWF. Direct views between the two wind farms would be mostly limited to a small number residential dwellings within 3 kilometres of both wind farms due to their position and orientation relative to the proposed Mod-4 and approved turbines.

Indirect views would occur within these same areas; however, the number of visible turbines would be relatively low and hence in addition to the individual impact assessment, the cumulative impact assessment would be low for the majority of these residential dwellings.

Motorists travelling along the Gwydir Highway would experience a low direct cumulative impact as turbine visibility is limited by local landform, tree cover and the direction of travel relative to turbine locations. Certain local roads would experience sequential views for relatively short durations.

The amended GIWF Mod-4 wind turbines would result in a low level magnitude of residual visual effects, and introduce elements which are neither prominent or out of character with the approved GIWF Mod-2 project. Therefore, the potential for the amended Mod-4 wind turbines to result in any additional significant cumulative visual effect is considered to be low.

The extent of approved Stage 1 and Stage 2 White Rock wind turbines visible from residential dwellings within 3 kilometres of the GIWF Mod-4 have been illustrated in the wire frames (**Figures 7** to **48**).

7.6 Night time obstacle lighting

The current consolidated consent condition 25 states that "*No external lighting other than low intensity security night lighting of infrastructure associated with the project, including wind turbine generators is permitted on site unless otherwise agreed or directed by the Secretary*."

An aviation hazard risk assessment is currently in preparation for GIWF. An assessment of potential visual impacts associated with obstacle lighting may be undertaken subject to confirmation for the requirement of night time obstacle lighting.

8 Wire frame models

8.1 Introduction

The wireframe model locations have been selected to illustrate viewpoints from residential dwellings with views toward the approved GIWF Mod-2 and the approved White Rock Wind Farm which is currently under construction.

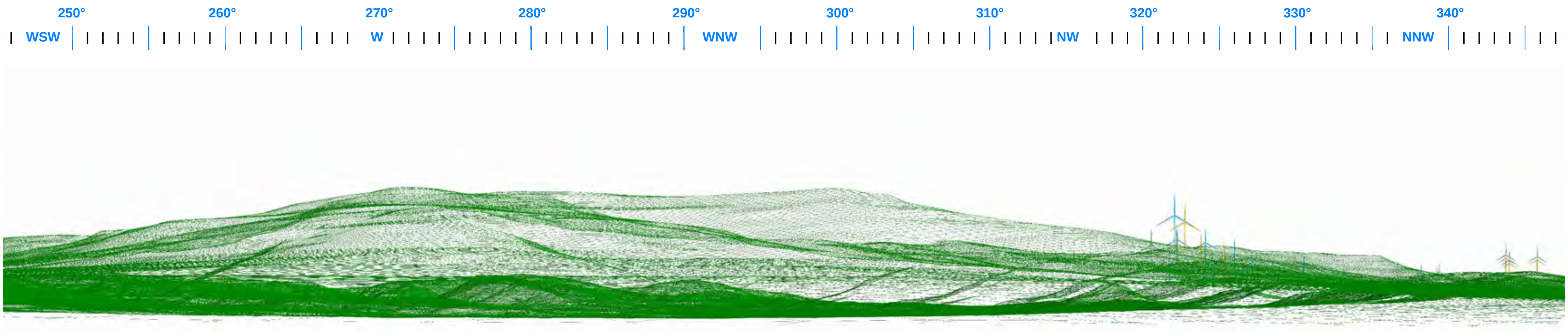
The twenty-three wireframe locations are illustrated in **Figure 7**, and the wireframes presented in **Figures 8** to **48**. The wireframe models illustrate views toward the approved GIWF Mod-2 and the proposed Mod-4 amendment. The wire frame models illustrate the wind turbines with and without their individual identification numbers for clarity.

The wire frame models do not include, or illustrate, the location of tree planting between the wire frame view point (dwelling) and the approved Mod-2 and proposed Mod-4 wind turbines. The wire frame models are therefore considered to be very conservative in both the extent of view and visibility of wind turbines indicated in each wire frame model.

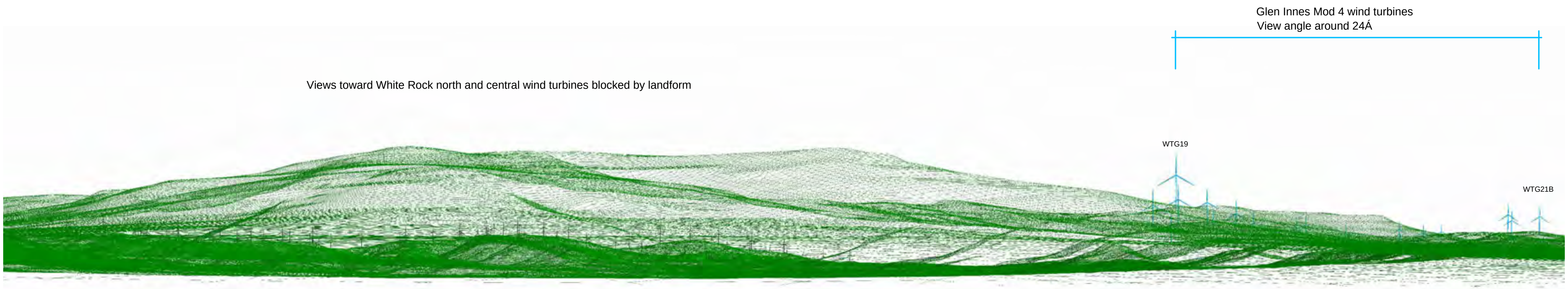
8.2 Wireframe model preparation

The wireframes have been prepared with regard to the general guidelines set out in the Scottish Natural Heritage (2017) Visual representation of windfarms: good practice guidance. The wireframe models were generated through the following steps:

- a digital terrain model (DTM) of the project site was created from a terrain model of the surrounding area using digital contours
- the site DTM was loaded in the DNV-GL 'WindFarmer' software package
- the layout of the wind farm and 3D representation of the wind turbine was configured in WindFarmer
- the location of each viewpoint was configured in WindFarmer
- the view from each wireframe model location was then assessed in WindFarmer. This process requires accurate mapping of the terrain as modelled
- the final image was converted to JPG format and imported and annotated as the final figure.



Furracabad Station: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.98 kilometres. Tips visible 10, Hubs visible 5
Distance to closest Glen Innes Mod 4 wind turbine 2.96 kilometres. Tips visible 12, Hubs visible 7



Furracabad Station: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 7 -
Wireframe 1 Furracabad Station

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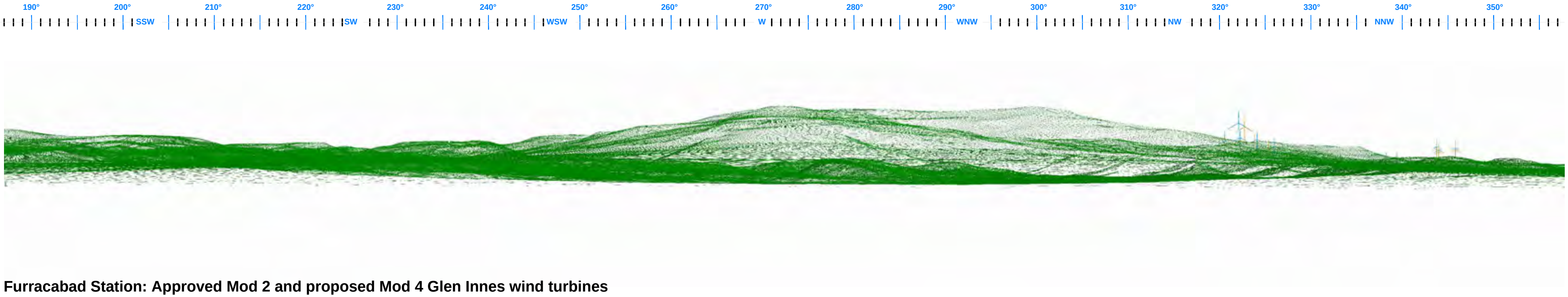
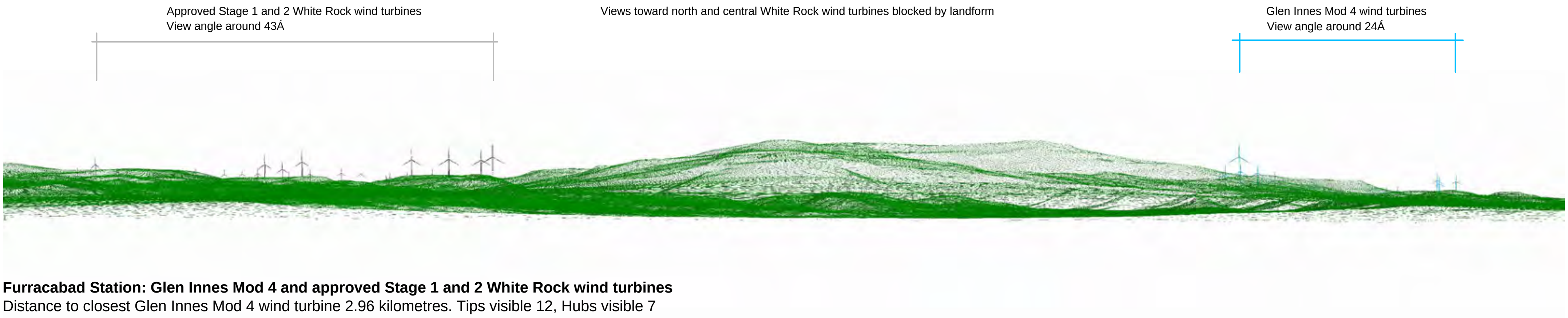
Glen Innes Wind Farm Modification 4



Furracabad Station: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.98 kilometres. Tips visible 10, Hubs visible 5
Distance to closest Glen Innes Mod 4 wind turbine 2.96 kilometres. Tips visible 12, Hubs visible 7



Furracabad Station: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.96 kilometres. Tips visible 12, Hubs visible 7
Distance to closest White Rock wind turbine 2.41 kilometres. Tips visible 24, Hubs visible 18


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Figure 8 -
Wireframe 2 Furracabad Station

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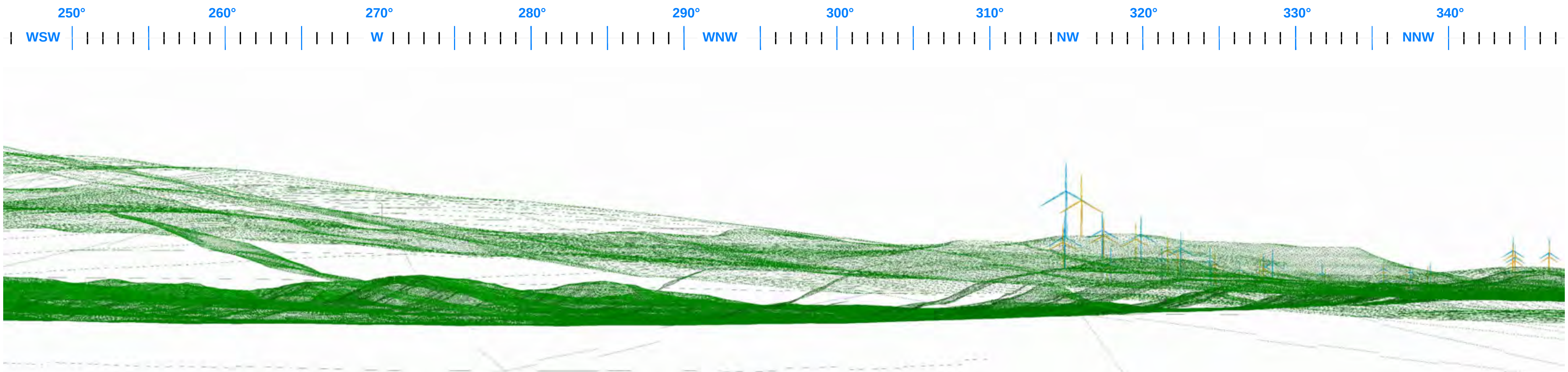
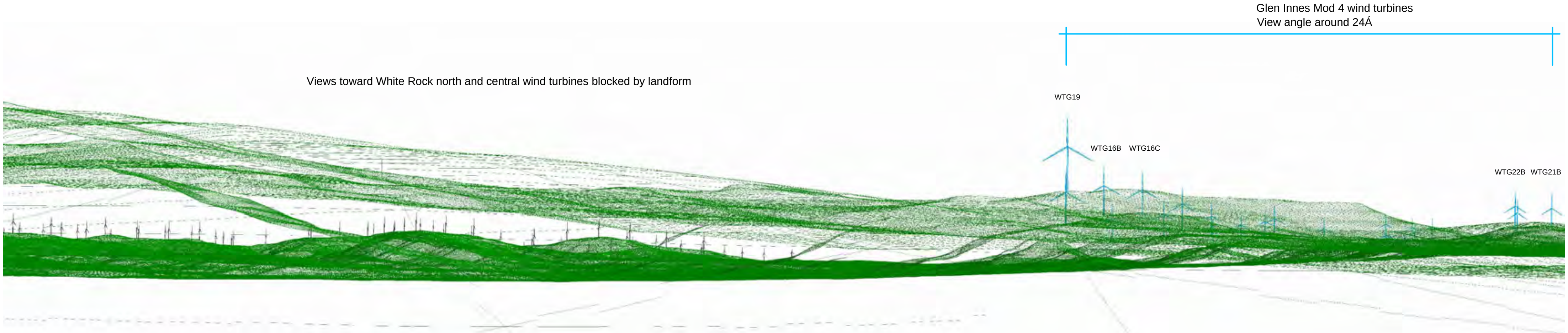
Glen Innes Wind Farm Modification 4



Klossie: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.13 kilometres. Tips visible 10, Hubs visible 4
Distance to closest Glen Innes Mod 4 wind turbine 2.12 kilometres. Tips visible 12, Hubs visible 7



Klossie: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines


Approved Glen Innes
Mod 2 wind turbine


Glen Innes Mod 4
wind turbine


Approved Stage 1 and 2
White Rock wind turbine

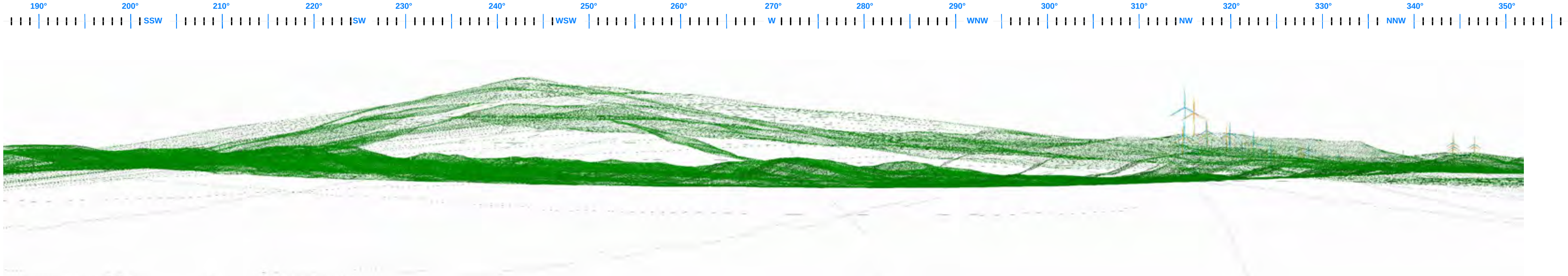
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 9 -
Wireframe 3 Klossie

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4

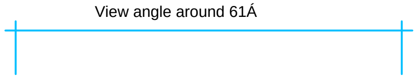


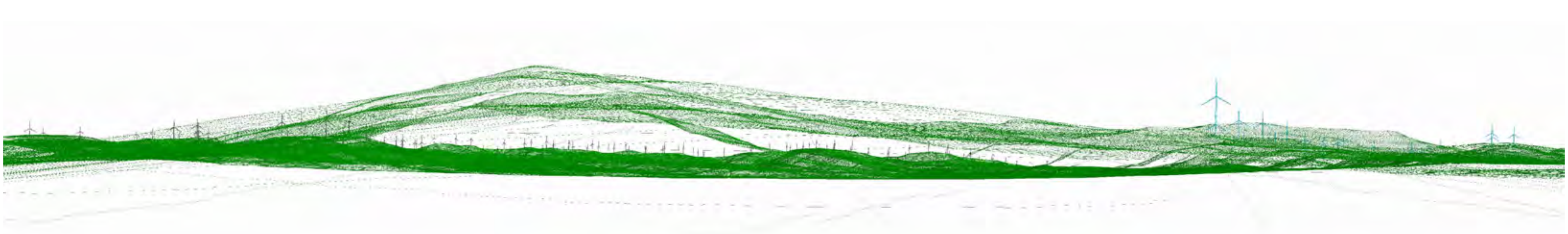
Klossie: Approved Mod 2 and proposed Mod 5 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.13 kilometres. Tips visible 10, Hubs visible 4
Distance to closest Glen Innes Mod 4 wind turbine 2.12 kilometres. Tips visible 12, Hubs visible 7

Approved Stage 1 and 2 White Rock wind turbines. View angle around 17Á

Views toward north and central White Rock wind turbines blocked by landform

Glen Innes Mod 4 wind turbines View angle around 61Á





Klossie: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.12 kilometres. Tips visible 12, Hubs visible 7
Distance to closest White Rock wind turbine 2.65 kilometres. Tips visible 12, Hubs visible 7


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Figure 10 -
Wireframe 4 Klossie

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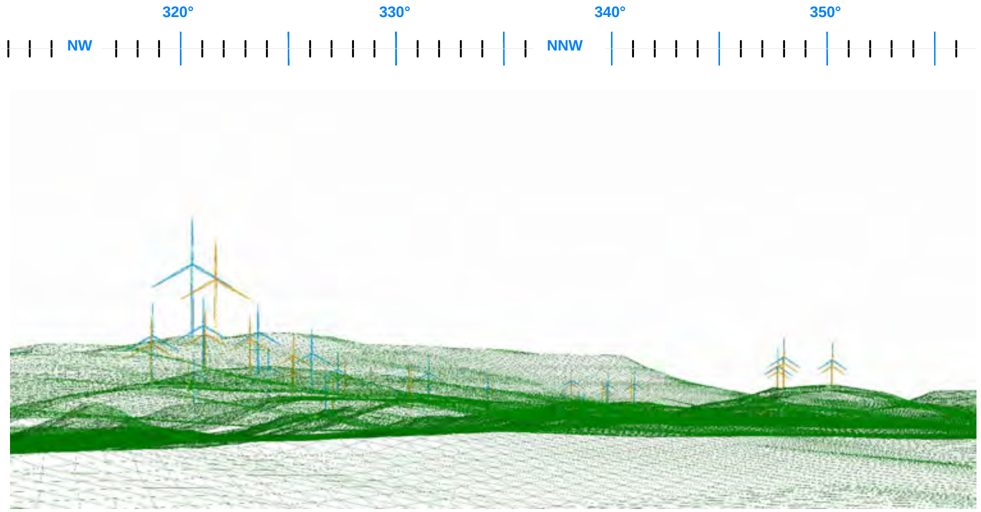
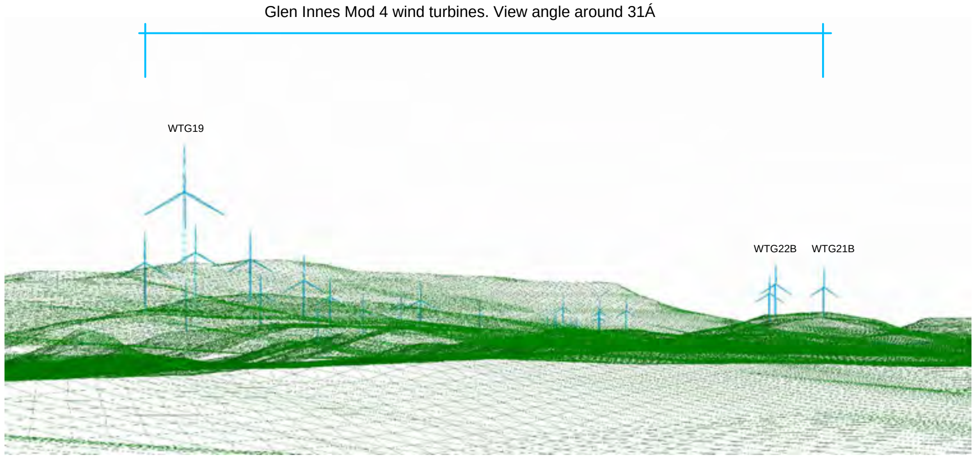
Glen Innes Wind Farm Modification 4



Green House: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 1.89 kilometres. Tips visible 8, Hubs visible 5
Distance to closest Glen Innes Mod 4 wind turbine 1.88 kilometres. Tips visible 8, Hubs visible 7



Green House: Glen Innes Mod 4 wind turbines
The wire frame modelling indicates that no White Rock wind turbines will be visible from the Green House residential dwelling


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 11 -
Wireframe 5 Green House

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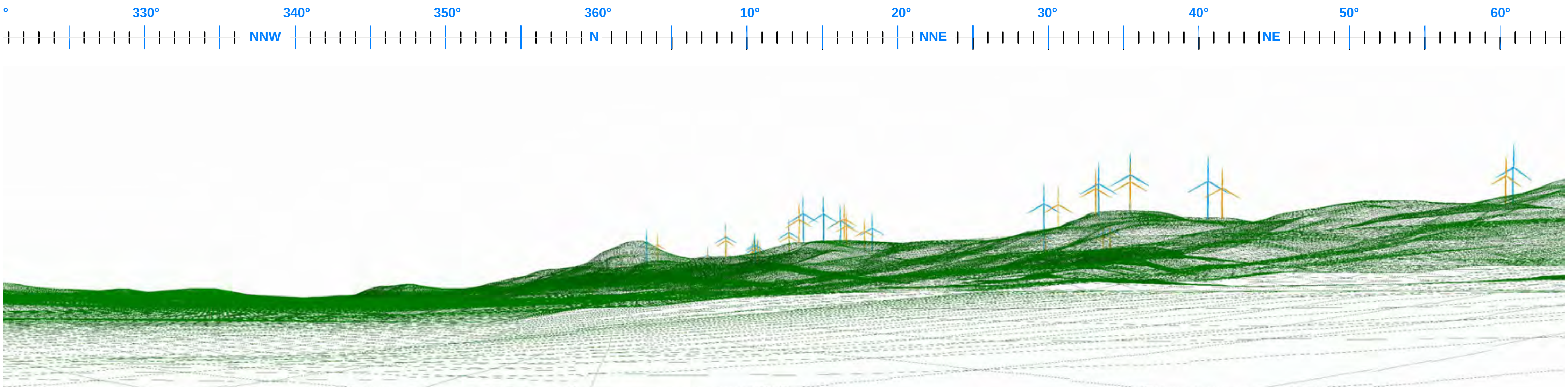
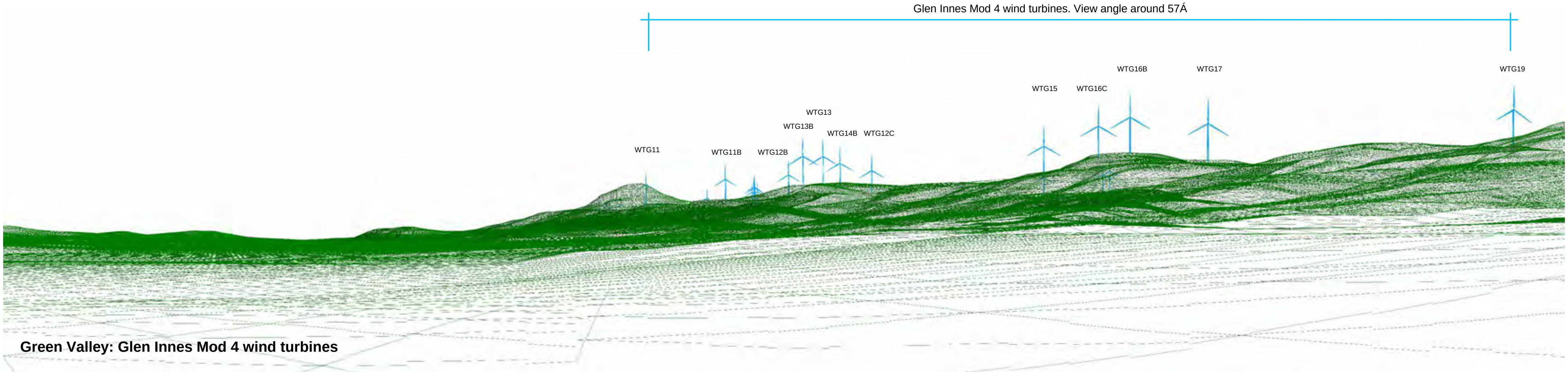
Glen Innes Wind Farm Modification 4



Green Valley: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.51 kilometres. Tips visible 18, Hubs visible 15
Distance to closest Glen Innes Mod 4 wind turbine 2.52 kilometres. Tips visible 18, Hubs visible 17



Green Valley: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

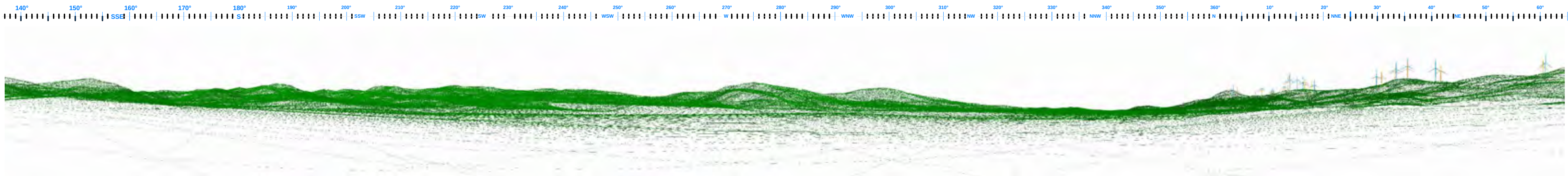
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

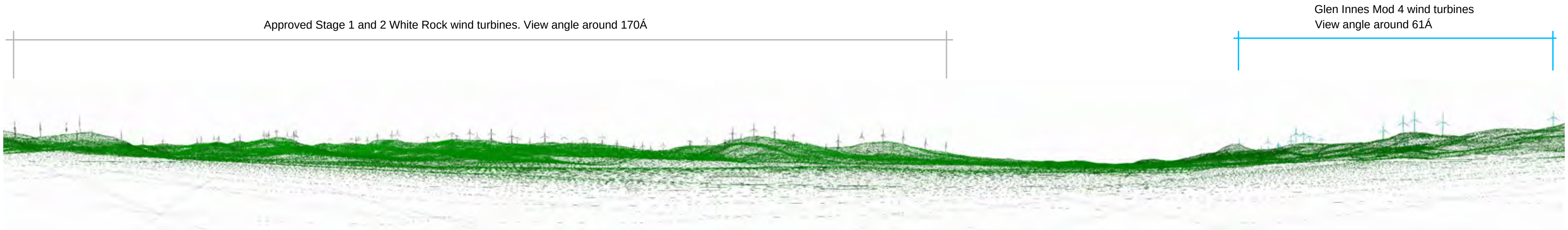
Figure 12 -
Wireframe 6 Green Valley

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Green Valley: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.51 kilometres. Tips visible 18, Hubs visible 15
Distance to closest Glen Innes Mod 4 wind turbine 2.52 kilometres. Tips visible 18, Hubs visible 17



Green Valley: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.51 kilometres. Tips visible 18, Hubs visible 15
Distance to closest White Rock wind turbine 2.95 kilometres. Tips visible 87, Hubs visible 70


Approved Glen Innes Mod 2 wind turbine

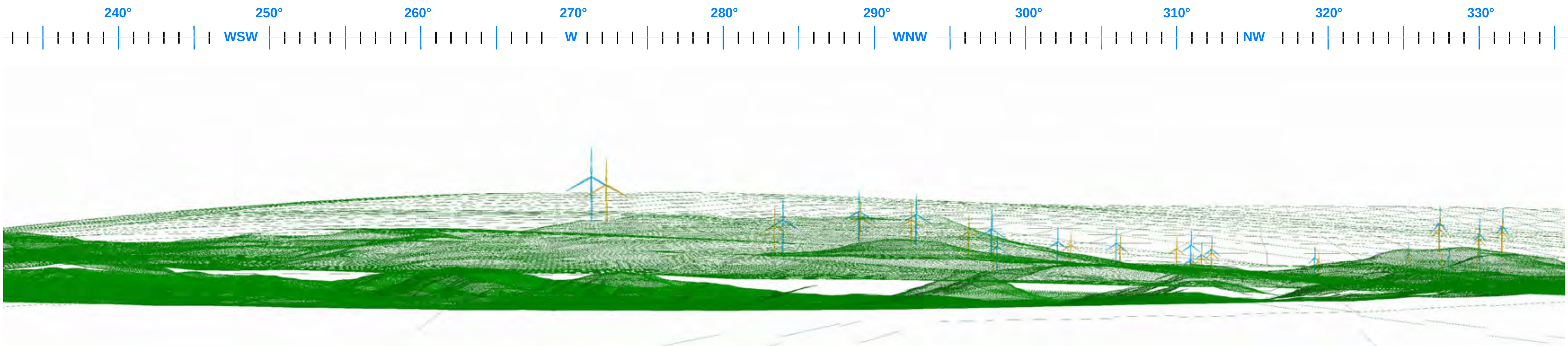

Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

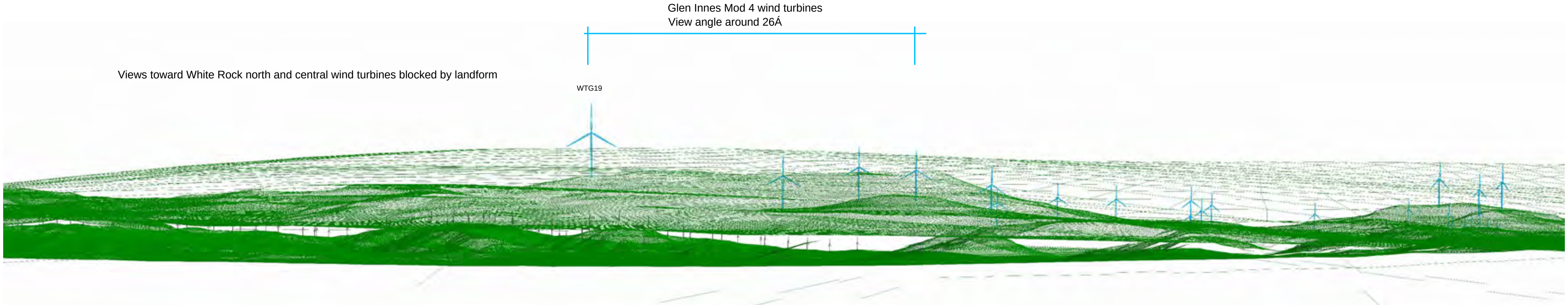
Figure 13 -
Wireframe 7 Green Valley

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Nullagai: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.11 kilometres. Tips visible 3, Hubs visible 1
Distance to closest Glen Innes Mod 4 wind turbine 2.13 kilometres. Tips visible 5, Hubs visible 1



Nullagai: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 14 -
Wireframe 8 Nullagai

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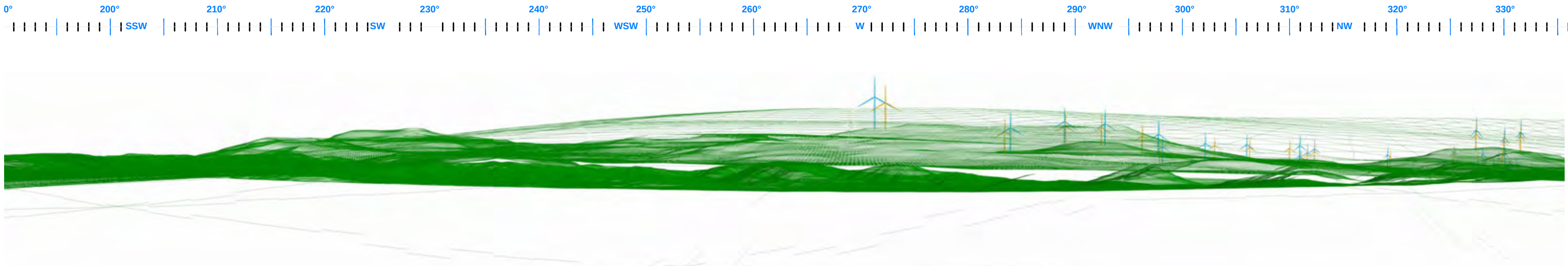
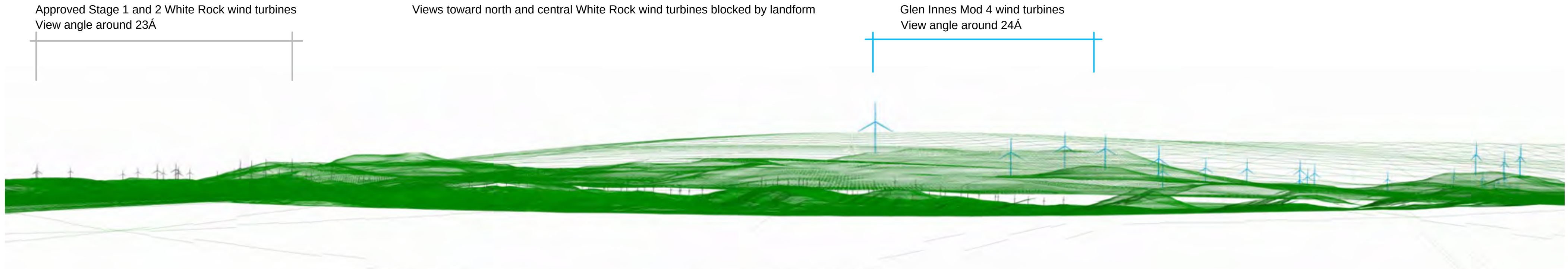
landscape architects

Glen Innes Wind Farm Modification 4



Nullagai: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.11 kilometres. Tips visible 3, Hubs visible 1
Distance to closest Glen Innes Mod 4 wind turbine 2.13 kilometres. Tips visible 5, Hubs visible 1



Nullagai: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.11 kilometres. Tips visible 5, Hubs visible 1
Distance to closest White Rock wind turbine 4.19 kilometres. Tips visible 17, Hubs visible 11


Approved Glen Innes Mod 2 wind turbine

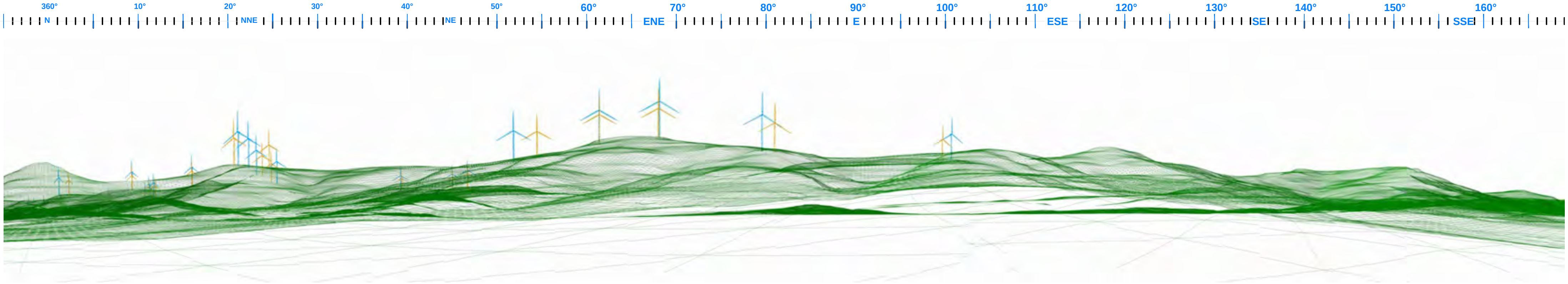

Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

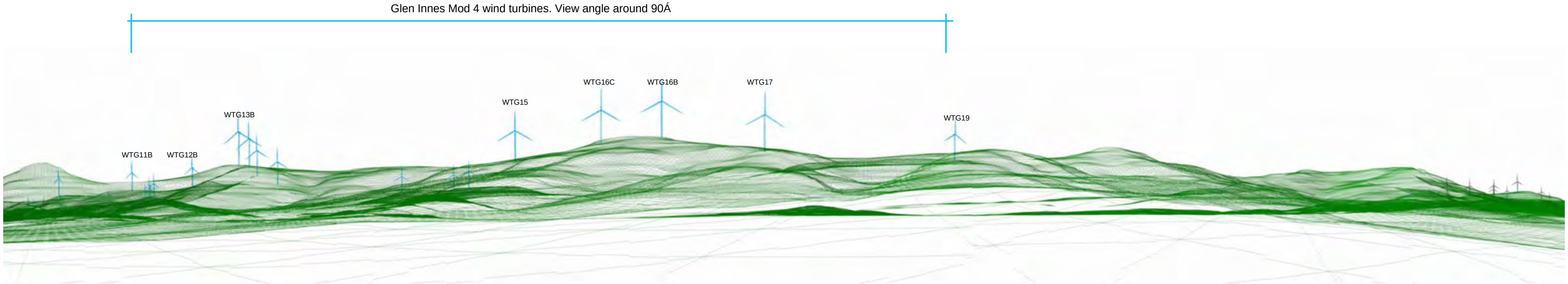
Figure 15 -
Wireframe 9 Nullagai

Glen Innes Wind Farm Modification 4

GREEN BEAN DESIGN
landscape architects



Ilparran A: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 1.53 kilometres. Tips visible 14, Hubs visible 11
Distance to closest Glen Innes Mod 4 wind turbine 1.52 kilometres. Tips visible 16, Hubs visible 11



Ilparran A: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 16 -
Wireframe 10 Ilparran A

GREEN BEAN DESIGN
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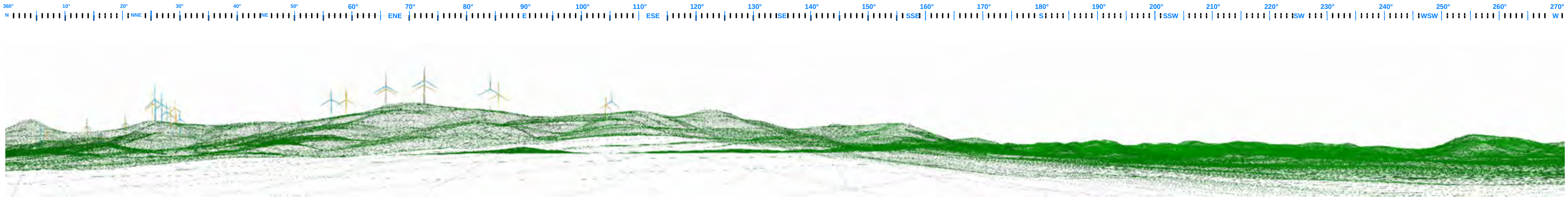
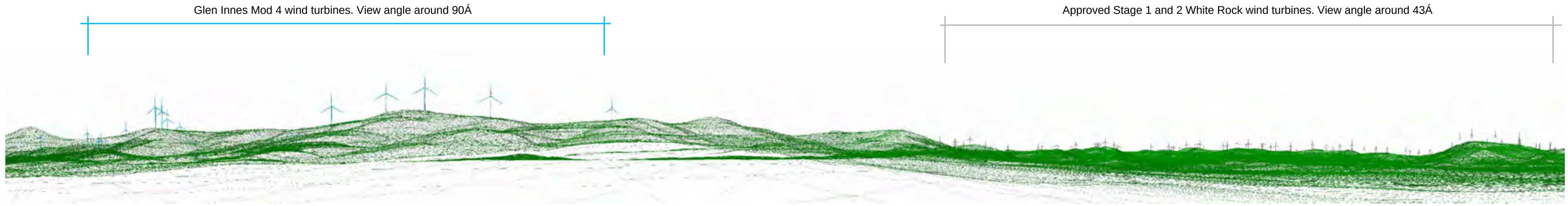
Glen Innes Wind Farm Modification 4



Ilparran A: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 1.53 kilometres. Tips visible 14, Hubs visible 11
Distance to closest Glen Innes Mod 4 wind turbine 1.52 kilometres. Tips visible 16, Hubs visible 11



Ilparran A: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 1.52 kilometres. Tips visible 16, Hubs visible 11
Distance to closest White Rock wind turbine 3.48 kilometres. Tips visible 99, Hubs visible 82

 Approved Glen Innes Mod 2 wind turbine

 Glen Innes Mod 4 wind turbine

 Approved Stage 1 and 2 White Rock wind turbine

Figure 17 -
Wireframe 11 Ilparran A

GREEN BEAN DESIGN
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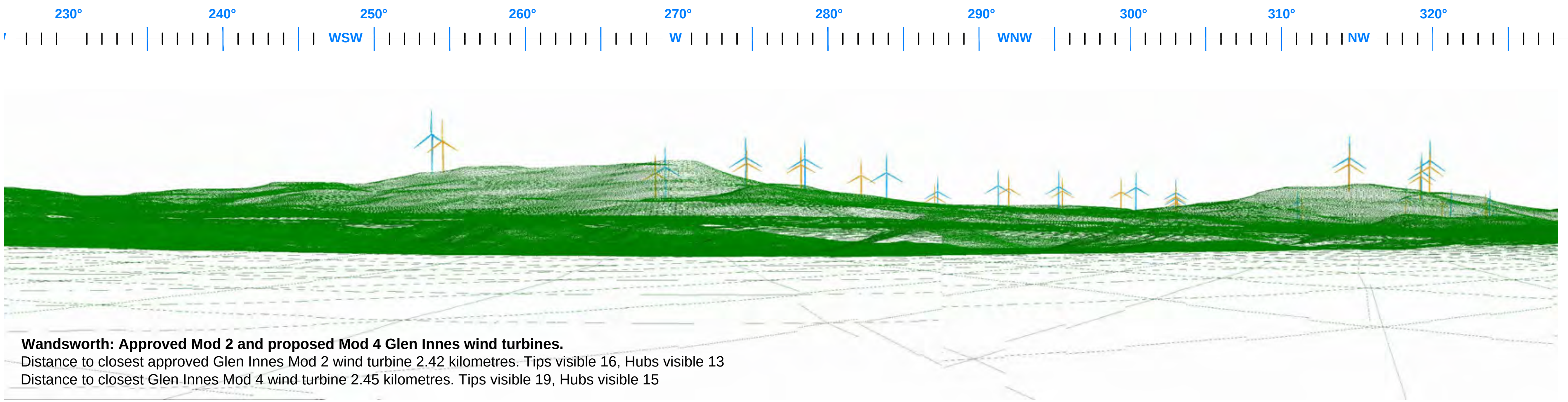
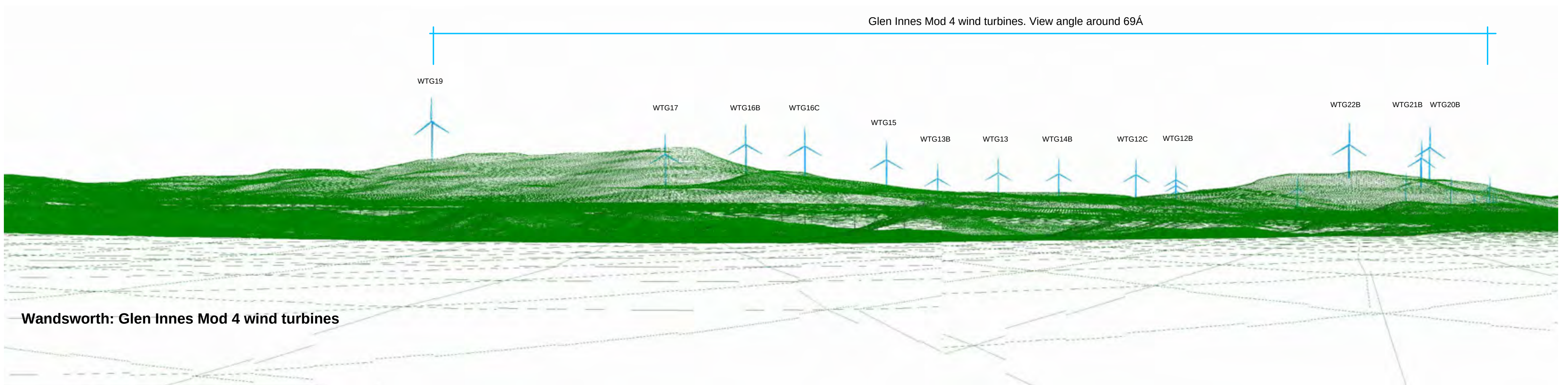


Wandsworth: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.42 kilometres. Tips visible 16, Hubs visible 13
Distance to closest Glen Innes Mod 4 wind turbine 2.45 kilometres. Tips visible 19, Hubs visible 15



Wandsworth: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 18 -
Wireframe 12 Wandsworth

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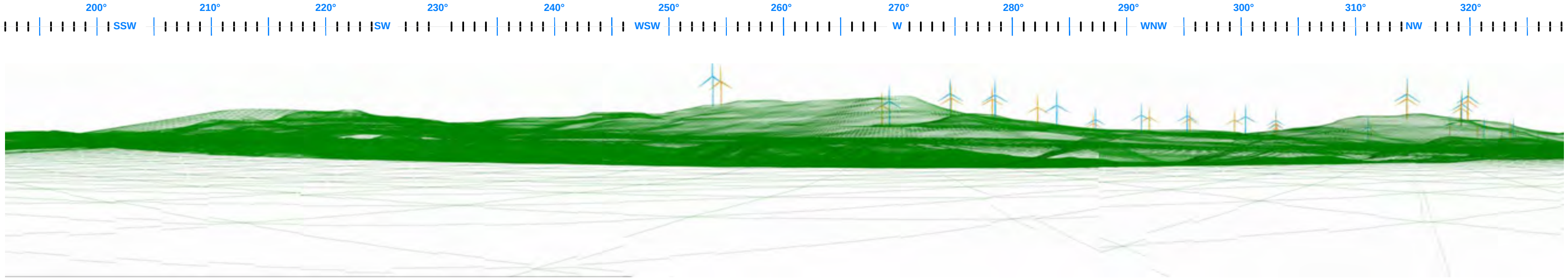
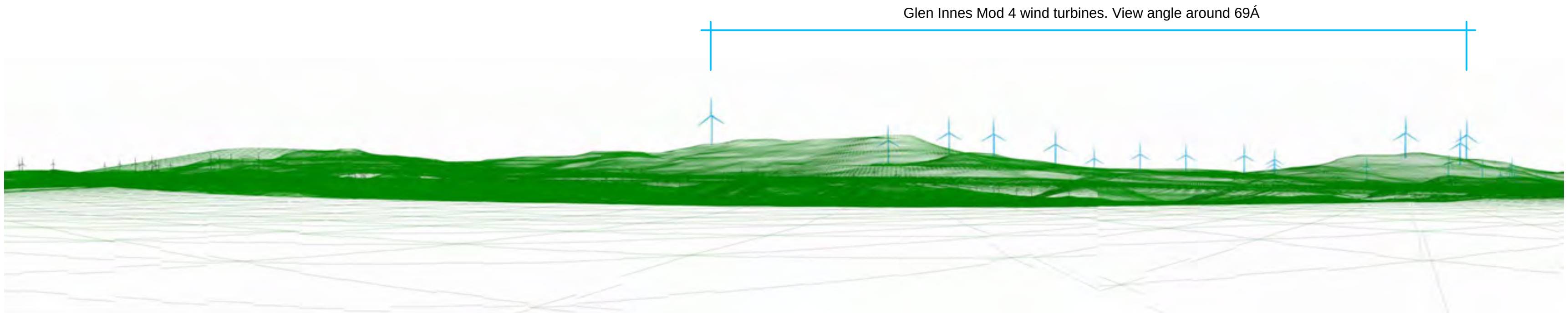
Glen Innes Wind Farm Modification 4



Wandsworth: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.42 kilometres. Tips visible 16, Hubs visible 13
Distance to closest Glen Innes Mod 4 wind turbine 2.45 kilometres. Tips visible 19, Hubs visible 14



Wandsworth: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.42 kilometres. Tips visible 16, Hubs visible 13
Distance to closest White Rock wind turbine 4.93 kilometres. Tips visible 10, Hubs visible 7


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Figure 19 -
Wireframe 13 Wandsworth

GREEN BEAN DESIGN
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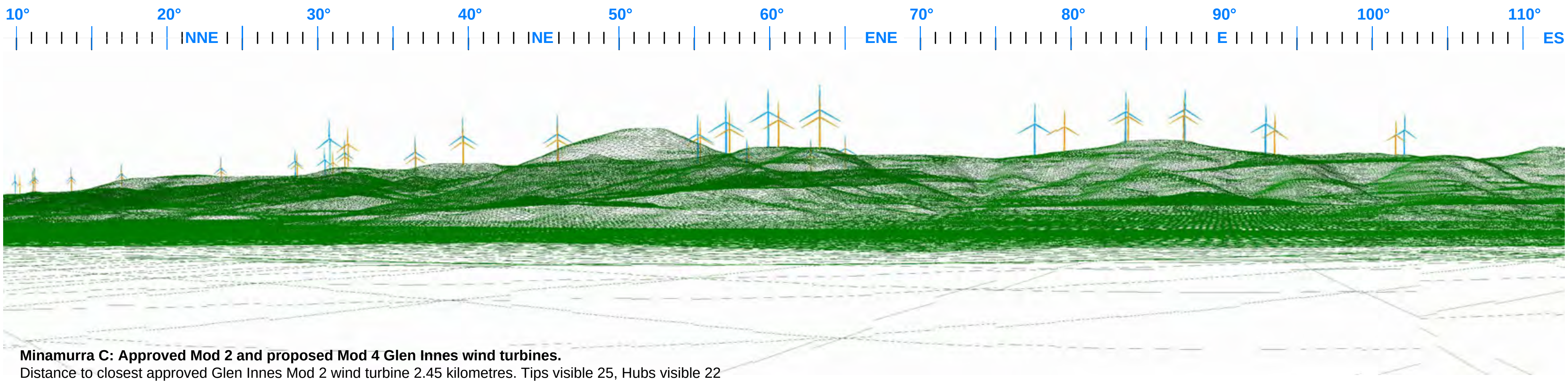
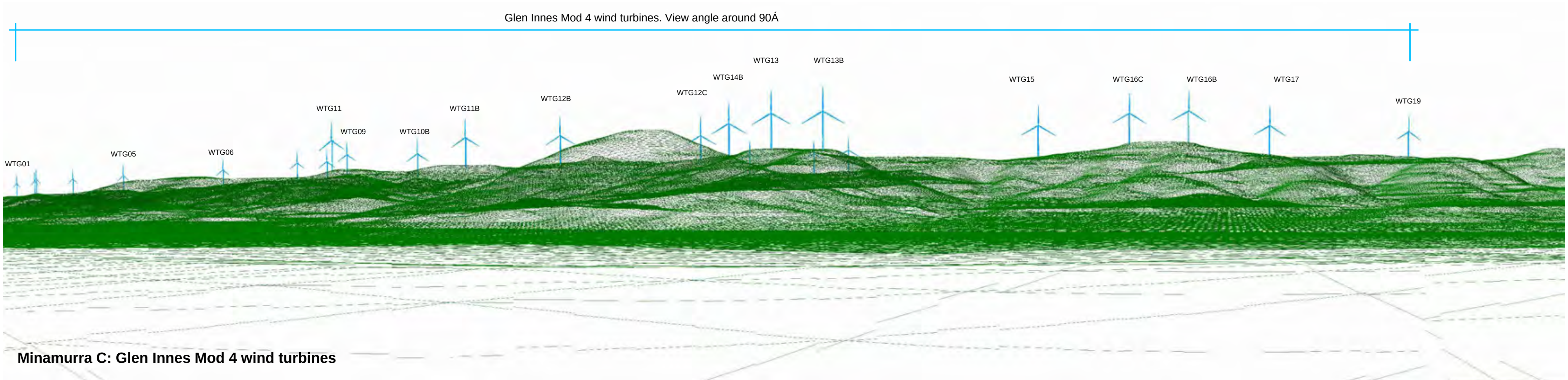
Glen Innes Wind Farm Modification 4



Minamurra C: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.45 kilometres. Tips visible 25, Hubs visible 22
Distance to closest Glen Innes Mod 4 wind turbine 2.47 kilometres. Tips visible 25, Hubs visible 23



Minamurra C: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 20 -
Wireframe 14 Minamurra C

GREEN BEAN DESIGN
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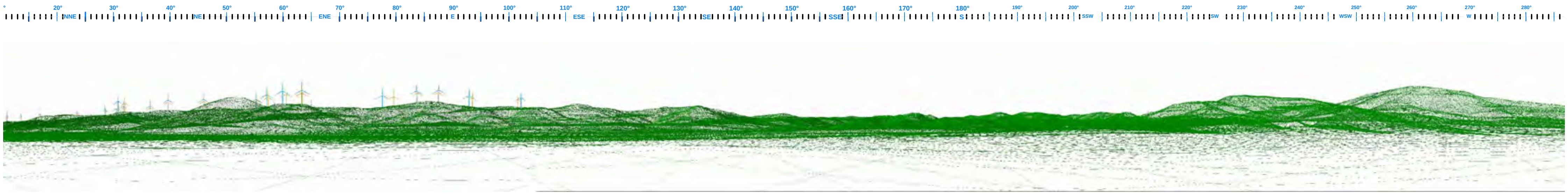
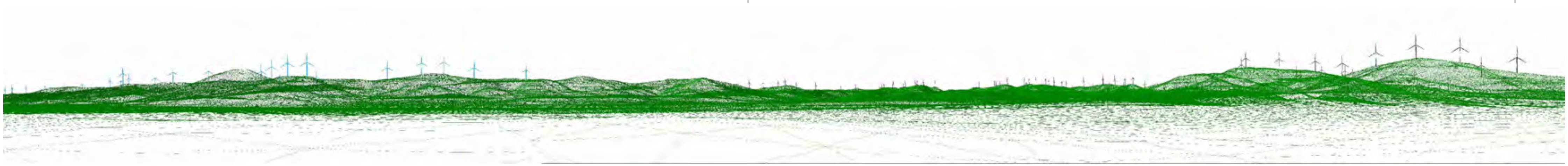
Glen Innes Wind Farm Modification 4



Minamurra C: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.45 kilometres. Tips visible 25, Hubs visible 22
Distance to closest Glen Innes Mod 4 wind turbine 2.47 kilometres. Tips visible 25, Hubs visible 23

Glen Innes Mod 4 wind turbines. View angle around 90Á

Approved Stage 1 and 2 White Rock wind turbines
View angle around 148Á



Minamurra C: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.47 kilometres. Tips visible 25, Hubs visible 23
Distance to closest White Rock wind turbine 1.83 kilometres. Tips visible 80, Hubs visible 64

Approved Glen Innes
Mod 2 wind turbine

Glen Innes Mod 4
wind turbine

Approved Stage 1 and 2
White Rock wind turbine

Figure 21 -
Wireframe 15 Minamurra C

GREEN BEAN DESIGN
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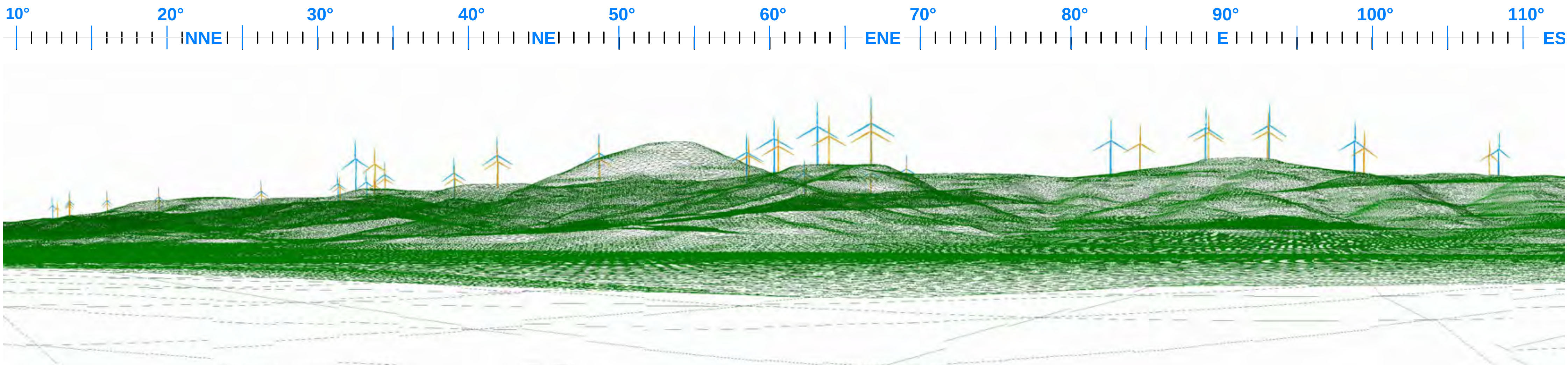
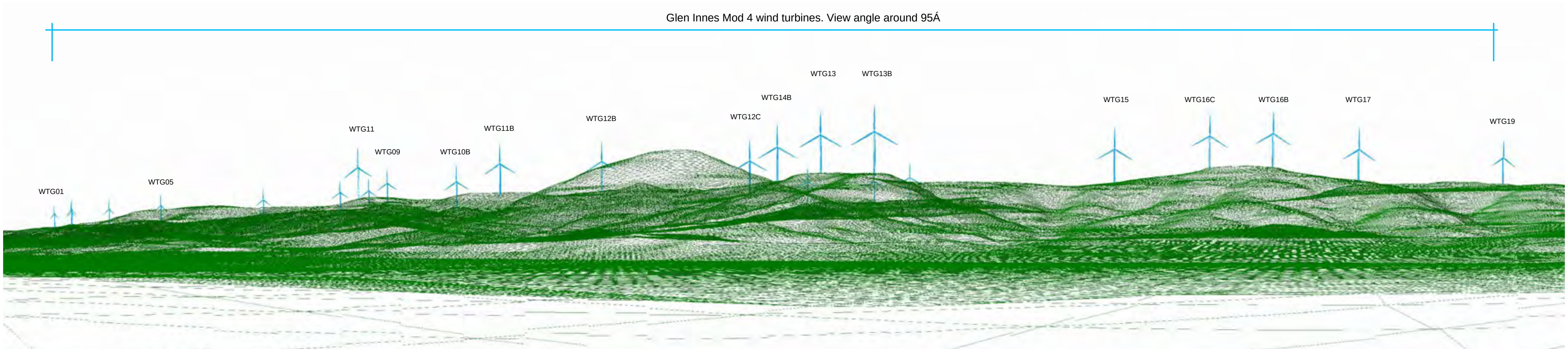
Glen Innes Wind Farm Modification 4



Minamurra A: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.24 kilometres. Tips visible 23, Hubs visible 21
Distance to closest Glen Innes Mod 4 wind turbine 2.26 kilometres. Tips visible 25, Hubs visible 23



Minamurra A: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 22 -
Wiireframe 16 Minamurra A

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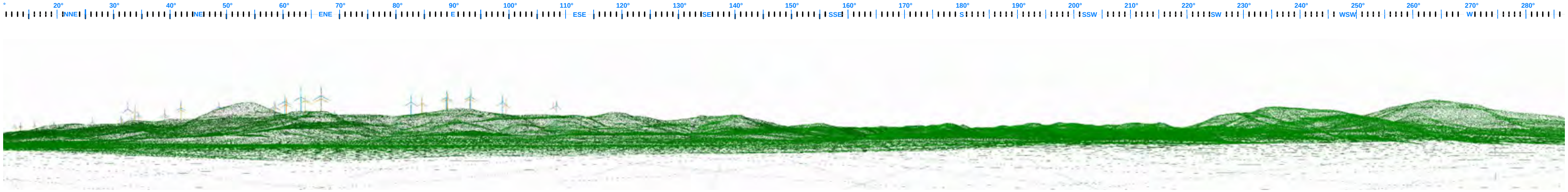
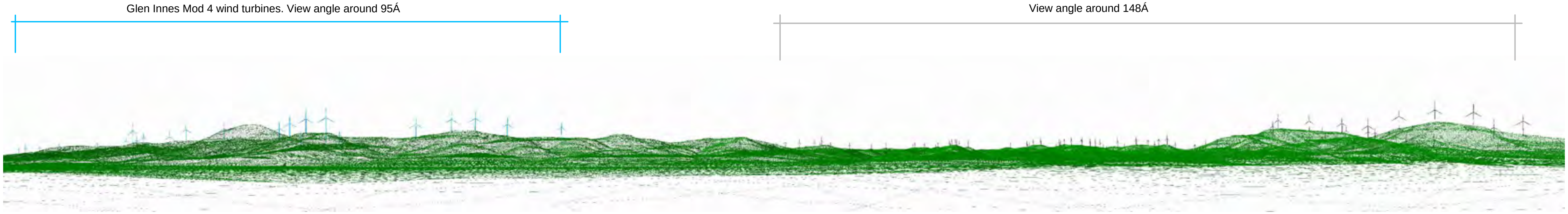
Glen Innes Wind Farm Modification 4



Minamurra A: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.24 kilometres. Tips visible 23, Hubs visible 21
Distance to closest Glen Innes Mod 4 wind turbine 2.26 kilometres. Tips visible 25, Hubs visible 23

Glen Innes Mod 4 wind turbines. View angle around 95Á

Approved Stage 1 and 2 White Rock wind turbines
View angle around 148Á



Minamurra A: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.26 kilometres. Tips visible 25, Hubs visible 23
Distance to closest White Rock wind turbine 2.03 kilometres. Tips visible 83, Hubs visible 68


Approved Glen Innes Mod 2 wind turbine

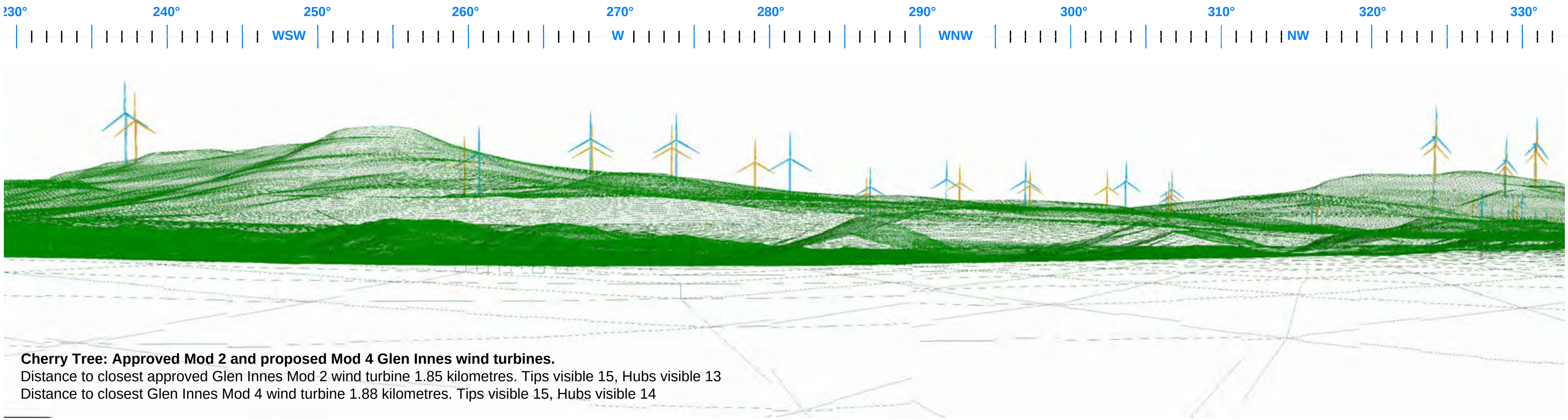

Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

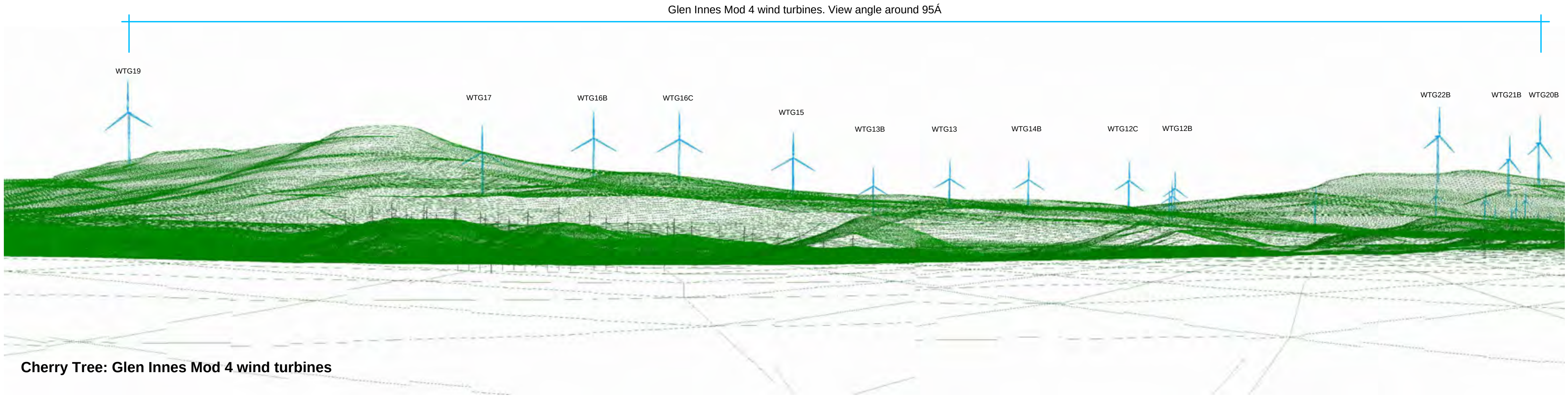
Figure 23 -
Wireframe 17 Minamurra A

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Cherry Tree: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 1.85 kilometres. Tips visible 15, Hubs visible 13
Distance to closest Glen Innes Mod 4 wind turbine 1.88 kilometres. Tips visible 15, Hubs visible 14



Cherry Tree: Glen Innes Mod 4 wind turbines

Approved Glen Innes Mod 2 wind turbine

Glen Innes Mod 4 wind turbine

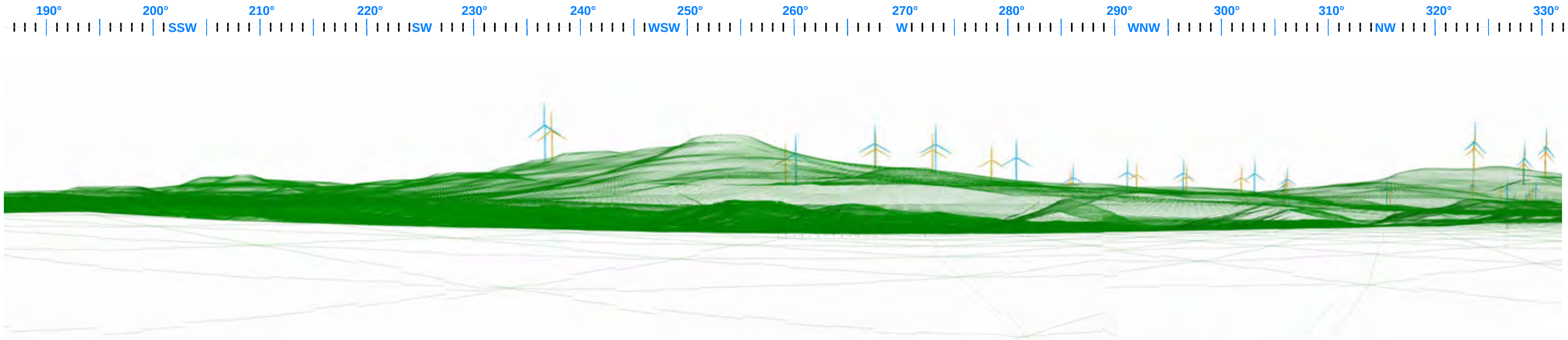
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 24 - Wireframe 18 Cherry Tree

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Cherry Tree: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 1.85 kilometres. Tips visible 15, Hubs visible 13
Distance to closest Glen Innes Mod 4 wind turbine 1.88 kilometres. Tips visible 15, Hubs visible 14

Cherry Tree: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 1.88 kilometres. Tips visible 15, Hubs visible 14
Distance to closest White Rock wind turbine 4.90 kilometres. Tips visible 13, Hubs visible 3


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Figure 25 -
Wireframe 19 Cherry Tree

GREEN BEAN DESIGN
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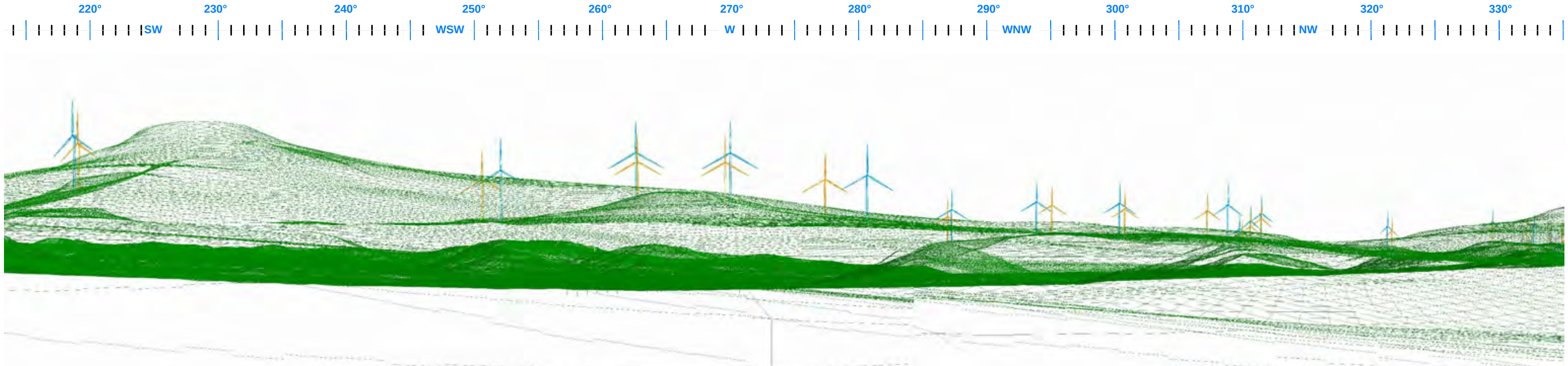
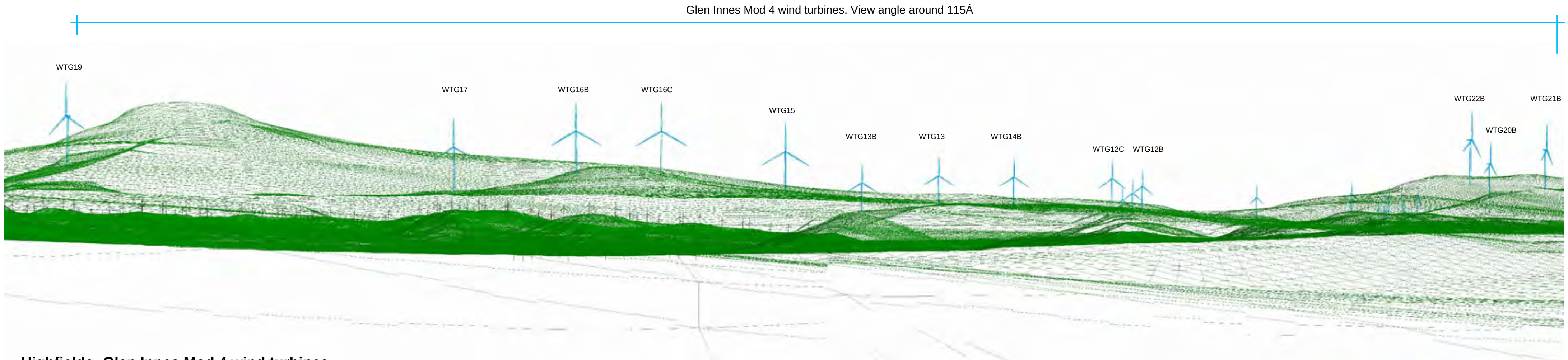
Glen Innes Wind Farm Modification 4



Highfields: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 1.42 kilometres. Tips visible 17, Hubs visible 14
Distance to closest Glen Innes Mod 4 wind turbine 1.45 kilometres. Tips visible 17, Hubs visible 17



Highfields: Glen Innes Mod 4 wind turbines

Approved Glen Innes Mod 2 wind turbine

Glen Innes Mod 4 wind turbine

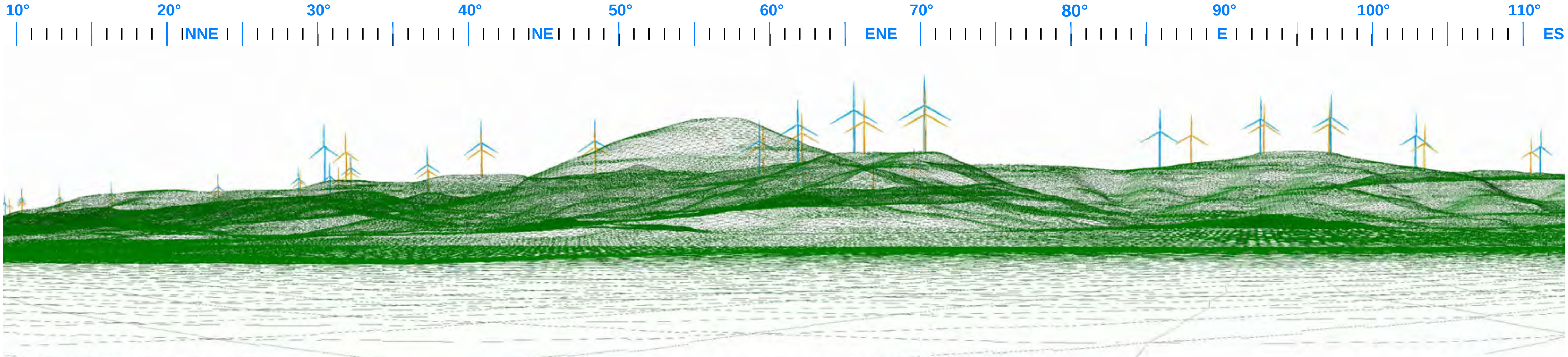
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

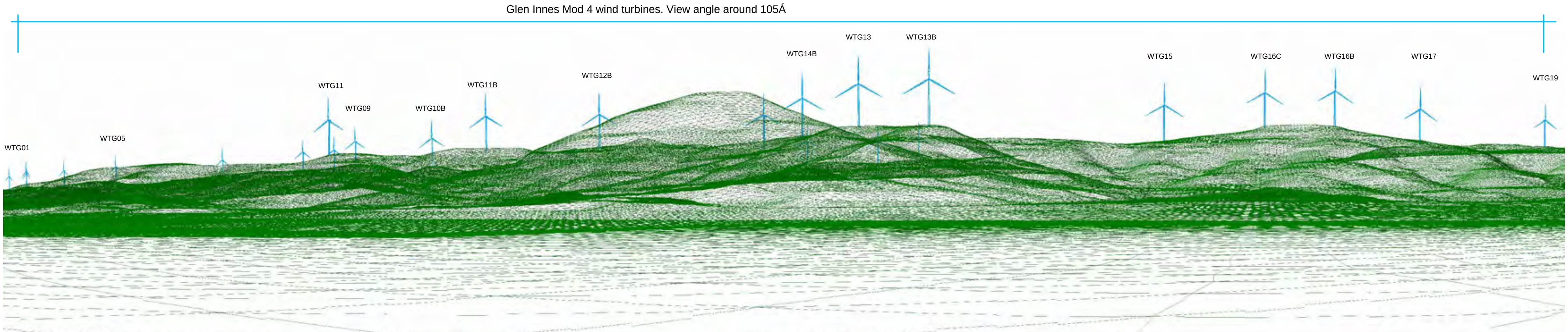
Figure 26 - Wireframe 20 Highfields

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Minamurra B: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.01 kilometres. Tips visible 21, Hubs visible 20
Distance to closest Glen Innes Mod 4 wind turbine 2.03 kilometres. Tips visible 23, Hubs visible 21



Minamurra B: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

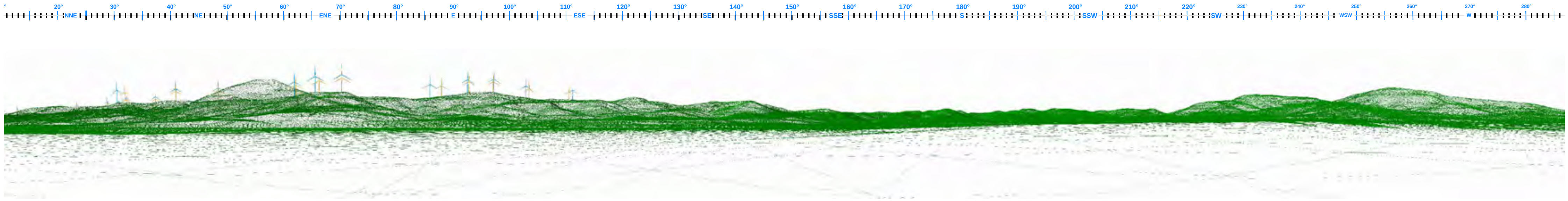
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

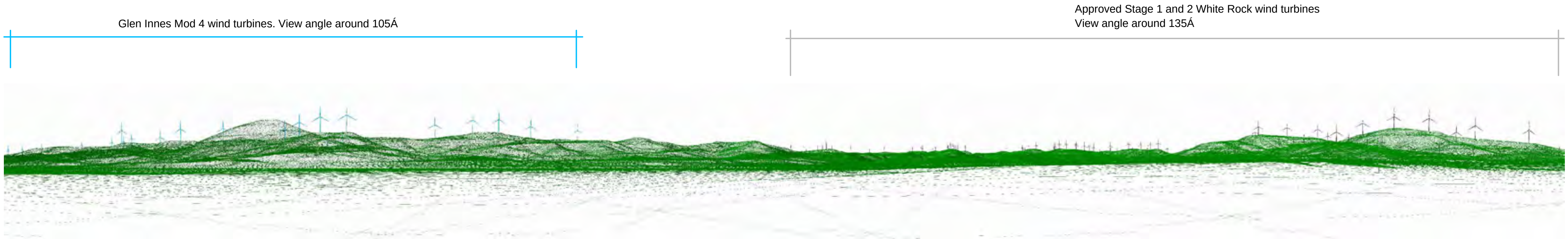
Figure 27 -
Wireframe 21 Minamurra B

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Minamurra B: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.01 kilometres. Tips visible 21, Hubs visible 20
Distance to closest Glen Innes Mod 4 wind turbine 2.03 kilometres. Tips visible 23, Hubs visible 21



Minamurra B: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.03 kilometres. Tips visible 23, Hubs visible 21
Distance to closest White Rock wind turbine 2.15 kilometres. Tips visible 86, Hubs visible 70


Approved Glen Innes Mod 2 wind turbine

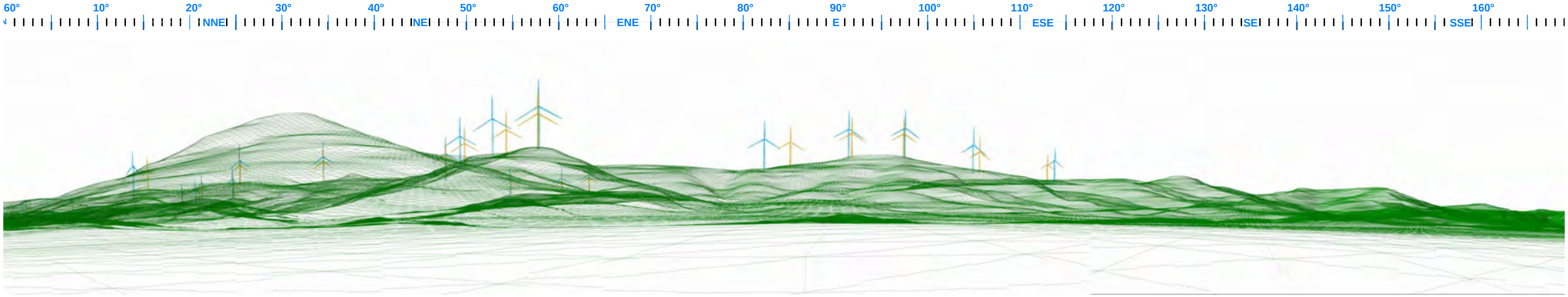

Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

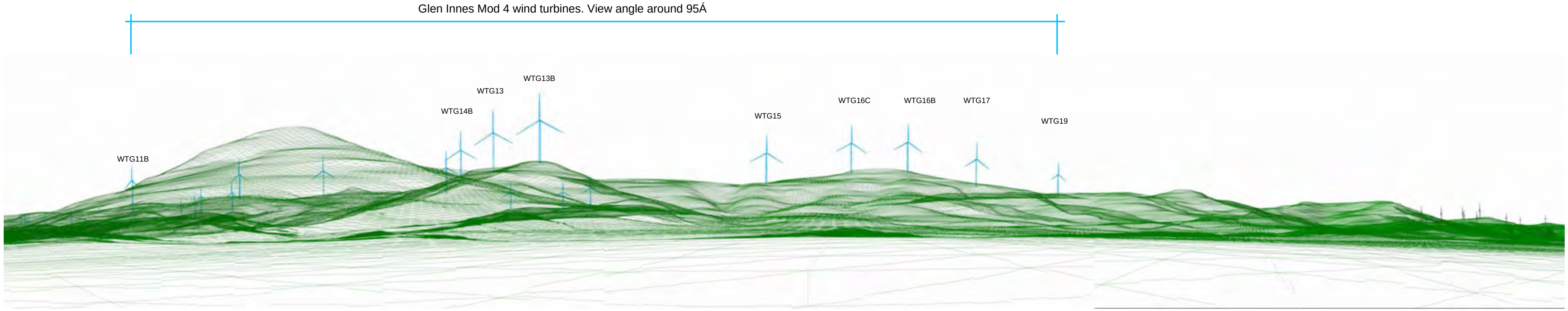
Figure 28 -
Wireframe 22 Minamurra B

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Ilparran B: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 1.30 kilometres. Tips visible 10, Hubs visible 8
Distance to closest Glen Innes Mod 5 wind turbine 1.32 kilometres. Tips visible 11, Hubs visible 10



Ilparran B: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 29 - Wireframe 23 Ilparran B

GREEN BEAN DESIGN
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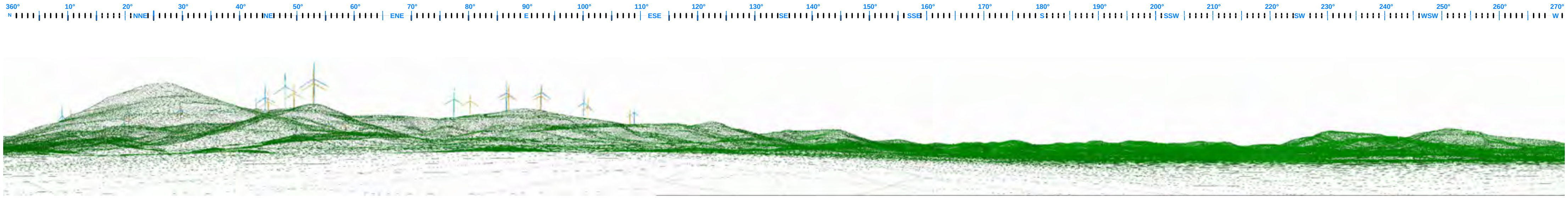
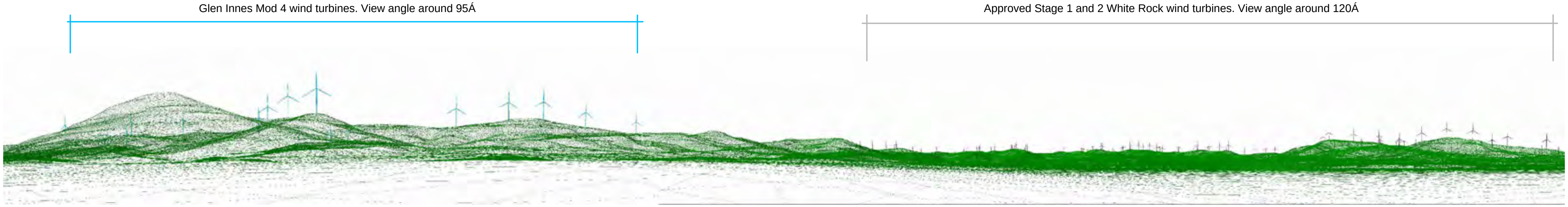
Glen Innes Wind Farm Modification 4



Ilparran B: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 1.30 kilometres. Tips visible 10, Hubs visible 8
Distance to closest Glen Innes Mod 4 wind turbine 1.32 kilometres. Tips visible 11, Hubs visible 10



Ilparran B: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 1.30 kilometres. Tips visible 11, Hubs visible 10
Distance to closest White Rock wind turbine 2.92 kilometres. Tips visible 94, Hubs visible 78


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Figure 30 -
Wireframe 24 Ilparran B

GREEN BEAN DESIGN
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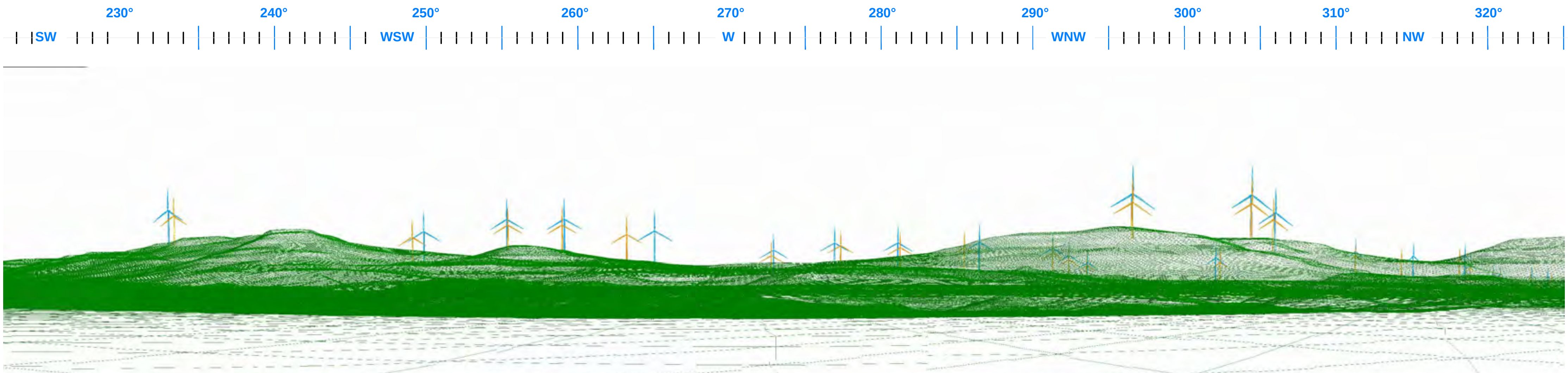
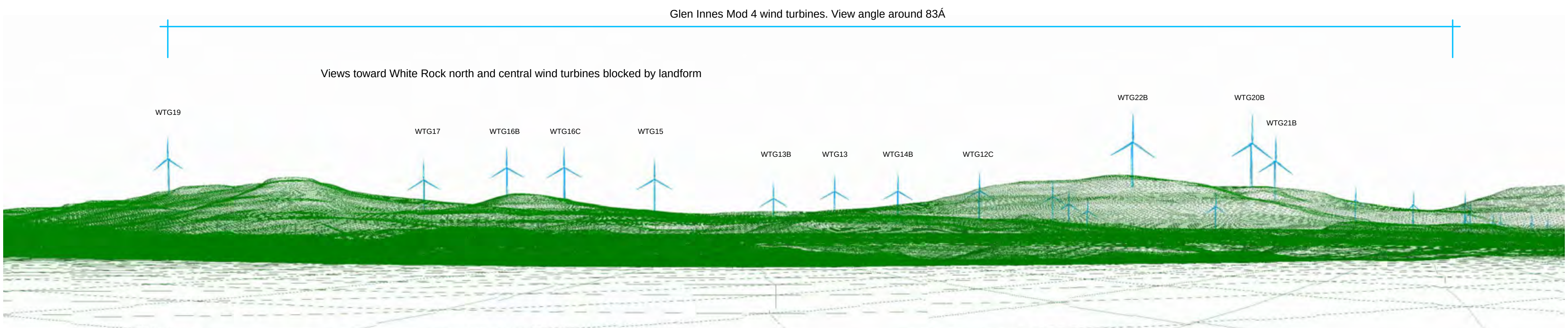
Glen Innes Wind Farm Modification 4



Lombardy: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.15 kilometres. Tips visible 15, Hubs visible 12
Distance to closest Glen Innes Mod 4 wind turbine 2.15 kilometres. Tips visible 15, Hubs visible 13



Lombardy: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

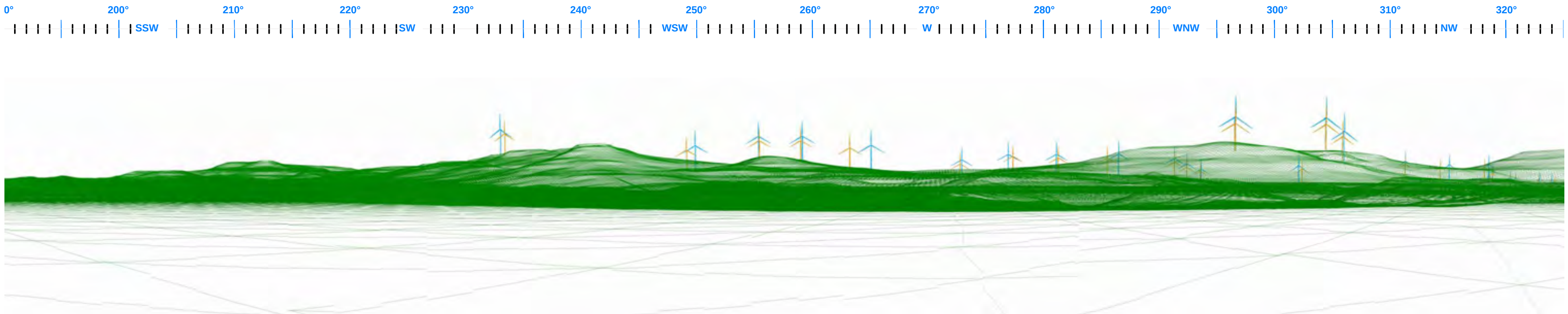
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

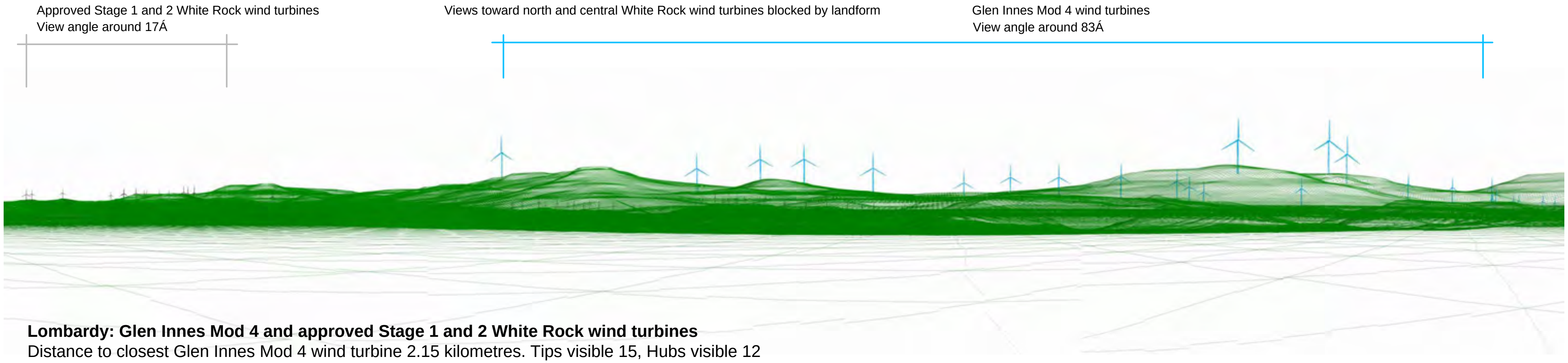
Figure 31 -
Wireframe 25 Lombardy

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Lombardy: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.15 kilometres. Tips visible 15, Hubs visible 12
Distance to closest Glen Innes Mod 4 wind turbine 2.15 kilometres. Tips visible 15, Hubs visible 13



Lombardy: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.15 kilometres. Tips visible 15, Hubs visible 12
Distance to closest White Rock wind turbine 5.82 kilometres. Tips visible 17, Hubs visible 10


Approved Glen Innes
Mod 2 wind turbine

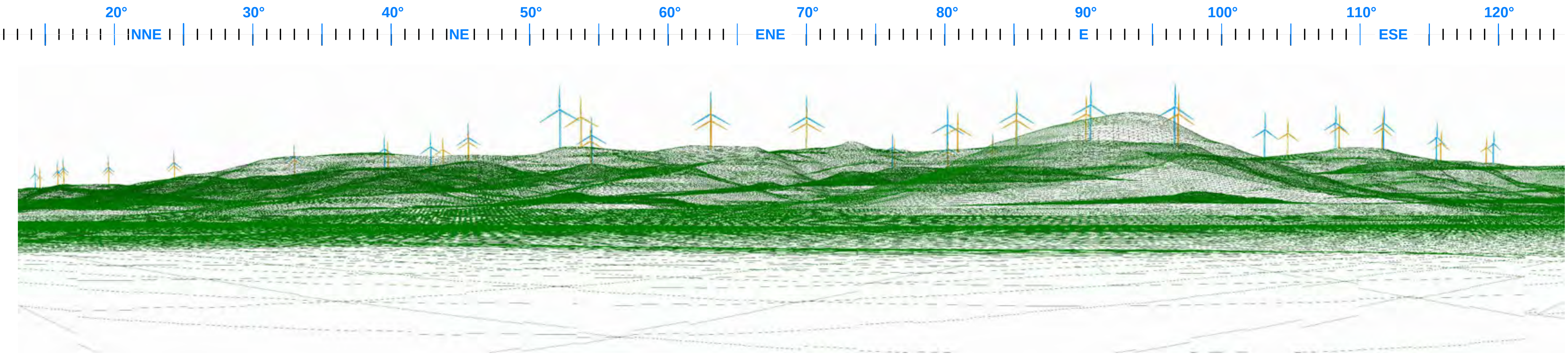

Glen Innes Mod 4
wind turbine


Approved Stage 1 and 2
White Rock wind turbine

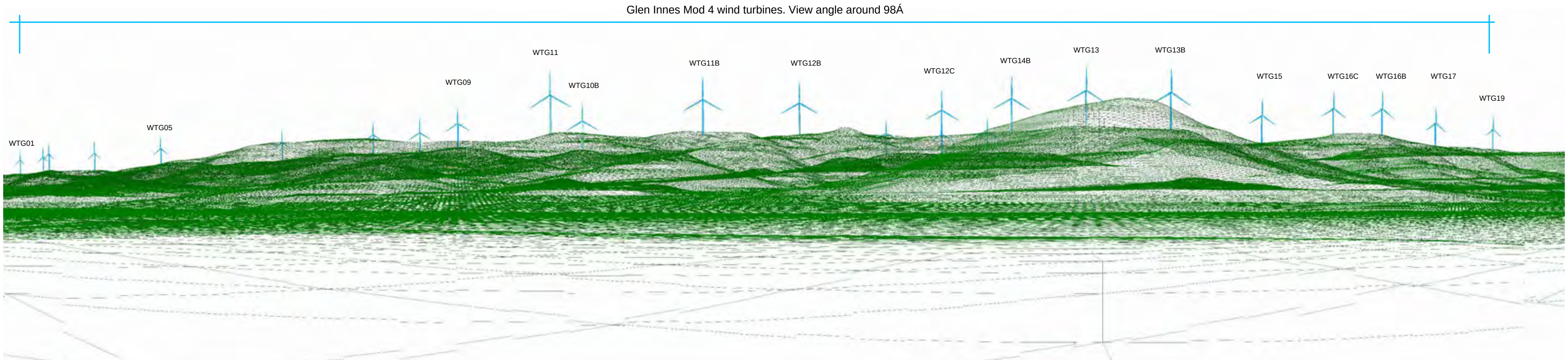
Figure 32 -
Wireframe 26 Lombardy

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Kalanga C: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.34 kilometres. Tips visible 25, Hubs visible 21
Distance to closest Glen Innes Mod 4 wind turbine 2.32 kilometres. Tips visible 25, Hubs visible 23



Kalanga C: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

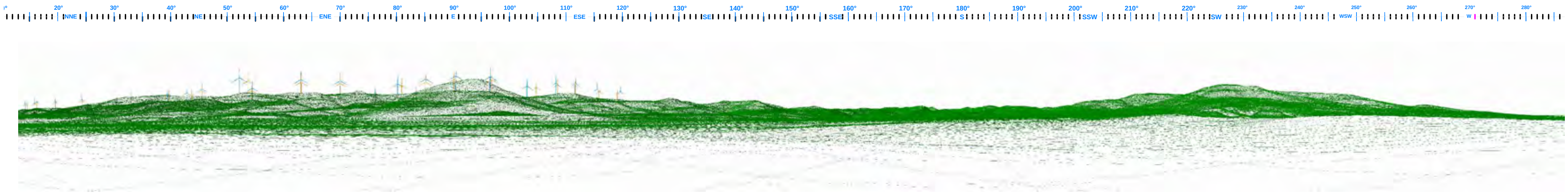
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 33 -
Wireframe 27 Kalanga C

GREEN BEAN DESIGN
landscape architects

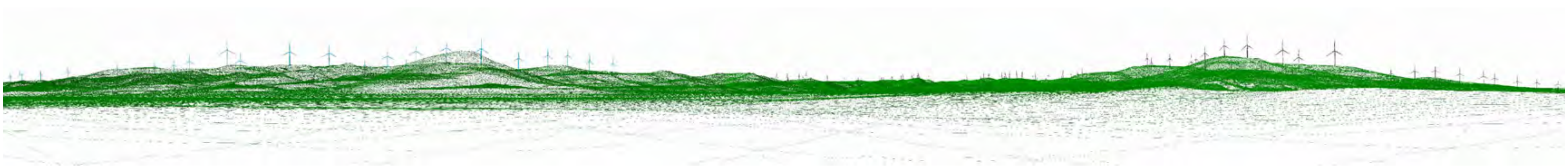
Glen Innes Wind Farm Modification 4



Kalanga C: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.34 kilometres. Tips visible 25, Hubs visible 21
Distance to closest Glen Innes Mod 4 wind turbine 2.32 kilometres. Tips visible 25, Hubs visible 23

Glen Innes Mod 4 wind turbines. View angle around 98Á

Approved Stage 1 and 2 White Rock wind turbines
View angle around 140Á



Kalanga C: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.32 kilometres. Tips visible 25, Hubs visible 23
Distance to closest White Rock wind turbine 1.88 kilometres. Tips visible 82, Hubs visible 71


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Figure 34 -
Wireframe 28 Kalanga C

GREEN BEAN DESIGN
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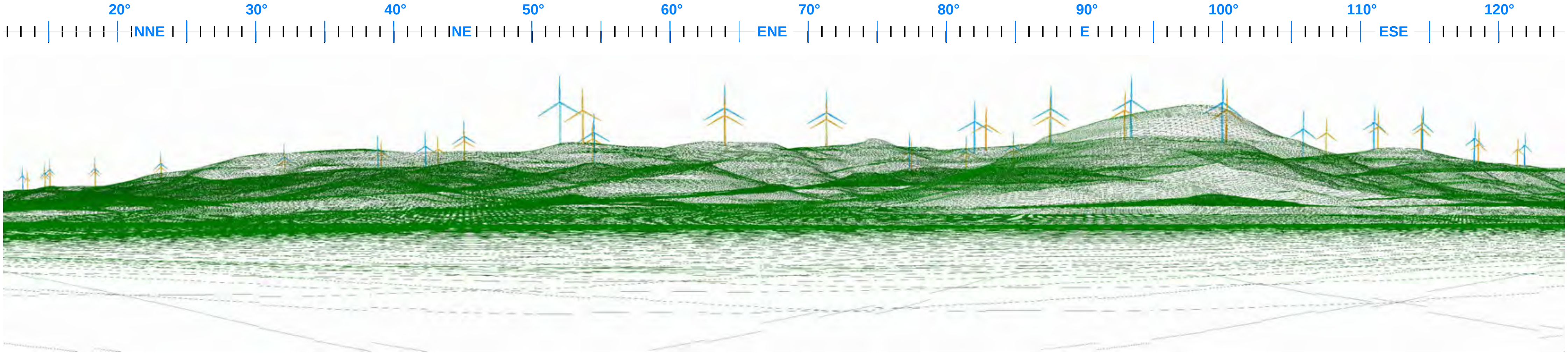
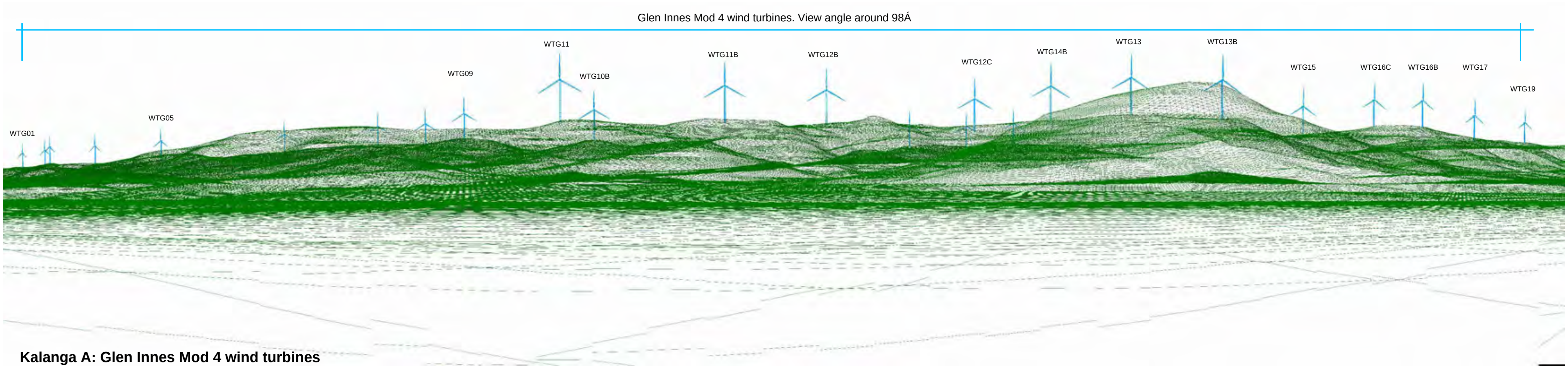
Glen Innes Wind Farm Modification 4



Kalanga A: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.16 kilometres. Tips visible 25, Hubs visible 19
Distance to closest Glen Innes Mod 4 wind turbine 2.31 kilometres. Tips visible 25, Hubs visible 23



Kalanga A: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

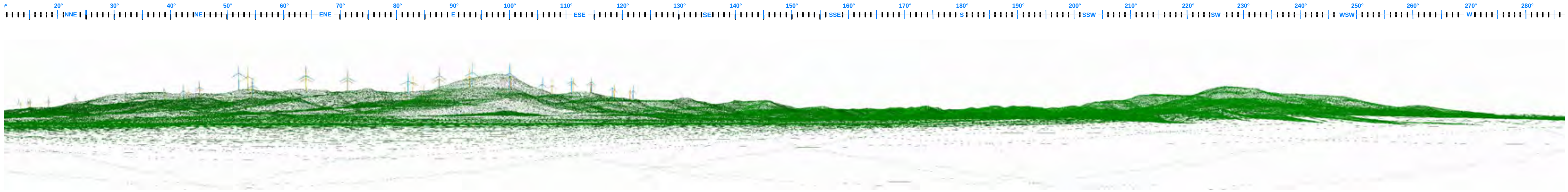
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 35 -
Wireframe 29 Kalanga A

GREEN BEAN DESIGN
landscape architects

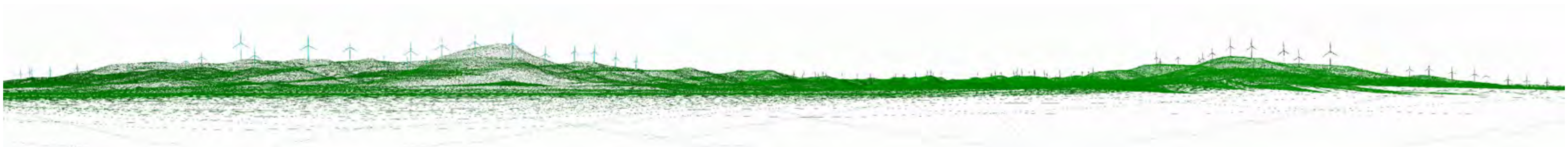
Glen Innes Wind Farm Modification 4



Kalanga A: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.16 kilometres. Tips visible 25, Hubs visible 21
Distance to closest Glen Innes Mod 4 wind turbine 2.13 kilometres. Tips visible 25, Hubs visible 23

Glen Innes Mod 4 wind turbines. View angle around 98Á

Approved Stage 1 and 2 White Rock wind turbines
View angle around 140Á



Kalanga A: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.13 kilometres. Tips visible 25, Hubs visible 23
Distance to closest White Rock wind turbine 2.06 kilometres. Tips visible 87, Hubs visible 72


Approved Glen Innes
Mod 2 wind turbine

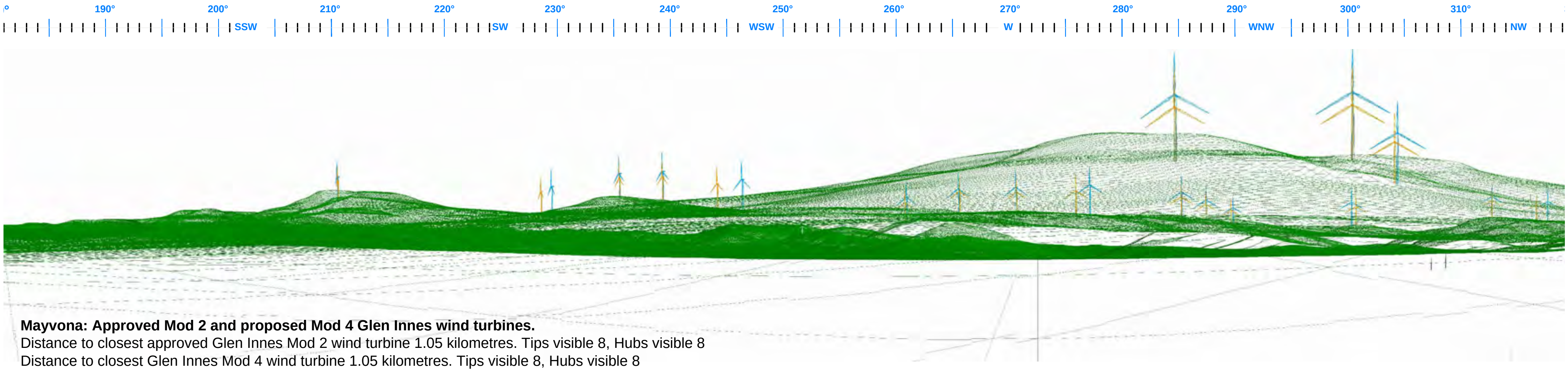

Glen Innes Mod 4
wind turbine


Approved Stage 1 and 2
White Rock wind turbine

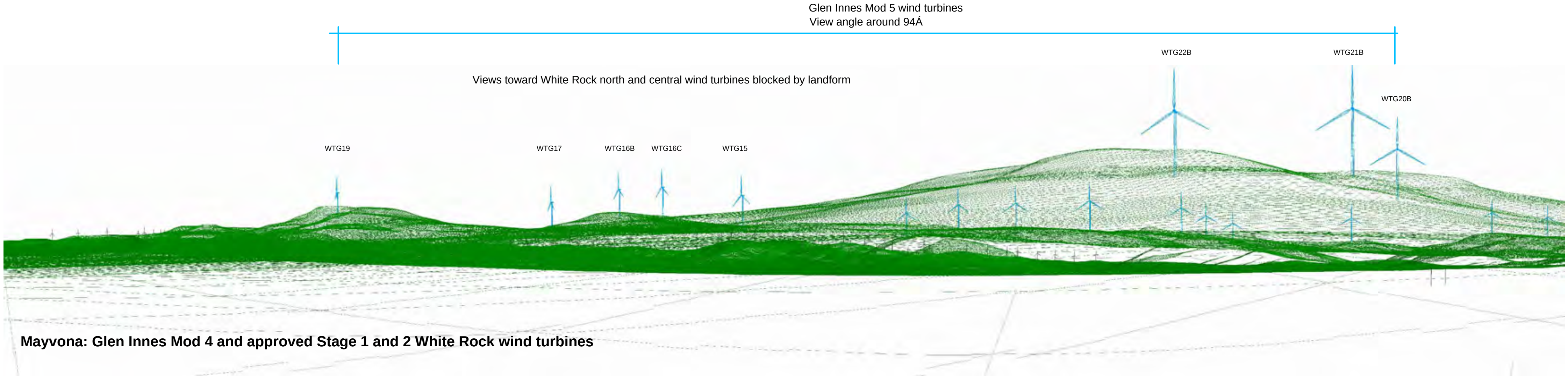
Figure 36 -
Wireframe 30 Kalanga A

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Mayvona: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 1.05 kilometres. Tips visible 8, Hubs visible 8
Distance to closest Glen Innes Mod 4 wind turbine 1.05 kilometres. Tips visible 8, Hubs visible 8



Mayvona: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

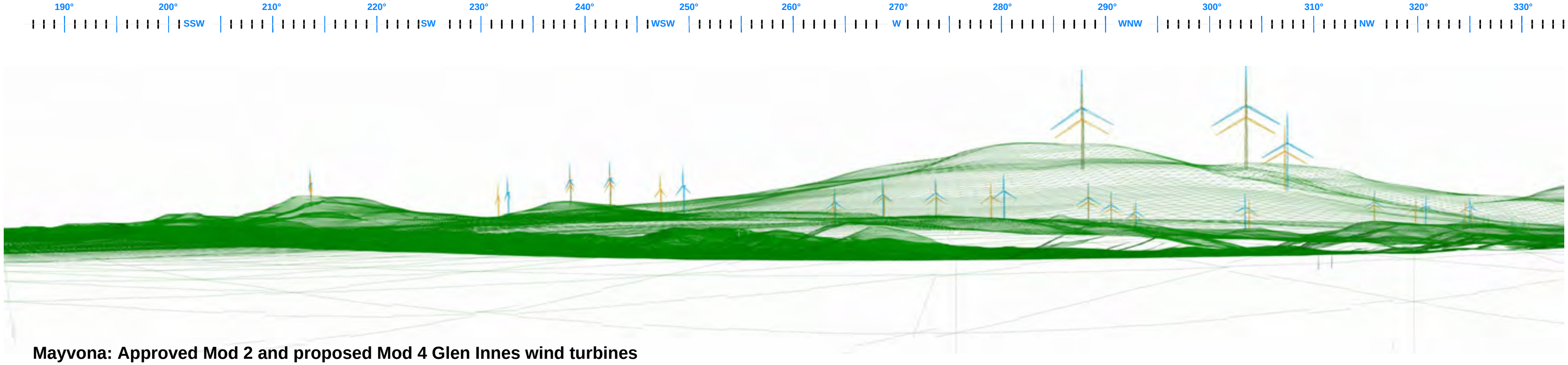
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

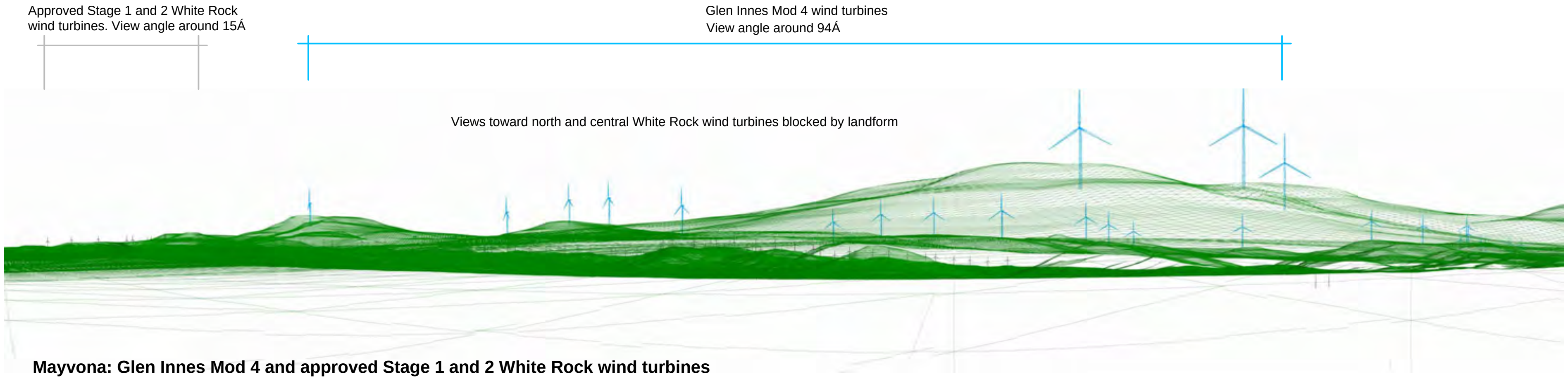
Figure 37 - Wireframe 31 Mayvona

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Mayvona: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 1.05 kilometres. Tips visible 8, Hubs visible 8
Distance to closest Glen Innes Mod 4 wind turbine 1.05 kilometres. Tips visible 8, Hubs visible 8



Mayvona: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 1.05 kilometres. Tips visible 8, Hubs visible 8
Distance to closest White Rock wind turbine 6.16 kilometres. Tips visible 13, Hubs visible 7


Approved Glen Innes Mod 2 wind turbine

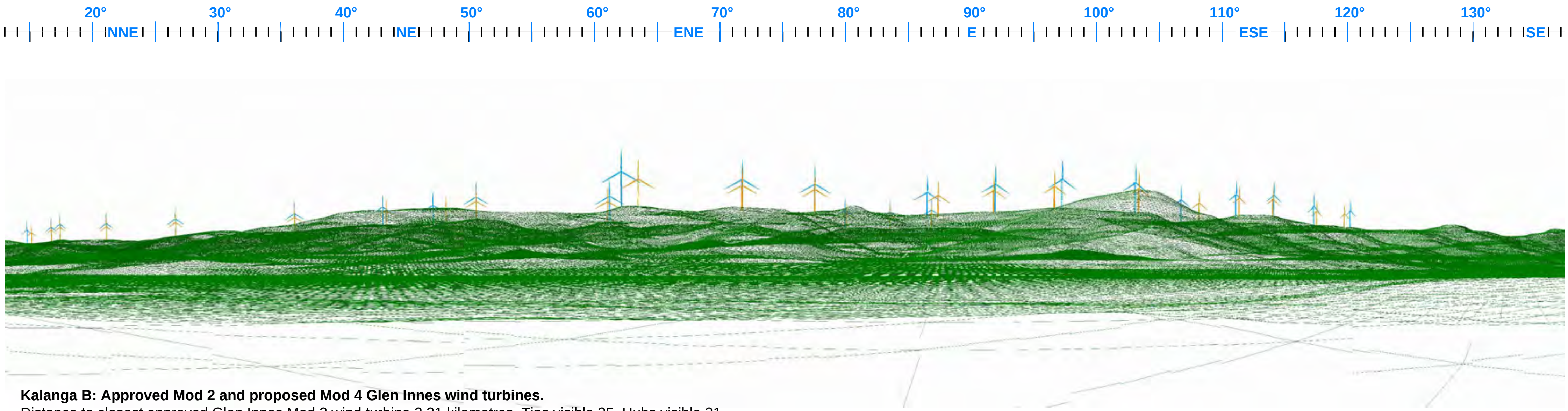

Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

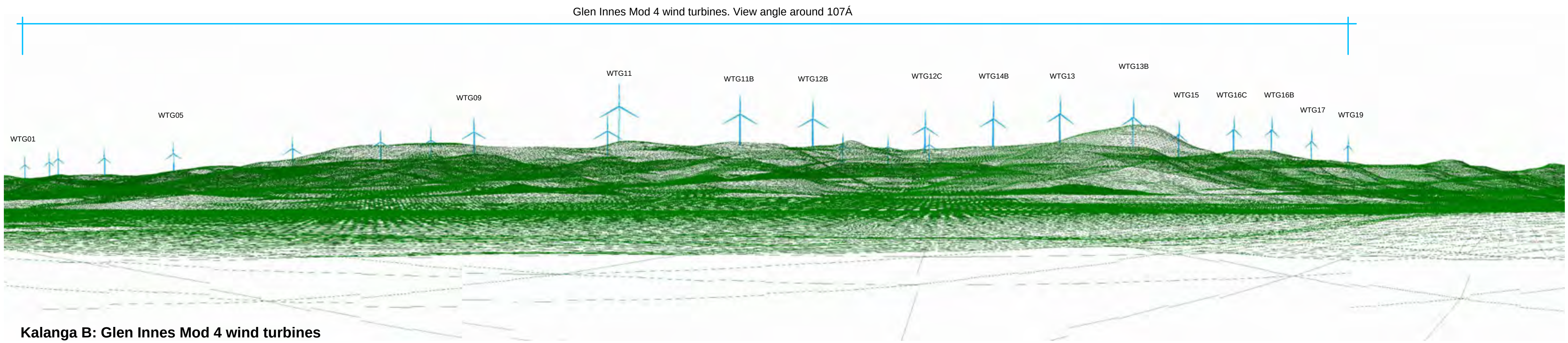
Figure 38 -
Wireframe 32 Mayvona

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Kalanga B: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.31 kilometres. Tips visible 25, Hubs visible 21
Distance to closest Glen Innes Mod 4 wind turbine 2.26 kilometres. Tips visible 25, Hubs visible 24



Kalanga B: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

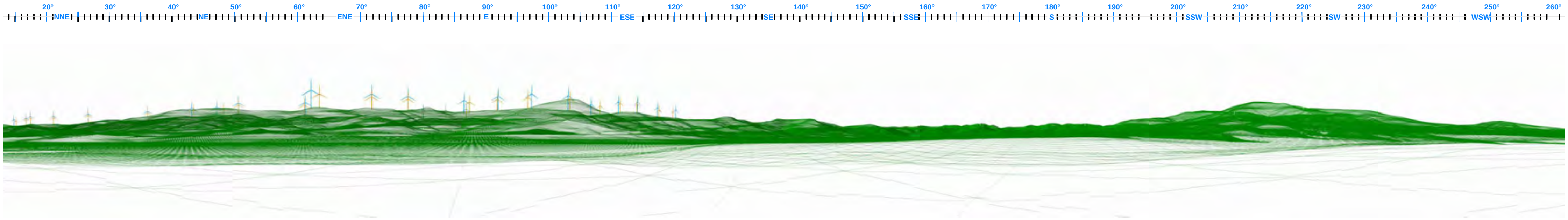
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 39 -
Wireframe 33 Kalanga B

GREEN BEAN DESIGN
landscape architects

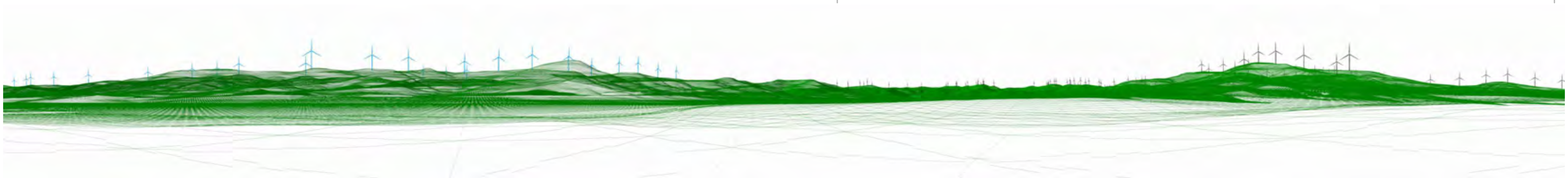
Glen Innes Wind Farm Modification 4



Kalanga B: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.31 kilometres. Tips visible 25, Hubs visible 21
Distance to closest Glen Innes Mod 4 wind turbine 2.26 kilometres. Tips visible 25, Hubs visible 24

Glen Innes Mod 4 wind turbines. View angle around 107Á

Approved Stage 1 and 2 White Rock wind turbines
View angle around 116Á



Kalanga B: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.26 kilometres. Tips visible 25, Hubs visible 24
Distance to closest White Rock wind turbine 1.95 kilometres. Tips visible 88, Hubs visible 72


Approved Glen Innes Mod 2 wind turbine

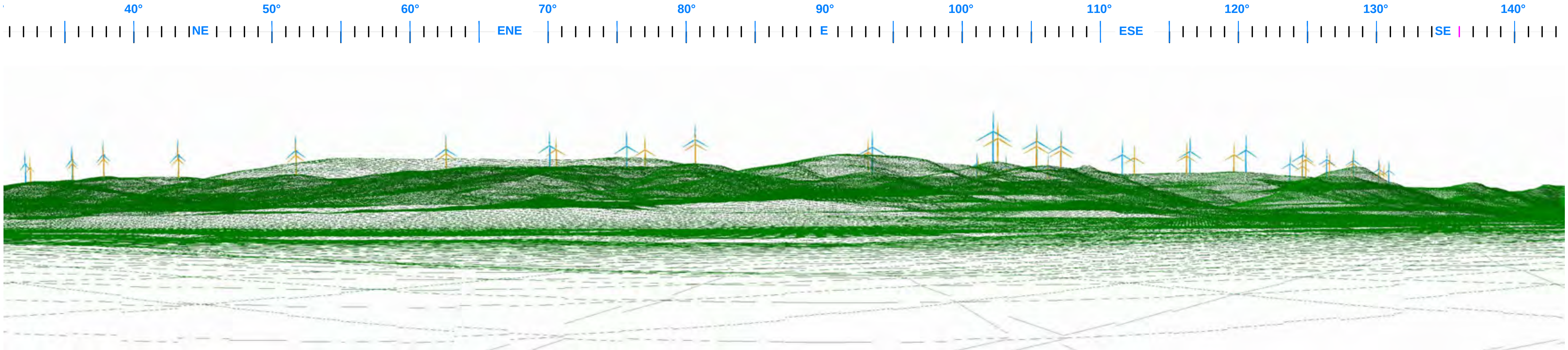

Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

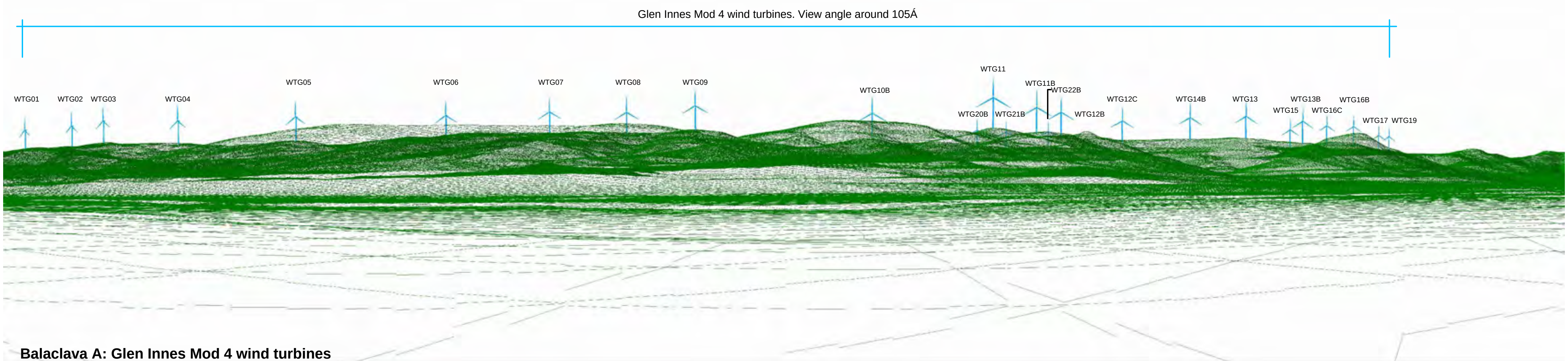
Figure 40 -
Wireframe 34 Kalanga B

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Balaclava A: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.90 kilometres. Tips visible 25, Hubs visible 22
Distance to closest Glen Innes Mod 4 wind turbine 2.83 kilometres. Tips visible 25, Hubs visible 24



Balaclava A: Glen Innes Mod 4 wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

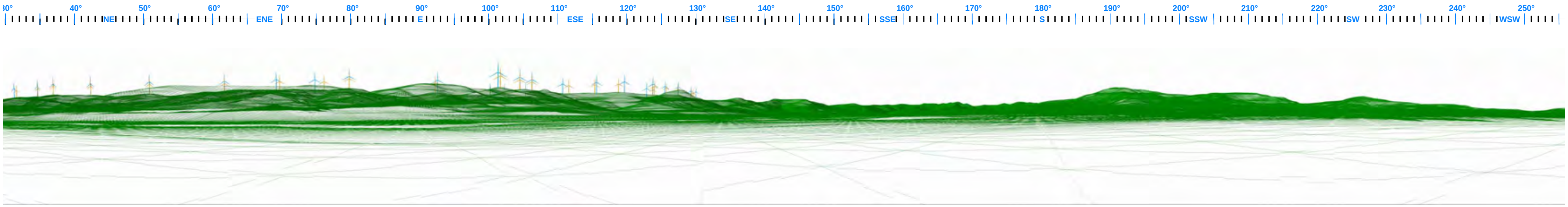
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

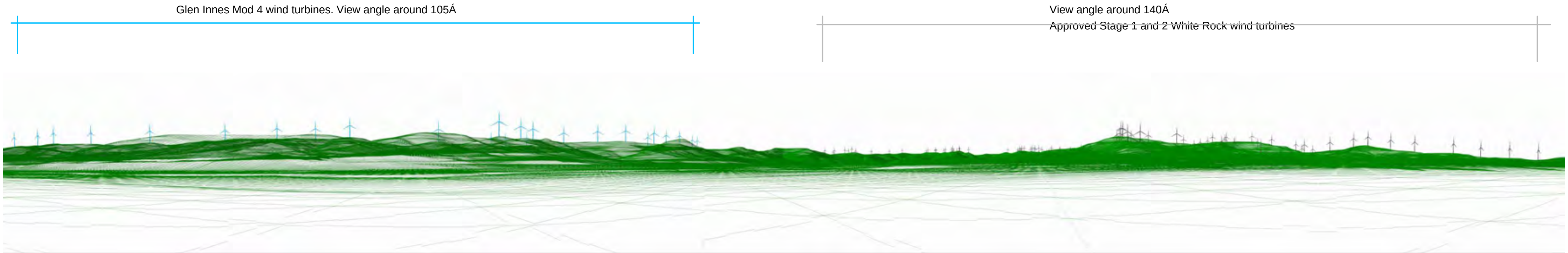
Figure 41 - Wireframe 35 Balaclava A

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Balaclava A: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.90 kilometres. Tips visible 25, Hubs visible 22
Distance to closest Glen Innes Mod 4 wind turbine 2.83 kilometres. Tips visible 25, Hubs visible 24



Balaclava A: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.83 kilometres. Tips visible 25, Hubs visible 24
Distance to closest White Rock wind turbine 2.95 kilometres. Tips visible 87, Hubs visible 78


Approved Glen Innes Mod 2 wind turbine

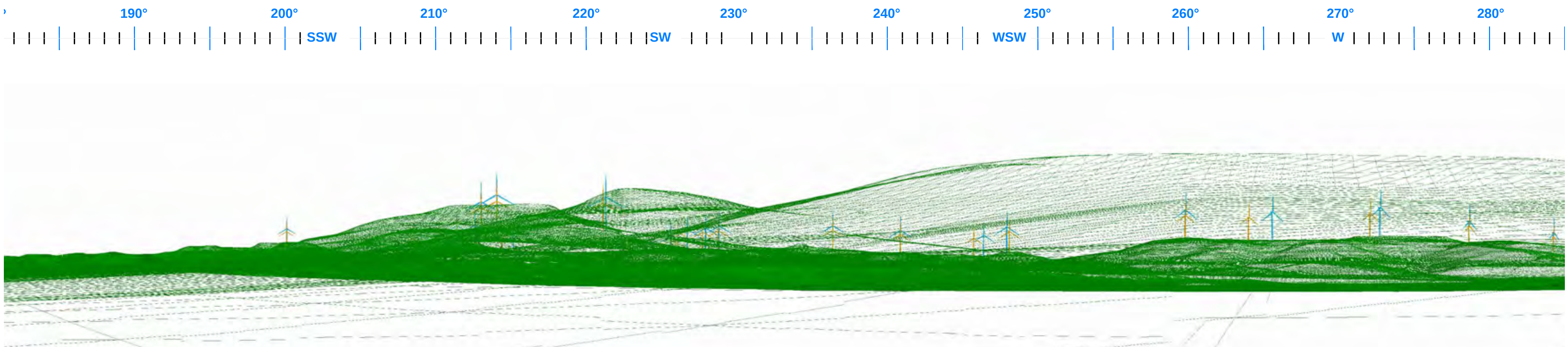

Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

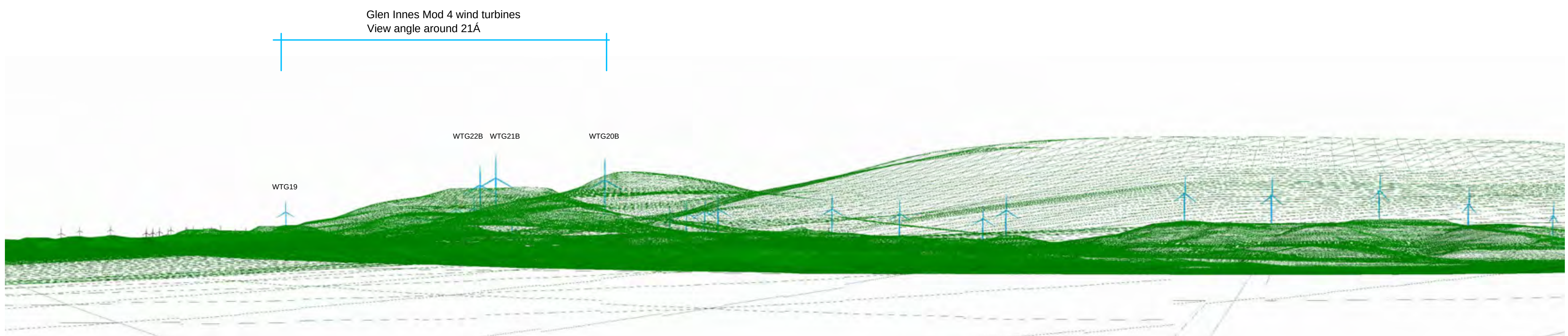
Figure 42 -
Wireframe 36 Balaclava A

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Glengarry: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.81 kilometres. Tips visible 4, Hubs visible 2
Distance to closest Glen Innes Mod 4 wind turbine 2.81 kilometres. Tips visible 4, Hubs visible 3



Glengarry: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

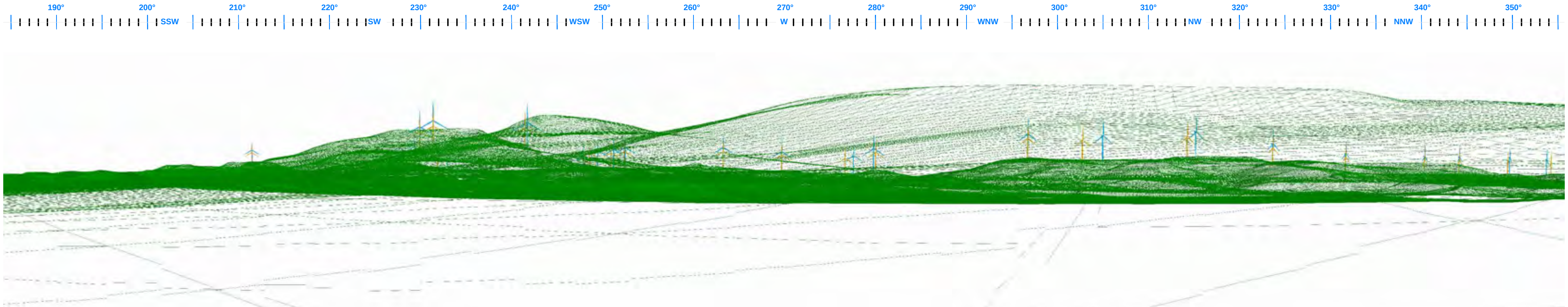
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

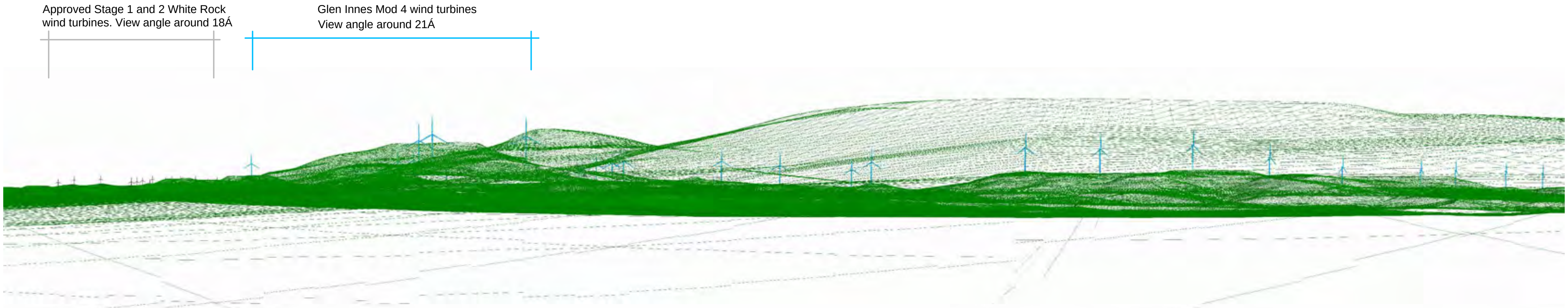
Figure 43 - Wireframe 37 Glengarry

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Glengarry: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 2.81 kilometres. Tips visible 4, Hubs visible 2
Distance to closest Glen Innes Mod 4 wind turbine 2.81 kilometres. Tips visible 4, Hubs visible 3



Glengarry: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 2.81 kilometres. Tips visible 4, Hubs visible 3
Distance to closest White Rock wind turbine 8.64 kilometres. Tips visible 18, Hubs visible 9


Approved Glen Innes
Mod 2 wind turbine


Glen Innes Mod 4
wind turbine


Approved Stage 1 and 2
White Rock wind turbine

Figure 44 -
Wireframe 38 Glengarry

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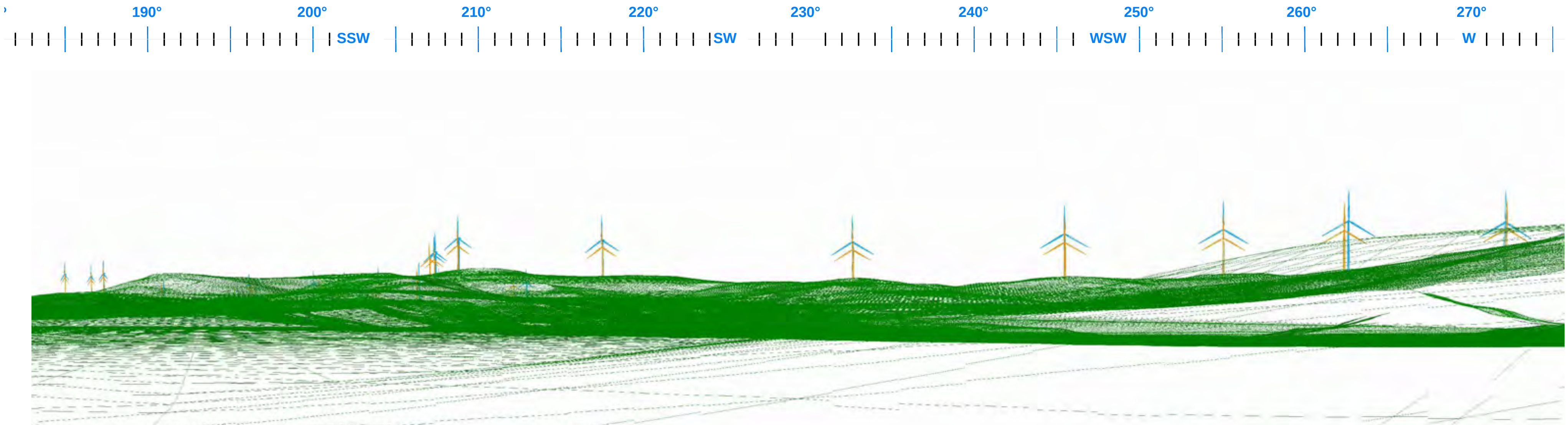
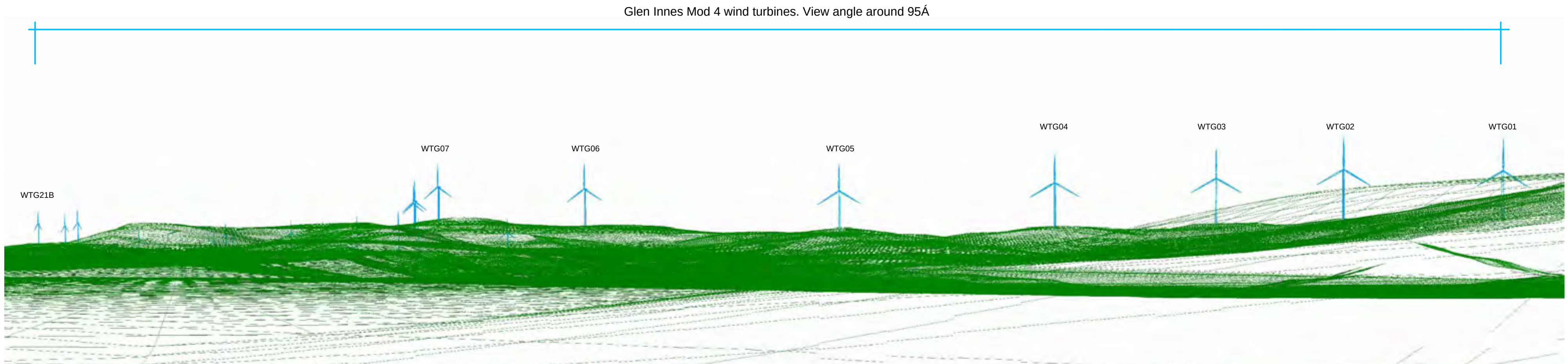
Glen Innes Wind Farm Modification 4



Girrahween: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 2.07 kilometres. Tips visible 14, Hubs visible 12
Distance to closest Glen Innes Mod 4 wind turbine 2.11 kilometres. Tips visible 22, Hubs visible 12



Girrahween: Glen Innes Mod 4 wind turbines
The wire frame modeling indicates that no White Rock wind turbines will be visible from the Girrahween residential view location.


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine

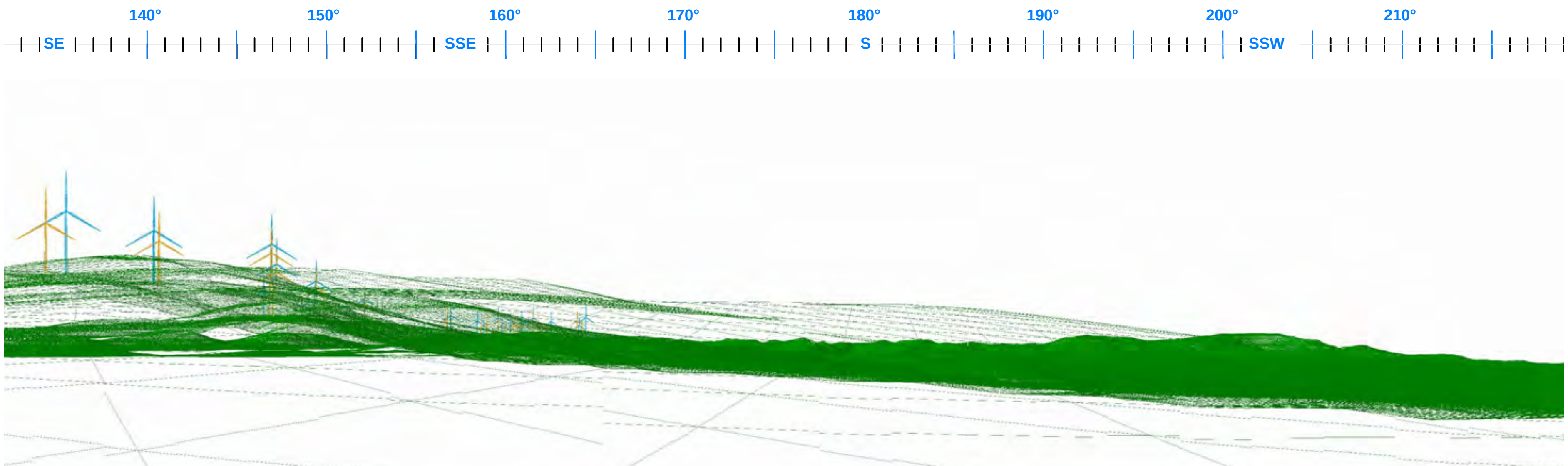
Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

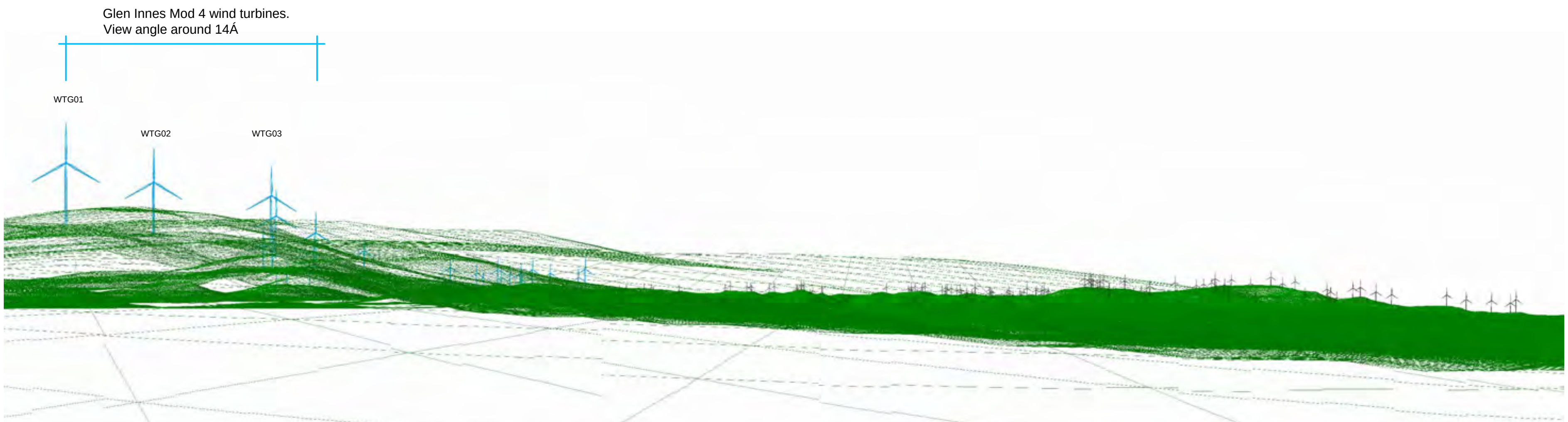
Figure 45 -
Wireframe 39 Girrahween

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Rivoli: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 1.85 kilometres. Tips visible 4, Hubs visible 3
Distance to closest Glen Innes Mod 4 wind turbine 1.83 kilometres. Tips visible 5, Hubs visible 4



Rivoli: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines


Approved Glen Innes Mod 2 wind turbine


Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 46 - Wireframe 40 Rivoli

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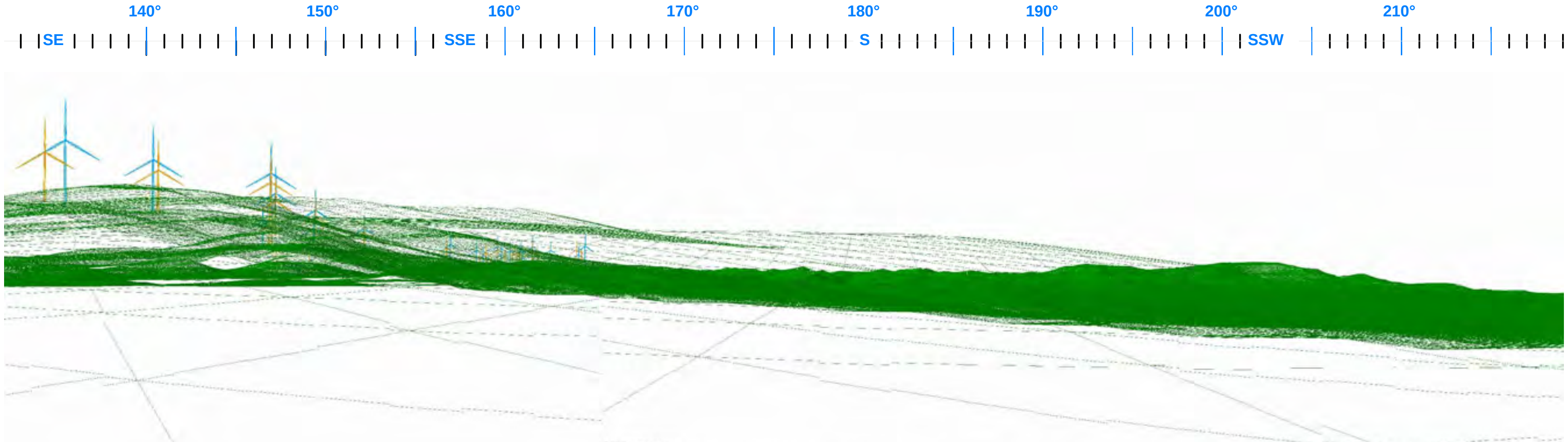
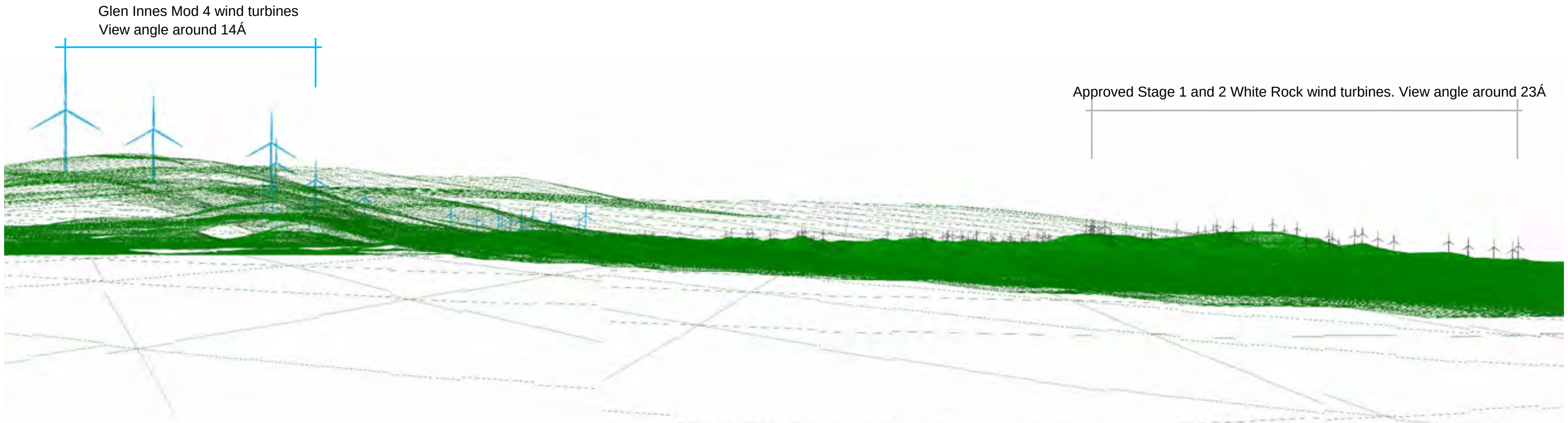
landscape architects

Glen Innes Wind Farm Modification 4



Rivoli: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines
Distance to closest approved Glen Innes Mod 2 wind turbine 1.85 kilometres. Tips visible 4, Hubs visible 3
Distance to closest Glen Innes Mod 4 wind turbine 1.83 kilometres. Tips visible 5, Hubs visible 4



Rivoli: Glen Innes Mod 4 and approved Stage 1 and 2 White Rock wind turbines
Distance to closest Glen Innes Mod 4 wind turbine 1.83 kilometres. Tips visible 5, Hubs visible 4
Distance to closest White Rock wind turbine 7.23 kilometres. Tips visible 29, Hubs visible 22


Approved Glen Innes Mod 2 wind turbine

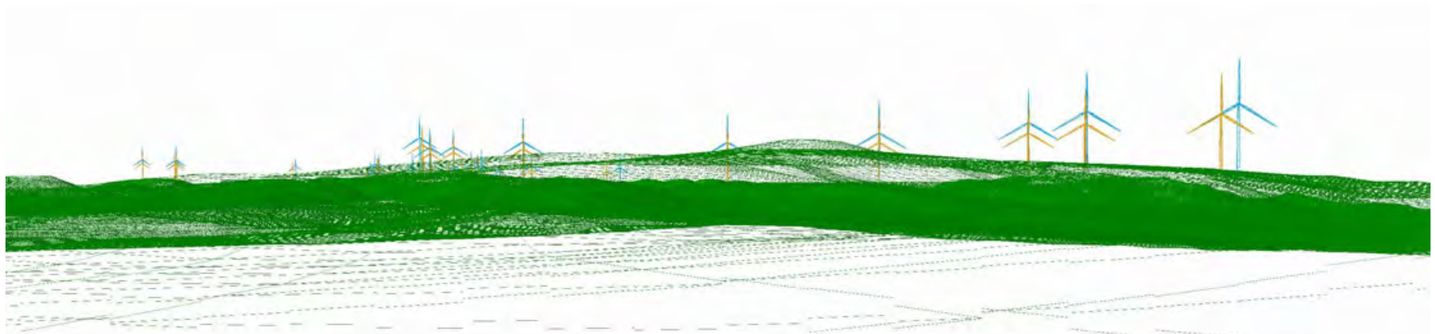

Glen Innes Mod 4 wind turbine


Approved Stage 1 and 2 White Rock wind turbine

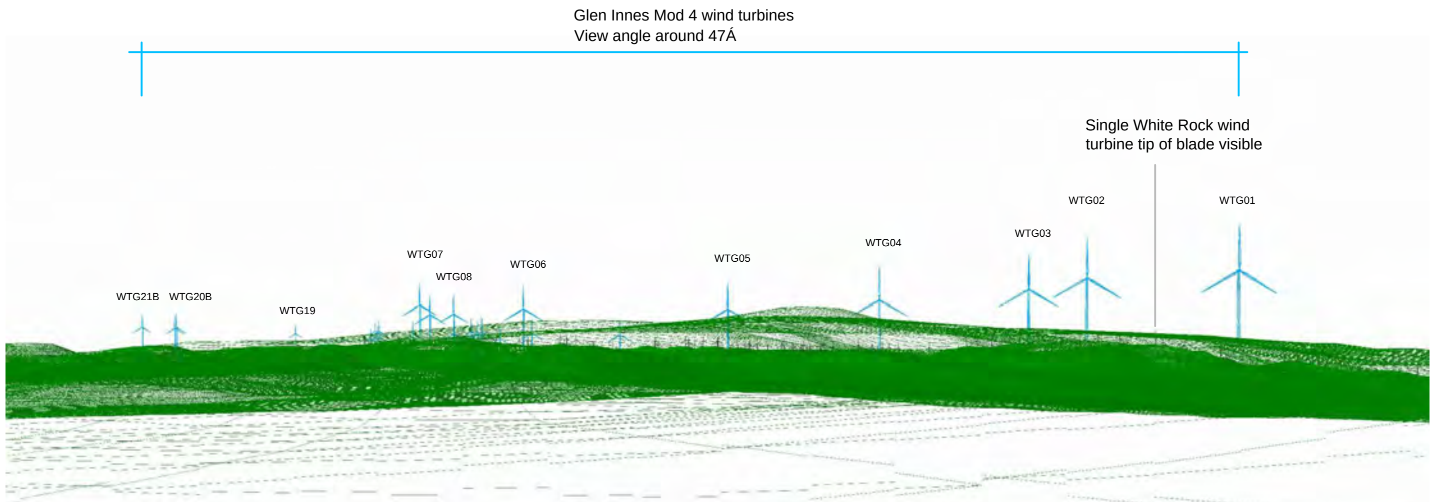
Figure 47 -
Wireframe 41 Rivoli

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4



Wattle Vale: Approved Mod 2 and proposed Mod 4 Glen Innes wind turbines.
Distance to closest approved Glen Innes Mod 2 wind turbine 1.90 kilometres. Tips visible 22, Hubs visible 15
Distance to closest Glen Innes Mod 4 wind turbine 1.94 kilometres. Tips visible 25, Hubs visible 18



Wattle Vale: Glen Innes Mod 4 wind turbines

Approved Glen Innes Mod 2 wind turbine

Glen Innes Mod 4 wind turbine

Notes:
Views toward wind turbines or portions of wind turbines below the green wireframe will be screened by landform.

The wireframe model does not account for existing tree cover and/or planting which may screen views toward the wind turbines.

Figure 48 -
Wireframe 42 Wattle Vale

GREEN BEAN DESIGN
landscape architects

Glen Innes Wind Farm Modification 4

9 Review of Conditions of Consent

9.1 Introduction

The GIWF consolidated Mod-2 and Mod-3 Conditions of Consent have been reviewed as part of this VIA to determine the type and extent of additional mitigation measures that would be required, or should be modified as a result of the proposed Mod-4 amendments.

9.2 Review of Conditions of Consent

The following Table outlines the existing Conditions relevant to mitigate the potential visual effects of the GIWF proposed Mod-4.

Table 8 Conditions of Consent

Condition	Description	Comment
Condition 2.1	Prior to the commencement of construction, the Proponent shall notify in writing the owner/s of non-associated residences within 4 kilometres of any wind turbine that they have the right to request implementation of visual impact mitigation measures at their residence if the wind turbines will be visible from the residence (including its curtilage). Note: If the construction of the development is being staged, the Proponent is only required to notify those owners that would be within 4 kilometres of any wind turbine that forms part of the relevant stage.	This condition remains valid.
Condition 2.1A	If following the commencement of construction, the Proponent receives a written request from the owner of any residence referred to in condition 2.1 above for the implementation of visual impact mitigation measures, then the Proponent shall implement measures such as landscaping treatments or vegetation screens at the residence (including its curtilage) in consultation with the landowner. These mitigation measures must be reasonable and feasible, directed towards reducing the visual impacts of the wind turbines on the residence (including its curtilage), and commensurate with the level of visual impact. The mitigation measures must be implemented within 12 months of receiving the written request, unless the Secretary agrees otherwise. If the Proponent and the owner cannot agree on the measures to be implemented, or there is a dispute about the	This condition remains valid.

Condition	Description	Comment
	implementation of these measures, then either party may refer the matter to the Secretary for resolution. Notes: • To avoid any doubt, the visual impact mitigation measures must be aimed at reducing the visibility of the wind turbines from the residence and its curtilage. Mitigation measures are not required to be implemented to reduce the visibility of wind turbines from other locations on the property. • In some cases, mitigation measures may not be warranted as the wind turbines would not be visible from the residence and its curtilage. • The identification of appropriate visual impact mitigation measures will be easier following the construction of the wind turbines. While landowners may ask for the implementation of visual impact mitigation measures shortly after the commencement of construction, they should consider the merits of delaying this request until the wind turbines are visible from their residence.	
Condition 2.2	Prior to the commencement of operation, the Proponent shall consult with Council and the RMS in relation to the need to provide landscaping screening measures along public road reserves including but not limited to the Gwydir Highway and shall report to the Secretary on the outcomes of this consultation. The Proponent shall implement landscaping screening measures in accordance with the Secretary's requirements.	This condition remains valid.
Conditions 2.3	Wind turbine generators shall be painted matt off-white/grey. The blades shall be finished with a surface treatment that minimises any potential for glare or reflection.	These conditions remain valid.
Condition 2.4	No advertising, signs or logos shall be mounted on the turbines, except where required for safety purposes. A corporate logo may be placed on the turbines provided it is not distinguishable by the naked eye from any publicly accessible location or from any, properties not associated with the project.	This condition remains valid.

Condition	Description	Comment
Condition 2.7	Prior to the commencement of construction, the Proponent shall in consultation with Council and/or the RMS, investigate the potential for a wind farm viewing site, interpretive signage and associated facilities to be installed and maintained in the locality. If required by Council and/or the RMS, the Proponent shall install a viewing site, signage and associated facilities. Responsibilities for maintenance of the viewing site shall be agreed to between the Proponent and Council and/or the RMS.	This condition remains valid.
Condition 6.5	As part of the Operational Environmental Management Plan required under condition 6.4, the Proponent shall prepare and implement the following management plans: **b) a Landscape Management Plan** to outline measures to ensure appropriate development and maintenance of landscaping on the site to address the visual impacts arising from the project including, turbines, site access roads, substation and control and facilities building, as far as is reasonable and feasible. The Plan shall be prepared by a qualified landscape architect and meet the requirements of Council.	This condition remains valid.
Condition 25	*"No external lighting other than low intensity security night lighting of infrastructure associated with the project, including wind turbine generators is permitted on site unless otherwise agreed or directed by the Secretary."*	It is requested that GIWF consent condition 25 be replaced with the following, or similar: *"With the exception of aviation hazard lighting implemented in accordance with the requirements of this condition, no external lighting other than low intensity security night lighting is permitted on site unless otherwise agreed or directed by the Secretary, or required by Civil Aviation Safety Authority.* *Prior to the commencement of construction, the Proponent shall consult with the Civil Aviation Safety Authority on the need for aviation hazard lighting in relation to the wind turbines. Any aviation hazard lighting shall be implemented in a manner that minimises visual*

Condition	Description	Comment
		intrusion to surrounding non-associated residences as far as reasonable and feasible."

10 Conclusion

A determination for potential increases to the visual effects associated with the approved GIWF Mod-2 has been based upon professional judgement in consideration of:

- the proposed Mod-4 amendments to the wind turbine layout
- the blade length (and tip height difference) between approved GIWF Mod-2 and proposed Mod-4 wind turbines
- the overall visibility and visual scale of the GIWF Mod-4 wind turbines and
- the GIWF Mod-4 magnitude of visual effect compared to the approved Mod-2 wind turbines.

This VIA has illustrated and compared the approved GIWF Mod-2 project against the proposed GIWF Mod-4 wind turbine design and layout. This VIA concludes that the proposed increase in wind turbine tip height would be discernible from some surrounding and proximate view locations where views toward the approved GIWF Mod-4 wind turbines exist. Additional levels of visibility would be limited to two or three wind turbine hubs and/or blade tips.

The GIWF Mod-4 wind turbine is not considered to be of a magnitude that would significantly increase visual effects and visual impact ratings associated with the approved GIWF Mod-2 development.

Appendix F

CCC Minutes

GLEN INNES COMMUNITY CONSULTATION COMMITTEE (GCCC)

Minutes of the Committee Members Meeting

Held Wednesday 26th April 2017

at the New England Club

West Avenue, Glen Innes at 6.00pm

Present: Dave Brown (Senior Dev Officer Glen Innes Wind Power.), Max Elphick (Chairman), Jane Newsome , Allan Fletcher (Project Landowners rep) Jim Ritchie and John Lynn.

Apologies: **G Putland.**

Previous Minutes: It was resolved on a motion of Allan Fletcher and Jane Newsome that the Minutes of the Meeting held on 14th Sept 2016 be adopted.

Business Arising: Nil

Correspondence: Nil

General Business

Progress Report from Dave Brown.

Dave advised that construction had started prior to the end of January with Geotech work being done.

A Principal Contractor (Senvion) has been appointed for the project. They are putting together a tender process for interested sub contractors.

Dave is preparing a submission to increase the height of the turbines. Office of Environment & Heritage (OEH) has recommended blade tips be 20 to 25 metres above ground level to provide safety for migrating birds. The original height was 10 metres above ground level. Consequently the towers will be raised to increase the height of the blades.

Dave pointed out that Saphire wind project towers will be a similar height. The blades to be 67 metres long and towers approximately 110 metres high.

Meeting requested Dave to ensure local contractors are given the opportunity to tender for work on the project.

It was moved on a motion of J Newsome and A Fletcher that the Committee support the increase in tower height. Motion Carried.

Community Enhancement Program;

Dave distributed a copy to all present . He advised that Council had endorsed the Program.

The program was approved on a motion moved J Ritchie, Sec J Newsome.

Fund guidelines on spending areas;
Meeting agreed to leave as is until Wind Farm is commissioned.

Site Visit;
Visit to site to be left until September when next CCC meeting to be held.

New Mod 4.
David to send out the new updated Mod 4 with the increase in Tower heights.

There being no further business the meeting closed at 6.55 pm.
Next meeting September.

Signed as a true record

Chairman

Appendix G

Acoustic Specialist Advice

sonus.

Nexif Energy
448 St Kilda Road
MELBOURNE VIC 3000

S4967C5

Attention: David Brown

23 November 2017

Dear David,

GLEN INNES WIND FARM
CUMULATIVE NOISE

Consideration has been given to the cumulative noise from the proposed Glen Innes Wind Farm and the White Rock Wind Farm.

The NSW "*Wind Energy: Noise Assessment Bulletin for State significant wind energy development*" adopts the methodology of the 2009 South Australian document "Wind farms – environmental noise guidelines" (SA 2009) for assessing wind farm noise. The SA 2009 Guidelines state that the noise criteria are set at a level which accounts for the potential cumulative effect from more than one wind farm. That is, the noise criteria apply to each wind farm, not from the combination of all wind farms. Therefore, an assessment of cumulative noise from more than one wind farm is not required in NSW.

Notwithstanding the above, the layout of the two windfarms and residences in the vicinity is such that the wind will not be blowing in the direction from both wind farms toward a residence at the same time. Therefore, it is unlikely that there will be a significant increase in noise associated with the two wind farms operating together.

Yours faithfully
Sonus Pty Ltd

Chris Turnbull
Principal

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ct@sonus.com.au