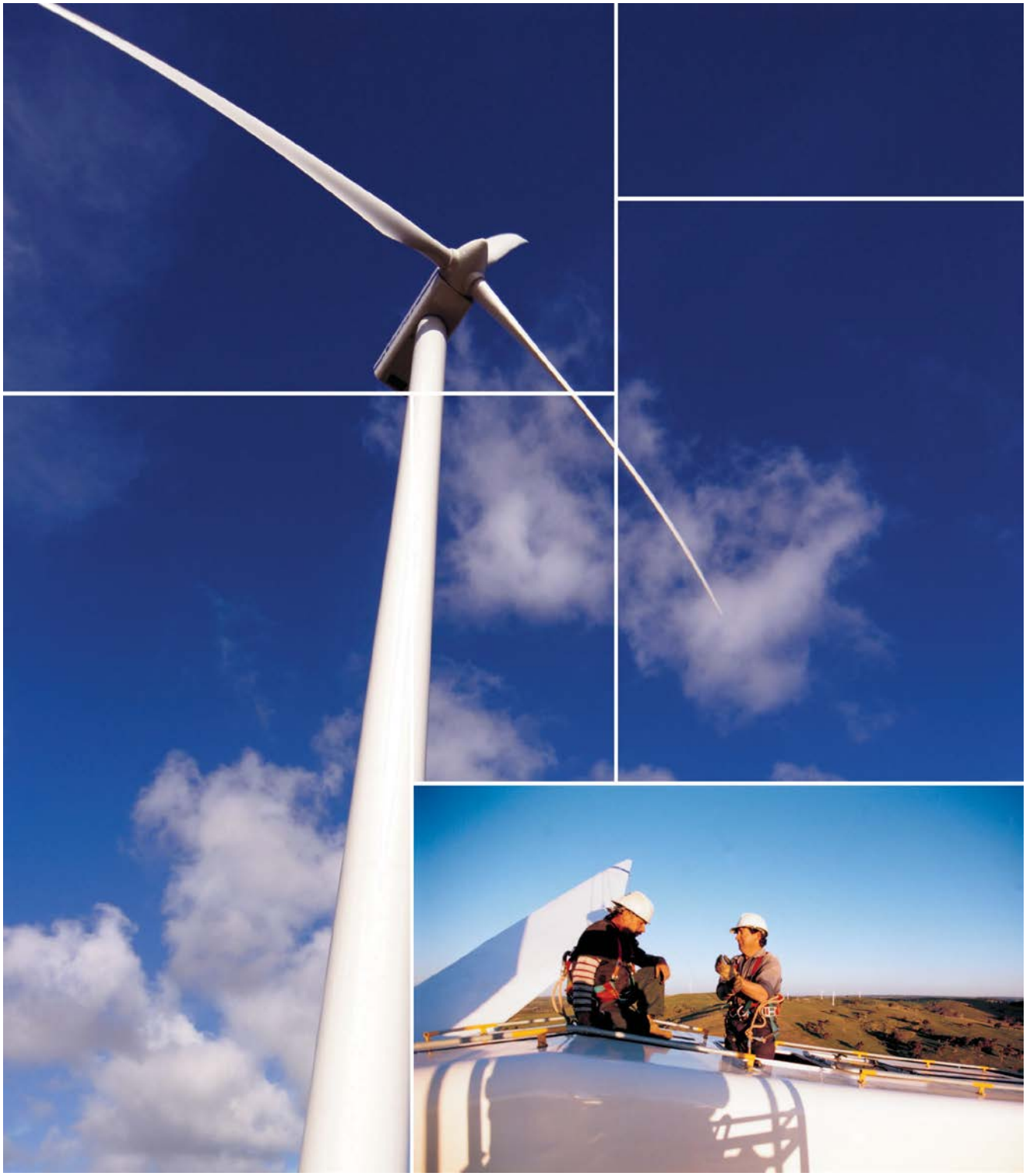
Appendix D
Visual Assessment



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Glen Innes Wind Farm DA Approval Modification

Visual Assessment Report

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Title	Environmental Scientist	Title	Technical Director

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1. Introduction

1.1 Overview of assessment

This Visual Impact Report provides an assessment of the proposed modifications to the Glen Innes Wind Farm project in the context of the existing development consent. It addresses the visual impact of the revised turbine layout and increased turbine size.

The key function of this assessment is to enable comparison with the assessment provided in relation to the approved project. Accordingly, this assessment revisits the description of the local landscapes provided in the original Environmental Assessment (EA), it considers the visual features of the proposed changes to the wind farm development and reviews the visual catchment of the proposed changes that would occur within the visual catchment of the Glen Innes Wind Farm.

The assessment includes simulated views of the wind farm with the micro-sited new turbines from representative and potentially impacted viewpoints and compares these with simulations presented in the 2008 Environmental Assessment and the additional simulations provided in the Submissions Report prepared in 2009.

1.2 Background

A CSIRO report exploring community acceptance of rural wind farms in Australia found landscape change and visual amenity were most often cited as reasons for rejecting wind farms. Although visual impact is one of the most important factors in community acceptance of wind farms, levels of concern amongst the public are highly subjective and can differ depending on location and local context (CSIRO 2012).

In 2009, the NSW Government granted planning approval for the construction of 26 wind turbines at Glen Innes Wind Farm running in a general north-south orientation on an elevated ridge of the Great Dividing Range referred to as Waterloo Range. Following a review of the project by the New south Wales Land and Environment Court (NSWLEC 2010), the project layout was amended to approve 25 wind turbines. The amended project was approved in August 2010.

Under the existing Conditions of Approval, Glen Innes Wind Farm Pty Ltd must comply with the following visual amenity requirements:

> ***Landscaping Requirements***
>
> ***2.1*** *The Proponent shall, at the request of any owners of residential dwellings with views of a turbine(s) located within 3 km of their dwellings, provide and bear the full cost of landscaping treatments to visually screen these dwellings. Such a request may be made in writing by the owner of the dwelling within 6 months from the commencement of operation of the project, and landscaping treatments (addressing, amongst other things, the species of the tree, the maturity of the trees and the spacing and location of the trees) agreed between the parties shall be implemented and completed within 12 months of such an agreement. Should the parties not be able to reach agreement on the scope of landscaping treatments, then either party may refer the matter to the Director-General for resolution. The Director-General's decision on such a referral shall be binding on the parties.*
>
> ***2.2*** *Prior to the commencement of operation, the Proponent shall consult with Council and the RTA in relation to the need to providing landscaping screening measures along public road reserves including but not limited to the Gwydir Highway and shall report to the Director-General*

on the outcomes of this consultation. The Proponent shall implement landscaping screening measures in accordance with the Director-General's requirements.

Turbine External Design

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.*

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 publically accessible location or from any, properties not associated with the project.*

Lighting

2.5 *No external lighting other than low intensity security lighting of infrastructure associated with the project, including wind turbine generators is permitted on site unless otherwise agreed or directed by the Director-General*

Shadow-flicker

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

Within 6 months of the commencement of the operation of the project (or such other period as agreed to by the Director-General), the proponent shall prepare a Shadow Flicker Report for the approval of the Director-General which assesses the impact of blade flicker at Cherry tree, being Lot 89 DP 753270 and Highfields, being Lot 2 DP 229974

Viewing Site

2.7 *Prior to the commencement of construction, the Proponent shall in consultation with Council and/or the RTA, 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 RTA, the Proponent shall install a viewing site, interpretive signage and associated facilities. Responsibilities for maintenance of the viewing site shall be agreed to between the Proponent and Council and/or the RTA.*

2. Wind farm visual characteristics

A wind turbine is comprised of several main components as described below.

- **Footing:** A reinforced concrete footing which may be tensioned and have rock anchors to bolt the footing to the underlying rock.
- **Tower:** A tapered cylindrical steel tower mounted on the footing.
- **Nacelle:** The household mounted on top of the tower that encloses a gearbox, generator, electric motors, brakes, electronic components, wiring and hydraulic and lubricating oil systems. The nacelle is typically constructed of steel and fibreglass and is able to rotate (yaw) to face toward the wind.
- **Blade:** Parts of a wind turbine that capture the energy of the wind. Each blade is attached to the hub and the blades can be rotated (pitched) to control the speed of the rotor and the power produced.
- **Blade Chord Length**: the length across the blade, in the direction of the wind flow.
- **Rotor:** the assembly of the blades and hub, which is mounted on the front of the nacelle and turned by the wind.

The overall height (tip) of the turbine is equal to the hub height plus half the rotor diameter and is measured from the ground level at the turbine.

A wind turbine is comprised of several main components as described below. A schematic illustration of the proposed wind turbine proportions is shown in Figure 1.

A schematic illustration of the proposed wind turbine proportions is shown in Figure 1.

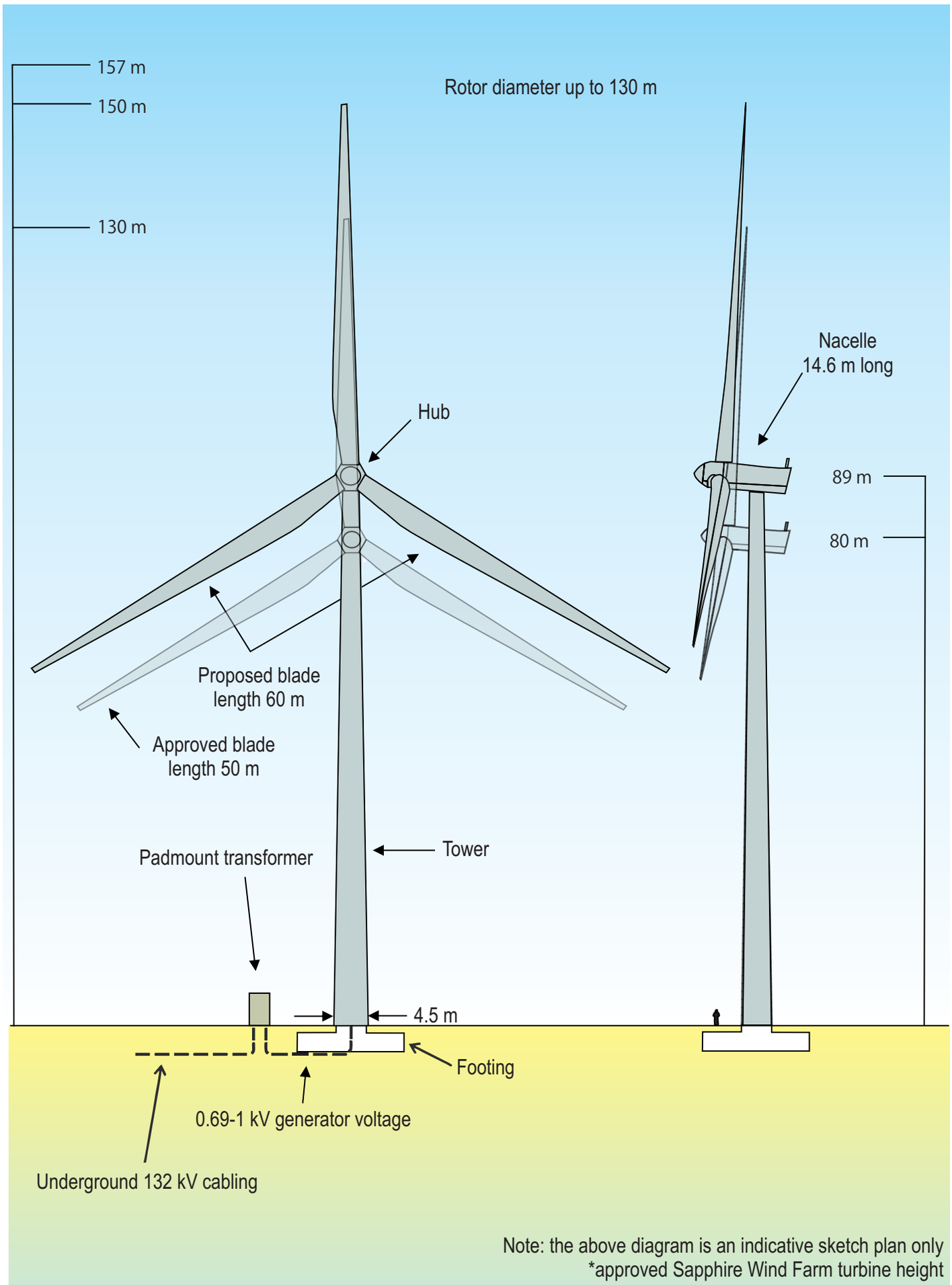

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Figure 1: Wind Turbine Generator Schematic Diagram

The general location and extent of the wind farm and the associated landscape features of the proposed modification remain unchanged. The dimensions of the Alstom ECO122 turbine model have been selected as being representative of the new higher efficiency turbines for inclusion in the overall approval envelope. Accordingly its specifications have been used to assess the visual impacts resulting from this proposed modification application.

Table 1 provides a comparison of the general specifications of ECO122 turbine model with the proposed turbine model that was approved:

Table 1 – General Wind Farm specifications

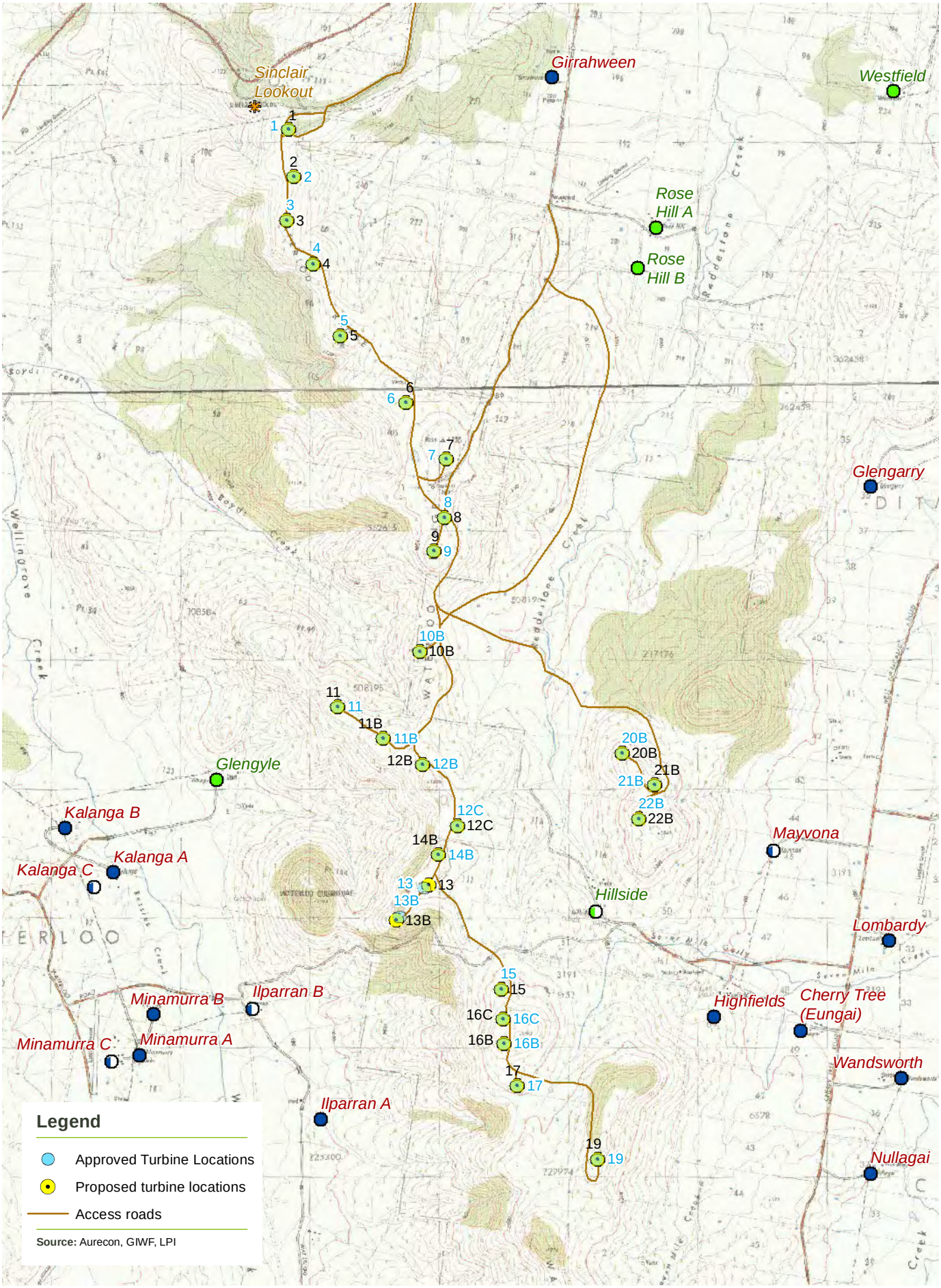
Component	Approved Wind Farm	Proposed Modification
Number of Turbines	25	25
Hub Height	80 m	89 m
Rotor diameter	50 m	59.3 m
Maximum blade tip height	130 m	150 m
Maximum blade cord length	Not specified	3.95 m
Rotor diameter	100 m	122 m
Rated rotor speed	18 rpm	12.25 rpm

This presents an increase in the turbine hub height of 9 m (11%), a blade diameter increase of 22 m (22%) and a subsequent maximum blade tip height increase of 20 m (15%). The proposed modification retains the same number of turbines and the locations for most turbines remain (see Table 2). T13 and T13B have been micro-sited to the north east and south west of the approved turbine locations.

Table 2 – Wind Turbine Layout Comparisons

Approved (August 2010)			Proposed			Difference	
Label	Eastings	Northings	Label	Eastings	Northings	Distance (m)	Bearing
1	364943	6710288	1	364943	6710288	0	
2	364981	6709924	2	364981	6709924	0	
3	364926	6709583	3	364926	6709583	0	
4	365131	6709251	4	365131	6709251	0	
5	365343	6708692	5	365343	6708692	0	
6	365850	6708179	6	365850	6708179	0	
7	366162	6707735	7	366162	6707735	0	
8	366146	6707285	8	366146	6707285	0	
9	366063	6707025	9	366063	6707025	0	
10B	365955	6706247	10B	365955	6706247	0	
11	365319	6705820	11	365319	6705820	0	
11B	365675	6705575	11B	365675	6705575	0	
12B	365980	6705375	12B	365980	6705375	0	
12C	366250	6704900	12C	366250	6704900	0	
13	365988	6704420	13	366026	6704440	43	NE
13B	365804	6704198	13B	365775	6704165	44	SW
14B	366100	6704675	14B	366100	6704675	0	
15	366585	6703630	15	366585	6703630	0	
16B	366608	6703210	16B	366608	6703210	0	
16C	366601	6703405	16C	366601	6703405	0	
17	366712	6702887	17	366712	6702887	0	
19	367335	6702318	19	367335	6702318	0	
20B	367524	6705460	20B	367524	6705460	0	
22B	367651	6704952	22B	367651	6704952	0	
21B	367774	6705217	21B	367774	6705217	0	

Figure 2 provides a visual comparison between the turbine layouts of the proposed modification with what was approved in August 2010.



Glen Innes Wind Farm **Visual Impact Assessment**

Projection: GDA 1994 MGA Zone 56

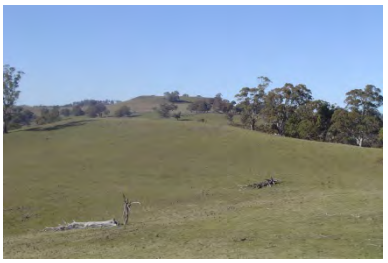
FIGURE 2: Turbine Layout Comparison

2.1 Landscape analysis

As described in the 2008 EA, the landscape elements within the wind farm site comprise various combinations of cleared pastoral land with scattered areas of remnant woodland with different amounts of slope and relief. Built features such as buildings, roads, fences and power lines are scattered through the landscape at a low density.

The representative photomontages included in Plates 1 – 20 enable individuals to gain their own appreciation of the landscape elements and to compare the visual impact of the proposed modification layout relative to the approved project included in the 2008 Environmental Assessment and 2009 Submissions Report.

The main landscape elements present at the landscape locality shown in Table 3 below have been taken from the 2008 Environmental Assessment.

Landscape element	Main features present in the landscape	Representative view
Pastoral scene on Waterloo Range	Elevated above surrounding rural lands. Extensively cleared but with large areas of remnant woodland mainly on the steeper slopes that flank the more gently sloping pastoral lands.	
Pastoral scene within West Furracabad Valley	Flat rural grassland between moderate size hills. Extensive clearing is evident. Scattered rural residential development is spread through the valley at a low density. Cultural features include roads, fencing, power lines and sheds	
Pastoral scene in Reddestone Creek Valley	Flat narrow valley, mostly cleared, some willows along creekline and a low density of rural residences. The heavily cleared lowland contrasts with the wooded slopes that flank Waterloo Range and nearby hills.	
Rural scene Wellingrove Valley viewed from Waterloo Range	Narrow valley with slopes to the east and the west rising some 200 to 300 m above the valley. The valley floor has been extensively cleared. Significant areas of remnant woodland occur on slopes. Scattered rural residences are present mainly on the lowland areas and roads, fences and buildings are evident.	

Landscape element	Main features present in the landscape	Representative view
Wellingrove Valley view toward Waterloo Range	View of Waterloo Range above rural lands in Wellingrove Valley. Gwydir Highway in foreground. Remnant woodland evident on slopes in contrast to heavily cleared area of valley floor. Poplar trees are evident in places along the Highway. There is a low level of rural residential development in this landscape.	
Rural settlement (West Furracabad Valley shown)	The western part of Furracabad Valley includes isolated residences but in some places two or more may be in close proximity. Establishment of trees around residences is common in rural areas that are at times subject to strong winds. Extensive clearing is a feature of the valley.	
Hilly range to the south west of the wind farm	A significant elevated topographic feature occurs to the south of the wind farm. It is characterized by steeper slopes and lesser development in terms of clearing and rural residences than for the valley floor. The density of rural settlement is low within Wellingrove Valley but clearing has been extensive.	
Furracabad grassland with elevated land to the south	This view from Mayvona shows the cleared grassland in the southern Furracabad Valley with the Lombardy residence in mid distance and the elevated ranges to the south between the wind farm and Ben Lomond localities. The view is from close to the wind farm but away from it.	
Residence in rural setting	This view is from Hillside Road toward Highfields residence situated amongst the trees. The former residence is visible at the right of the photo. T18 is located on the hill behind the Highfields residence.	

Landscape element	Main features present in the landscape	Representative view
Urban area in rural setting	The view from Martins Lookout to the east of Glen Innes includes the urban areas in the foreground, Furracabad Valley in the mid distance and Waterloo Range in the background. Within Glen Innes itself views of the surrounding landscape are screened by built structures and trees	

3. Visual Impact Assessment

3.1 Visibility assessment

The visibility of the wind farm project was reviewed against the following assessment criteria:

- The distance from the wind farm (for the nearest wind turbine)
- The spatial extent of the visible turbines (referred to here as the wind farm view angle)
- The number of turbines visible.

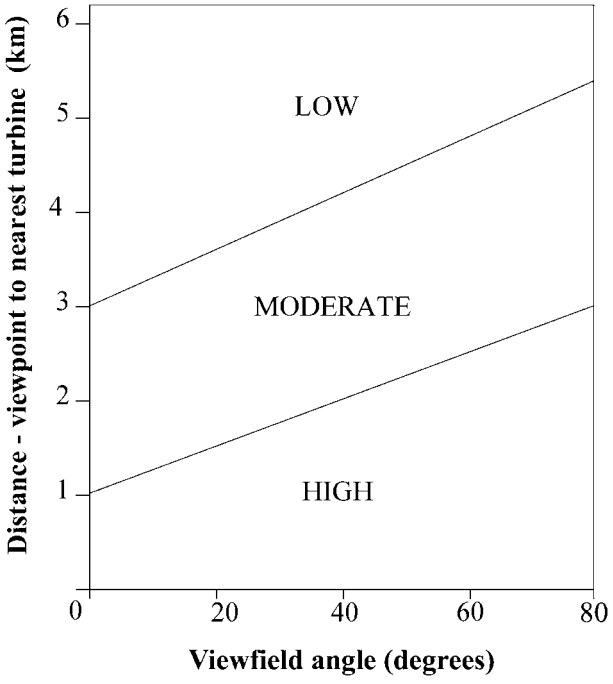
Consistent with the original assessment, the following descriptors (Aurecon 2008) were adopted.

High Visibility: Scenes having high visibility include viewpoints within 1 km and viewpoints up to 3 km depending on the wind farm view field angle

Low Visibility: Low visibility is assigned to all viewpoints beyond 5 km and viewpoints between 3 and 5 km depending on the wind farm view field angle. It should be noted, however, that low visibility does not necessarily correspond to low visual impact.

Moderate Visibility: This classification was applied to viewpoints intermediate between the low and high classes

While the above classification scheme is somewhat arbitrary, it was used to rank visibility for the respective viewpoints and enable comparison between them. It was previously stressed that visibility rankings do not represent the visual impact which, as indicated in Section 2.5, is subject to a range of other considerations. Similarly, the visibility ranking does not indicate whether the visibility is adverse or favourable.



The viewfield angle can be described as the angle subtended by the wind farm at the observer's location. This angle varies for different waypoints and is influenced by the distance from the wind farm, the number of turbines, the layout and its orientation relative to the viewer and the effect of intervening topography. In some cases, only part of the wind farm will be visible. The angle between the left hand and right hand edge of the view field of the wind farm defines the affected portion of the viewpoint. A person normally sees about 100° at any point and can easily see a much broader field by scanning from side to side.

As noted in the 2008 EA (Aurecon 2008), the angle subtended by the wind farm is, in part, dependent on distance. That is, as the distance from the wind farm increases, the view field angle for the same width of wind farm will decrease. Beyond about 3 km, there is only a small decrease in the view angle as distance increases.

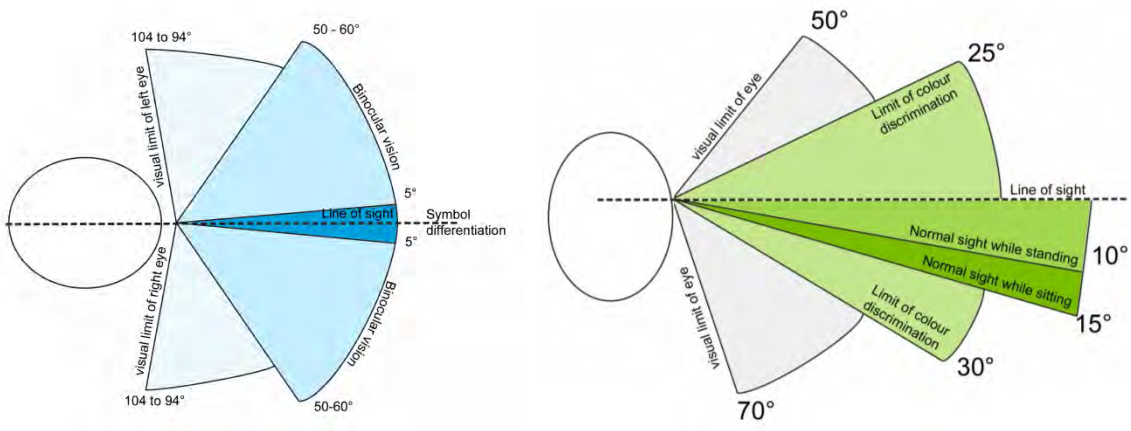


Figure 3 – Horizontal (Left) and Vertical (Right) human line of sight

As the turbine locations for the approved project and proposed modification are identical except for two turbines which have been micro-sited, the horizontal view angles of the wind farm will remain relatively unchanged and this impact assessment will focus on changes to the vertical angle of view.

3.2 Visual Catchment of the wind farm

The Visual Catchment of the wind farm identifies the areas surrounding the project area from which the development may be partially or completely visible. This area is determined through the use of digital topographic information processed through a Geographical Information System (GIS).

The effect of screening by trees or built structures was not included in the computation of the visual catchment as data was not available for the relevant heights. Accordingly, the computed visual catchment will overestimate the extent of the wind farm's visual catchment and represents a theoretical worst case scenario. This applies equally to the original assessment which is used to compare the relative changes of this proposal.

The extent of visibility for the new turbine specifications has been determined and illustrated in Figure 2 and has been compared with the visual catchment of the approved turbine locations and dimensions.

Due to the north-south alignment of the Waterloo Range, viewpoints located west and east of the Waterloo Range Ridgeline and viewpoints at a greater distance from the wind farm development will generally be able to see more wind turbines. However, as the view distance increases, the scale and therefore the visual impact of wind turbines decreases. The original EA considered that the visibility

and differentiation of the scale of turbines at distances beyond 10 km from Glen Innes Wind Farm beyond is minor and unnoticeable.

It should be noted that the layout for the approved wind farm is different to the wind farm layout assessed in the EA, and some of the distances are different to those quoted in the original document.

The visibility and scale of the approved and proposed wind farm development for locations within 3 km of the nearest turbine are compared in Table 3. Coordinates for residential dwellings can be found in Appendix A. A total of 29 viewpoints consisting of 27 residential dwellings, one church and one lookout have been assessed.

The table below provides more detail on parameters used in Table 3 which are used to determine the potential visual impact of the turbines.

Parameter	Description
No. tips visible[1]	For the purposes of calculating the number of tips visible from an individual viewpoint, it is always assumed that all rotors have a blade in a vertical position, regardless of how they may be portrayed in the photomontages. Visibility checks are determined every 10 m and it has been assumed that tips are visible, except those screened by topography. Coverage provided by existing vegetation or screening provided by intervening structures such as sheds and water tanks are disregarded.
No. hubs visible[1]	Number of turbine hubs visible from an individual viewpoint. Visibility checks are determined every 10 m and it has been assumed that all hubs are visible except those screened by topography. Coverage provided by existing vegetation or screening provided by intervening structures such as sheds and water tanks are disregarded.
Distance to nearest turbine (m)	Straight-line distance to the turbine for the viewpoint location.
Vertical subtended angle	The angle between the topmost and bottommost visible section of the proposed development (all turbines) for the viewpoint location and indicates the vertical portion of view taken up by the proposed turbines.
Horizontal subtended angle	The angle between the viewer and the leftmost and rightmost sections of the proposed development (all turbines) for the viewpoint location and indicates the horizontal portion of view taken up by the proposed turbines.
Visibility Rating	Based upon the distance between the proposed development and a viewpoint location. This is quantified by the vertical subtended angle and horizontal subtended angles.

Smaller subtended angles have a higher potential for screening of turbines to occur via existing structures such as residences, sheds and vegetation. As this visibility assessment compares the potential impact of the proposed modification against the approved development at the same locations, it has been assumed that the potential for visual screening of the development from existing buildings and vegetation are identical for both scenarios.

[1] GIS or Windfarmer software are the tools are used to calculate the no of tips and hubs which may be visible.

Table 3 – Residences within 3 km of the nearest turbine

	Approved						Changes With newer type turbines (Difference in brackets)					
View point name	No. tips visible	No. hubs visible	Distance to nearest turbine (m)	Vertical subtended angle	Horizontal subtended angle	Visibility Rating	No. tips visible	No. hubs visible	Distance to nearest turbine (m)	Vertical subtended angle	Horizontal subtended angle	Visibility Rating
Furracabad Station	9	5	2,981	4.11	25	M	12 (+3)	6 (+1)	2,981	4.49	25	M
Klossie	8	4	2,135	5.68	32	M	10 (+2)	4 (0)	2,135	6.21	32	M
Green House	7	4	1,899	6.17	32	M	8 (+1)	5 (+1)	1,899	6.77	32	M
Green Valley (Oakes)	17	14	2,514	6.24	56	M	18 (+1)	16 (+2)	2,514	6.67	56	M
Nullagai	1	1	2,115	1.99	3	M	3 (+2)	1 (0)	2,115	2.93	20	M
Ilparran A	12	11	1,536	9.58	96	H	14 (+2)	11 (0)	1,536	10.28	96	H
Wandsworth	16	13	2,428	5.41	69	M	16 (0)	13 (0)	2,428	5.87	69	M
Minamurra C	23	22	2,497	6.02	91	H	25 (+2)	22 (0)	2,457 (-2%)	6.5	91	H
Minamurra A	23	20	2,288	6.65	94	H	23 (0)	21 (+1)	2,247 (-2%)	7.18	94	H
Cherry Tree (Eungai)	15	12	1,852	6.84	92	H	15 (0)	13 (+1)	1,852	7.44	92	H
Highfields	17	14	1,419	8.86	127	H	17 (0)	15 (+1)	1,419	9.64	127	H
Minamurra B	21	18	2,052	7.48	99	H	21 (0)	20 (+2)	2,013 (-2%)	8.09	99	H
Ilparran B	10	8	1,350	8.49	98	H	10 (0)	8 (0)	1,308	9.58	98	H
Lombardy	15	11	2,157	4.97	84	H	15 (0)	12 (+1)	2,157	5.5	84	H
Kalanga C	25	19	2,349	6.19	104	H	25 (0)	21 (+2)	2,349	6.65	104	H
Kalanga A	24	19	2,161	6.7	107	H	25 (+1)	19 (0)	2,161	7.19	107	H
Mayvona	8	8	1,051	11.31	93	H	8 (0)	8 (0)	1,051	12.32	93	H
Kalanga B	25	20	2,311	6.05	104	H	25 (0)	21 (+1)	2,311	6.53	104	H
Balaclava A	24	22	2,905	3.86	98	M	25 (+1)	22 (0)	2,905	4.24	98	M
Glengarry	4	2	2,817	3.5	21	M	4 (0)	2 (0)	2,817	3.9	21	M
Girrahween	13	11	2,073	4.99	87	H	15 (+2)	12 (+1)	2,073	5.54	87	H
Rivoli	4	3	1,850	3.73	13	M	4 (0)	3 (0)	1,850	4.4	15	M
Wattle Vale	22	14	1,902	4.26	49	H	22 (0)	16 (+2)	1,902	4.86	49	H
Average				**6.05**	**72.78**					**6.64**	**73.61**	

As shown in Table 3, the turbine layouts for the approved project and proposed modification are almost identical, with the horizontal subtended angle for 27 of the 29 viewpoints remaining unchanged, while the number of turbine blade tips, turbine hubs and the vertical field of view the wind farm has increased marginally at some locations. These marginal increases are shown in red parenthesis in Table 3.

The biggest increase in the number of turbines visible for a non-associated landowner will occur at Furracabad Station, located 2,980 m south-east of T19. Three additional blade tips and one turbine hub will be visible. However, due to the separation distance between the station and the additional visible turbines, it is not anticipated that any significant loss of visual amenity will occur as a result of increasing turbine size.

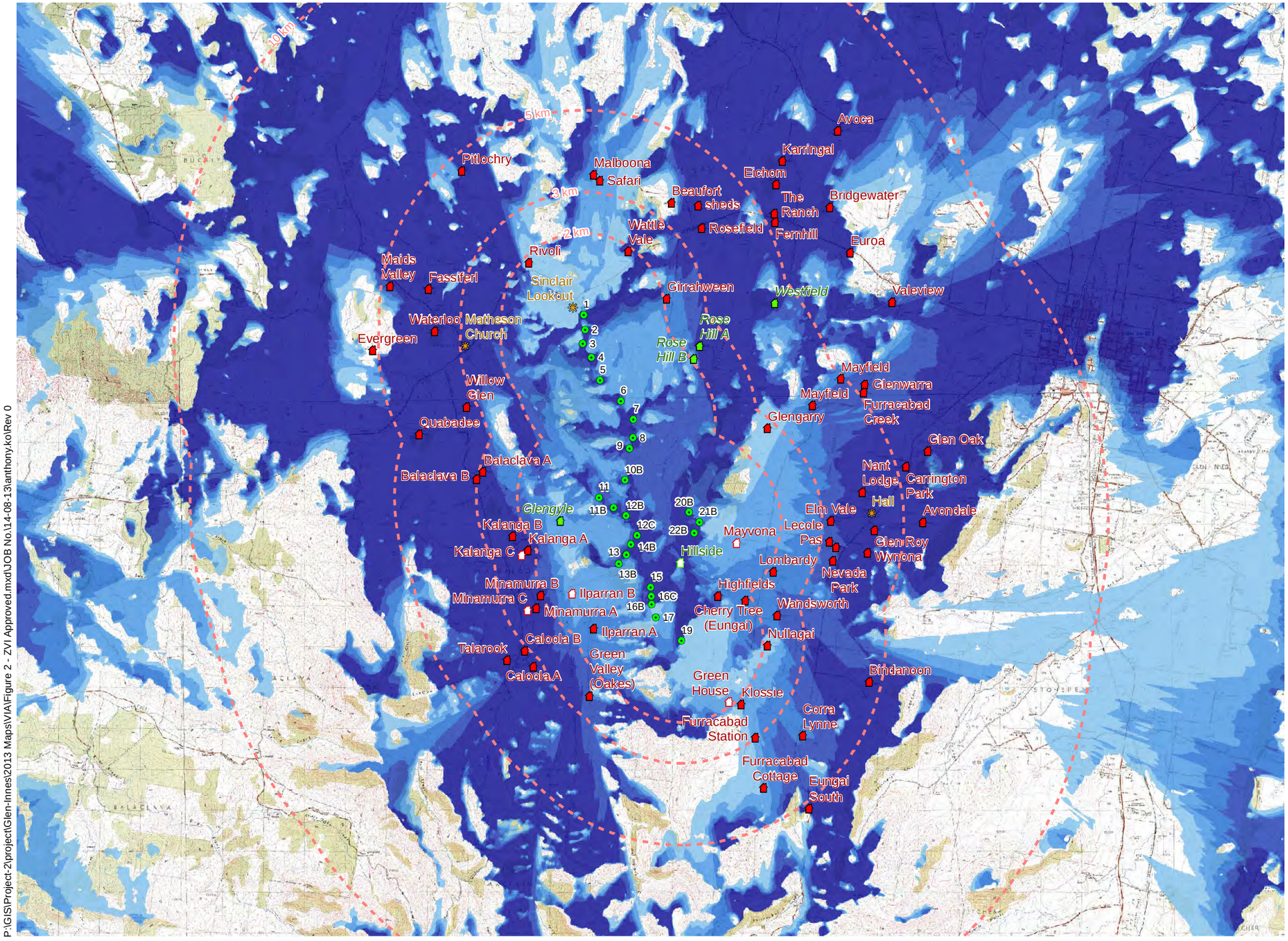
On average, the vertical subtended view angle for all non-associated residences within 3 km of the wind farm development will increase an additional 0.60°. The largest increases in vertical subtended view angle at a non-associated landowner occur at the Mayvona and Ilparran B dwellings with an increase of 1.01° and 1.09° respectively. Two photomontages (Plates 13-16) have been compiled to assist stakeholders with visualising the increase in scale that would be experienced from Mayvona.

3.2.1 Night Lighting

From the information provided in the Aviation Impact Assessment Report, it is anticipated that no aviation navigation lights will be required, since the proposed maximum blade tip height of the turbine model selected for the wind farm is below navigable air space of 500 feet.

Security lighting throughout the wind farm and substation will be kept to a practical minimal level to decrease the visual impact of the development with the night time landscape of the area. Motion sensing lights should be used for night time security lighting when required, and only during operational or emergency maintenance situations.

Therefore, night lighting requirements for the proposed modification will remain unchanged.



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Legend

- Approved Turbine Layout

Viewpoints

- community facility/lookout
- surrounding residence
- vacant surrounding residence
- vacant windfarmer residence
- windfarmer residence

Blade tips visible

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

Source: Aurecon, LPI, NP

1:100,000

0 2,000 4,000 m

Projection: GDA 1994 MGA Zone 56

Glen Innes Wind Farm **Visual Impact Assessment**

FIGURE 4: Zone of Visual Influence (Approved)

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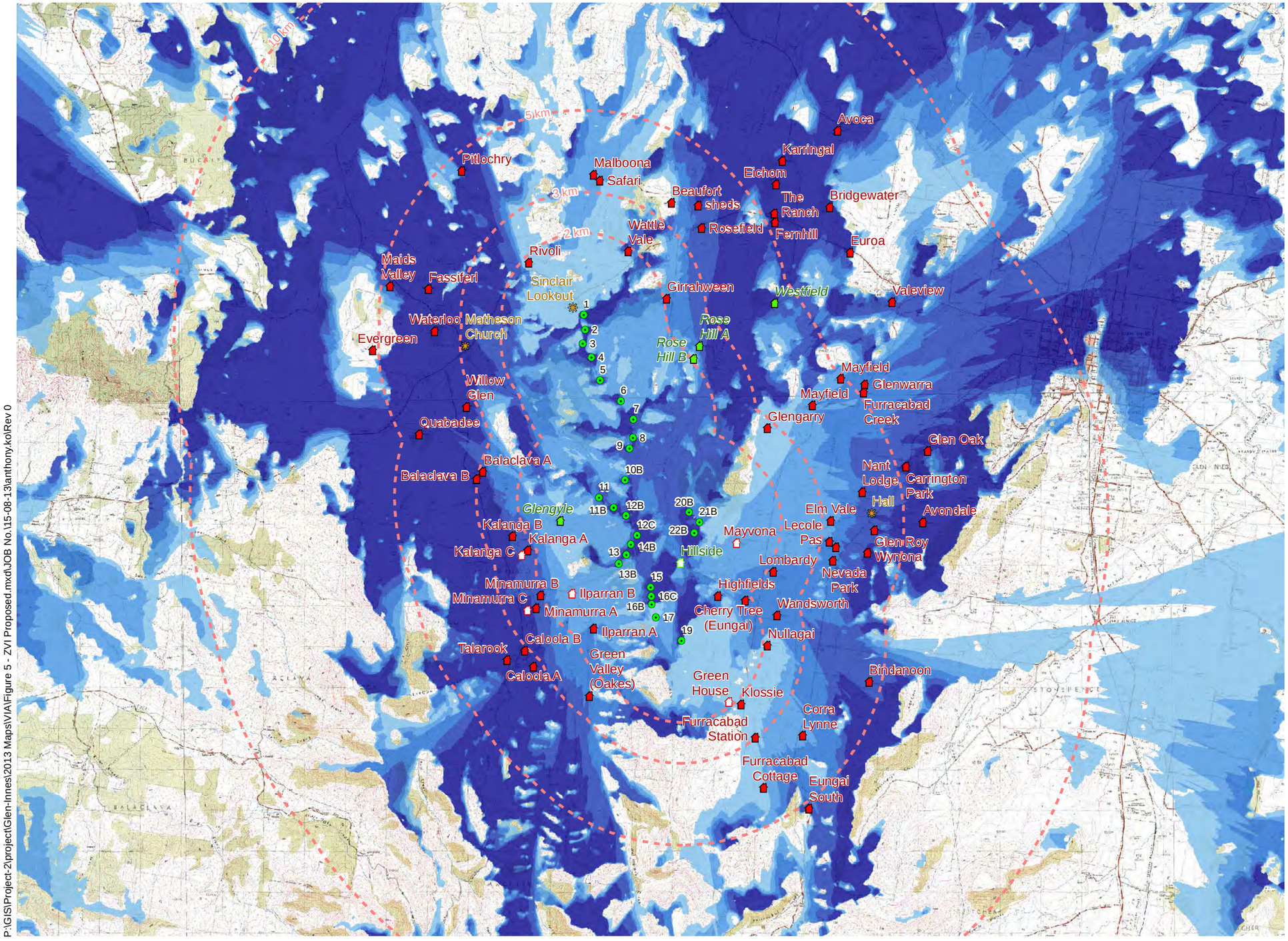

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Legend

Approved Turbine Layout

Viewpoints

- community facility/lookout
- surrounding residence
- vacant surrounding residence
- vacant windfarmer residence
- windfarmer residence

Approved Aug10_hub

Value

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

Source: Aurecon, LPI, NP

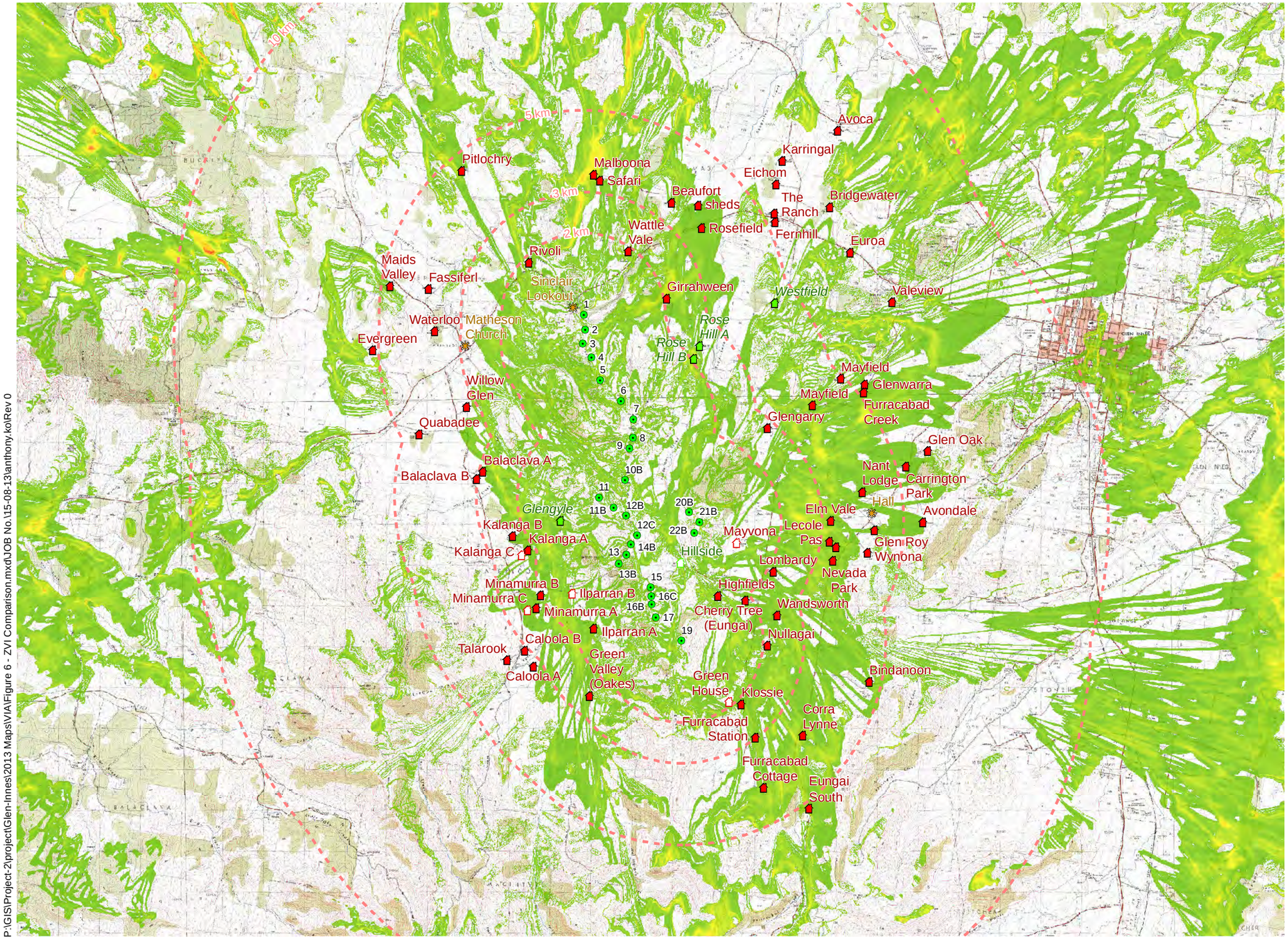
1:100,000

0 2,000 4,000m

Projection: GDA 1994 MGA Zone 56

Glen Innes Wind Farm **Visual Impact Assessment**

FIGURE 5: Zone of Visual Influence (Proposed)



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Legend

- Approved Turbine Layout

Viewpoints

- community facility/lookout
- surrounding residence
- vacant surrounding residence
- vacant windfarmer residence
- windfarmer residence

Additional Visible Blade Tips

-2, -1, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

Source: Aurecon, LPI, NP

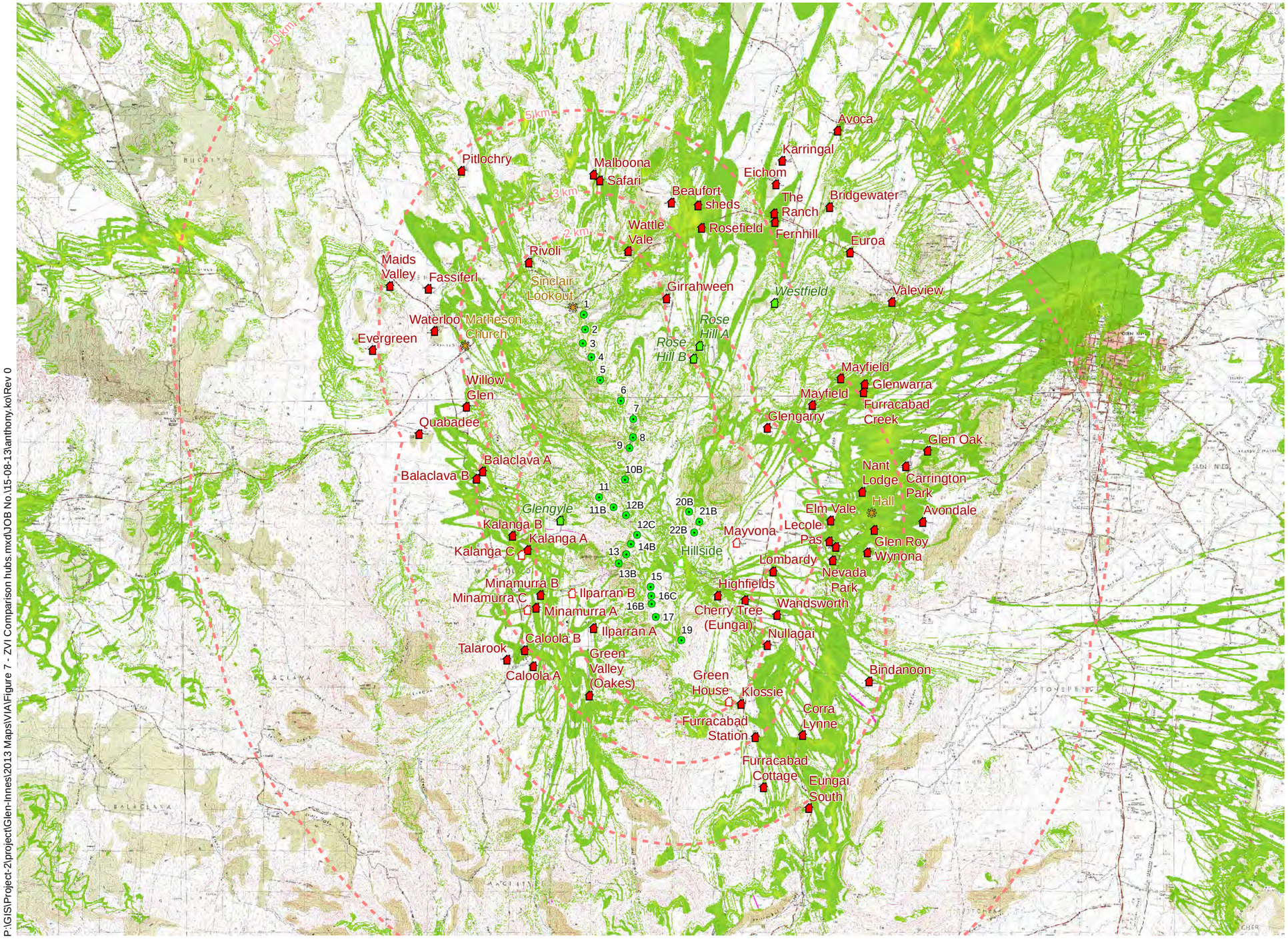
1:100,000

0 2,000 4,000m

Projection: GDA 1994 MGA Zone 56

Glen Innes Wind Farm **Visual Impact Assessment**

FIGURE 6: Zone of Visual Influence Comparison (Visible Blade Tips)



P:\GIS\Project-2\project\Glen-Innes\2013 Maps\VIA\Figure 7 - ZVI Comparison hubs.mxd\JOB No.\15-08-13\anthony.kol\Rev 0

Legend

- Approved Turbine Layout

Viewpoints

- community facility/lookout
- surrounding residence
- vacant surrounding residence
- vacant windfarmer residence
- windfarmer residence

Additional Visible Hubs

-2, -1, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Source: Aurecon, LPI, NP

1:100,000

0 2,000 4,000m

Projection: GDA 1994 MGA Zone 56

Glen Innes Wind Farm **Visual Impact Assessment**

FIGURE 7: Zone of Visual Influence Comparison (Visible Hubs)

3.3 Visual impact assessment sites

Viewpoints have been carefully selected to be representative of the range of views from the surrounding locality. Ten representative viewpoints were used to prepare photomontages for this assessment with the objective of providing comparative material for the proposed form of the wind farm and that described in the 2008 Environmental Assessment and 2009 Submissions Report for which consent was granted. Figure 8 shows the locations of the viewpoints.

The viewpoints comprise two viewpoint locations from the 2008 Environmental Assessment simulating views of the wind farm development from a public location and four viewpoints taken from neighbouring residence as requested by the Department of Planning in its letter on the 18 March 2009.. The selected viewpoints are summarised below:

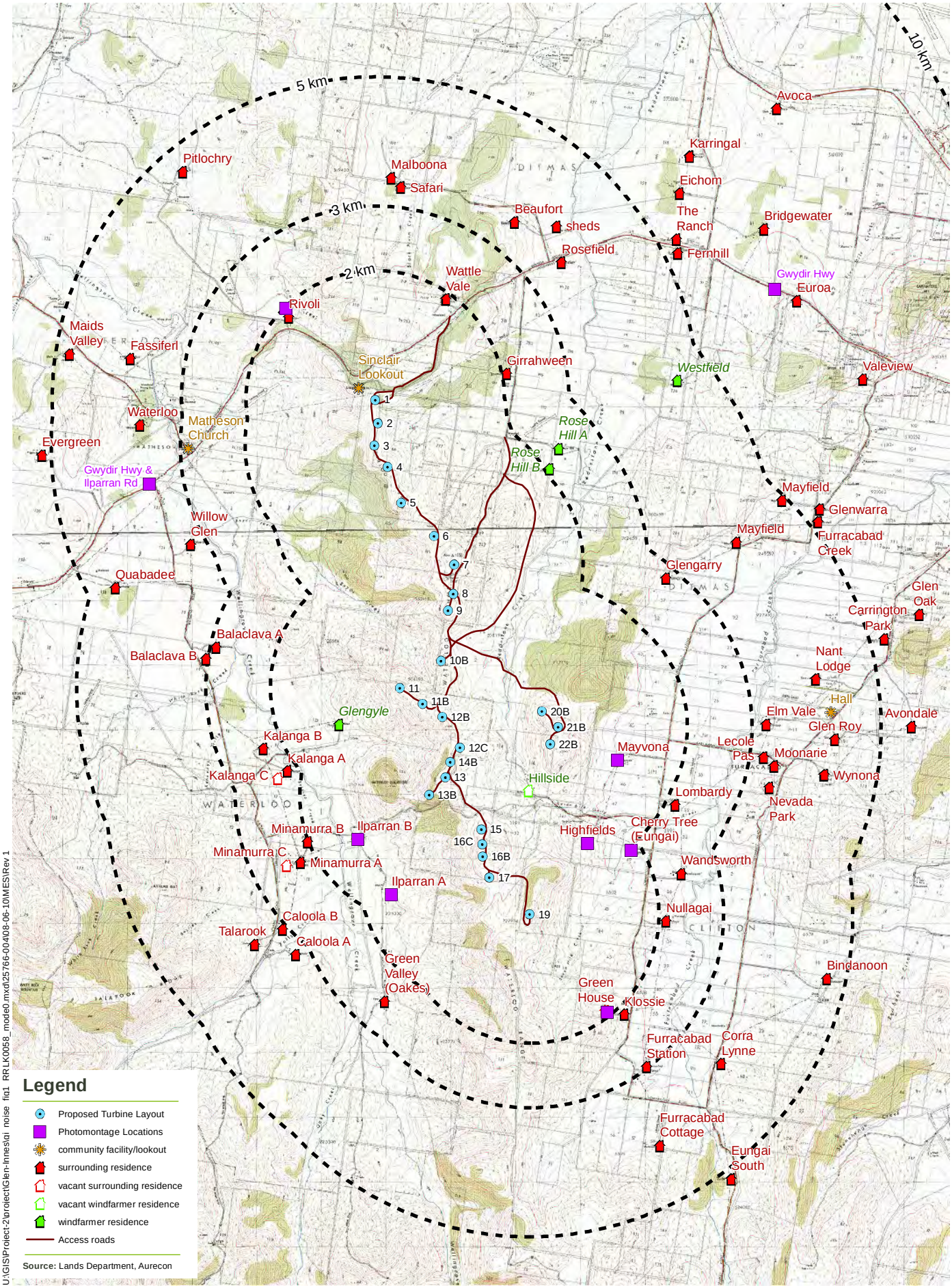
- Gwydir Highway and Ilparran Road Intersection (approximately 3.7 km west of T3)
- Gwydir Highway (approximately 6.4 km east north east of T1)
- Cherry Tree (2,304 m east of T16C)
- Highfields (1,634 m east of T16C)
- Ilparran A (1,544 m west of T17)
- Mayvona (1,070 m east of 22B)

The locations of viewpoints from the residences were previously guided by property owner preference at the time of the previous assessment and two photomontages were prepared at each location.

The same photographs used in the previous environmental assessment have been used to prepare photomontages for the proposed development. These will provide local stakeholders with realistic representations of the appearance and scale of the proposed modifications in comparison with the approved project. Production of photomontages for selected viewpoints

The orientation of each wind turbine will vary with the wind direction at the turbine site and, for most of the time; the turbines are likely to be facing the prevailing wind directions. The views of the wind turbines will look different, depending on the orientation of the turbine relative to the viewpoint. To maximise the visual impact of the turbines in the individual photomontages the turbines have been shown generally facing the viewpoint.

Three additional photomontages were prepared for the modification and are further detailed in Section 3.4



Legend

- Proposed Turbine Layout
- Photomontage Locations
- community facility/lookout
- surrounding residence
- vacant surrounding residence
- vacant windfarmer residence
- windfarmer residence
- Access roads

Source: Lands Department, Aurecon

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Projection: MGA

Glen Innes Wind Farm **Visual Impact Assessment**

FIGURE 8: Photomontage Locations

3.3.1 Cherry Tree

The Cherry Tree residence is approximately 1,852 m from the nearest turbine (Turbine 19) and is situated at an elevation of 1,100 m on the floor of the Furracabad Valley. It will have direct views of the southern turbines, 19, 22B, 21B and 20B. Photographic material was obtained from the following locations in 2009:

- Cherry Tree – view from top of steps from veranda to yard near north east corner of the house (Plates 1-2). It is noted that:
  - Existing vegetation provides partial screening for T20B and T20C
  - Existing transmission line provides some visual absorption for the turbines
  - Visual scale of turbines is comparable to the simulation provided in the 2009 submissions report.
- Cherry Tree – view from southern entrance to house view to south west (Plates 3-4). It is noted that:
  - Existing vegetation on the ridgeline will provide partial screening for several turbines;
  - Existing transmission line will provide minor visual absorption for T16B and T16C;
  - Increasing turbine dimensions will be marginally noticeable from this viewpoint

3.3.2 Highfields

The Highfields residence is the closest occupied non wind farmer residence to the approved wind farm at 1,419 m north east of the nearest turbine (T19). The homestead has an elevated north eastern facing away from the wind farm site. Photographs were obtained from the following locations in 2009:

- Highfields – view from the eastern corner of the yard – view to north west (Plate 5-6). It is noted that:
  - From the yard, existing trees provide screening from the wind farm development. The turbine hug and blade tip of T12C is visible and the turbine blade of T22B is also visible.
  - Existing vegetation provides complete and partial screening for all turbines and the increase in turbine dimensions is not easily discernible.
- Highfields – north western corner of residence – view spanning south west to north (Plate 7-8). It is noted that:
  - Existing trees provide screening from T19, with the hub for turbine T12C visible.
  - The visual impact of the proposed modifications does not appear to cause a significant decrease in visual amenity of the viewpoint when compared with the approved development.

3.3.3 Ilparran A

Ilparran A is situated to the south west of the wind farm development. Photographs were obtained from the following locations in 2009:

- Ilparran A – View from outside gate at driveway entrance to yard (Plate 7). It is noted that:
  - From this viewpoint, turbines 15, 16B, 16C and 17 are wholly or partially visible depending on where the viewer stands, with trees in the yard providing some screening

- Ilparran A – View from kitchen window (Plate 8). It is noted that:
  - T15 is located 1,720 m from this viewpoint and an increase in blade tip height of 20 m will result in an additional 0.66° of occupied vertical viewfield.
  - The hub and blades of T15 are visible from this location, with trees in the yard providing significant screening from the remaining turbines and along with the gate, provide some visual absorption capacity form this viewpoint.

3.3.4 Mayvona

The Mayvona residence is a dilapidated vacant residence situated to the east of the southern turbine group. It is situated in the Furracabad valley and with the land falling away slightly to the east. Photographs were obtained from the following locations in 2009:

- Mayvona – view from a location on the southern side of house and 5 to 10 m from the house (Plate 9). It is noted that:
  - Existing vegetation along the ridgeline and on the property provides partial coverage of the wind turbine array.
  - Wind turbines while prominent in the visual landscape are not dominant.
- Mayvona – view from a location on the western side of the house and within 5 m of the house (Plate 10). It is noted that:
  - A large mature tree provides significant visual screening at this location from T20B, T21B and T22B.
  - Existing vegetation on the ridge line produces partial screening of turbines.

3.3.5 Gwydir Highway & Ilparran Road Intersection

Situated on the Gwydir Highway & Ilparran Road intersection approximately 3.6 km west of the nearest turbine, this photomontage was identified as Viewpoint 3 in the 2008 Environmental Assessment. All turbines are either wholly or partially visible from this location.

- View of Turbines 1 to 7 (Plates 17-18). It is noted that:
  - Turbines are visually prominent on the ridgeline of Waterloo Range with vegetation providing little to no screening of the turbine;
  - Due to the distance between the viewpoint and the turbines, the increase in turbine height ranges from partially to unnoticeable.
- View of remaining turbines from north to south (Plates 19-20). It is noted that:
  - Existing vegetation provides partial screening for some turbines;
  - Due to the distance between viewpoint and the turbines, the increase in turbine height is barely noticeable for some turbines, while the change in height towards the southern extent of the wind farm is not discernible.

3.3.6 Gwydir Highway

Situated on the Gwydir Highway approximately 6.3 km east north east of the wind farm development, this photomontage was identified as Viewpoint 6 in the 2008 Environmental Assessment.

- View of turbines from south to north (Plates 21-22). It is noted that:
  - Due to the distance between the viewpoint and the turbines, the increase in turbine height is not discernible at this location;
  - Existing vegetation provides screening from some turbines at this location.

3.4 Additional Photomontages

Photomontages for three residential dwellings located within 2 km of a wind turbine were prepared as part of this Visual Assessment in December 2013. Landowners at a fourth location (Wattle Vale) also located within 2 km of a wind turbine was approached but declined the offer for photomontages to be taken from their property.

The additional viewpoints prepared for the modification assessment include:

- Rivoli (1,982 m north west of T1);
- Ilparran B (1,300 m south west of T13B);
- Green House (1,933 m south east of T19).

Photographs were taken from the viewpoints using a Nikon D90 DSLR with a 35 mm fixed lens which was mounted on a tripod with a Manfrotto 303 Pan Head. Photomontages were generated using WindFarmer 4.2.18.0 and Adobe Photoshop CS5.

The orientation of each wind turbine will vary with the wind direction at the turbine site and, for most of the time; the turbines are likely to be facing the prevailing wind directions. The views of the wind turbines will look different, depending on the orientation of the turbine relative to the viewpoint. To maximise the visual impact of the turbines in the individual photomontages the turbines have been shown generally facing the viewpoint.

3.4.1 Green House

The Green House property consists of an A-Frame building situated on a hill surrounded by remnant bushland vegetation. The A-Frame building is currently unoccupied and in a dilapidated state. Photographs were obtained from the following locations in December 2013:

- Second floor balcony overlooking the wind farm development to the north west (Plates 23-24). It is noted that:
  - The close proximity of mature native trees provides screening of the wind farm development from this viewpoint.
  - Due to the north –south orientation of the A-Frame, the wind turbines would not be visible from other sections of the building as there are no windows on the east/west face of the building.
  - The proposed increase in turbine size would not be significantly noticeable at this viewpoint.

- Access track approximately 75 m north of the A-Frame (Plates 25-26). It is noted that:
  - The existing ridgeline on which T19 is located provides partial screening of T15, T16 and T17.
  - Existing vegetation at this location would provide screening from T20B to T22B which are located over 4,000 m away.
  - The visual impact of the proposed modifications does not appear to cause a significant decrease in visual amenity of the viewpoint when compared with the approved development.

3.4.2 Rivoli

The Rivoli residence is situated on agricultural land with natural bushland vegetation north west of the wind farm development. The dwelling includes a southward facing veranda and home office which overlook the wind farm. Photographs were obtained from the following locations in December 2013:

- Rivoli – View of the wind farm from the veranda (Plates 27-28). It is noted that:
  - Fly screens and window frames around the enclosed section of the veranda would cause potential parallax errors with the photomontage; therefore the viewpoint was located in the uncovered area of the veranda.
  - Mature trees on the property and trees growing along the Gwydir Highway provides significant screening of the wind farm development.
- Rivoli – View of the wind farm from outside the home office window (Plates 29-30). It is noted that:
  - The existing tree in the front yard provides partial screening of T1 from this viewpoint.
  - Existing trees growing along the Gwydir Highway provide partial screening of T2 and provides complete screening of T3 and T4.
  - The visual impact of the proposed modifications does not appear to cause a significant decrease in visual amenity of the viewpoint when compared with the approved development.

3.4.3 Ilparran B

There are two residences on the Ilparran property. Ilparran B is currently vacant and is located on land which has been cleared for agricultural use, with remnant vegetation present on site. Photographs were obtained from the following locations in December 2013:

- View to the east from outside the living room window (Plates 31-32). It is noted that:
  - Existing vegetation on the ridgeline and the ridgeline itself provides partial or complete screening of T12C, T13 and T14B. T13B is the nearest turbine and is completely visible.
  - Existing trees adjacent to the property provides complete screening of T15-T19 at this location.

- Views to the south east from the fenced corner of the residential property (Plates 33-34). It is noted that:
  - An existing tree provides screening of T12C, T13, T13B, T14B and T15 from this viewpoint.
  - Partial screening of T16C provided by existing vegetation.
  - Existing vegetation on the ridgeline would provide partial screening of T16B and T17, while T19 is not visible.

3.5 Visual issues associated with ancillary works

As noted in the assessment, the visual impacts of most of the ancillary works will be significantly less than that of the wind turbines because they are low level aspects of the development and mostly will not be visible from public roads in the area around the site. It is not anticipated that the location of ancillary works would change.

4. Shadow Flicker and Blade Glint

4.1 Introduction

Shadow flicker is the fluctuation of light levels that can appear to flicker to an observer at a fixed ground location or by movement of an observer relative to stationary shadows. The effect will occur under circumstances where the wind turbine location and orientation is such that at certain times of the day, the sun's rays pass behind the swept area of the rotating blades and affect the viewpoint.

A shadow flicker study was completed in the 2008 Environmental Assessment based upon Turbine Layout Revision 31 August 2007. The turbine details on which the assessment was based upon had the following characteristics:

- A turbine rotation speed varying up to about 18 rpm and a three bladed turbine;
- An 80 m hub height; and
- A rotor diameter of 100 m (130 m maximum blade tip height)

Glen Innes Wind Farm Pty Ltd has since made minor revisions to the wind turbine layout and have chosen the Alstom ECO122 turbine model which has the following specifications:

- Maximum blade tip height of up to 150 m
- Tower height of 89 m
- Blade length of 59.3 m
- Maximum blade cord length of 3.95 m
- Rotor diameter of 122 m
- Rated rotor speed of 12.25 rpm.

4.2 Assessment Criteria

4.2.1 Draft National Wind Farm Development Guidelines

Since the completion of the previous shadow flicker study in 2008, the Environment Protection and Heritage Council of Australia have released *National Wind Farm Development Guidelines DRAFT – July 2010.* These Guidelines contain a recommended shadow flicker limit for the worst-case (theoretical) duration which is to be calculated by a prescribed method. This limit is 30 hours/year (Table E-1 Recommended exposure limits) and the guideline states in Section E.4.3 that the method of assessment is to include:

- Determination of the extent of shadows up to a distance of 265 x maximum blade chord (no assessment is required for residences beyond this distance);
- The assumption the turbine rotor is orientated towards the sun at all times;
- Provision of a map of receptor locations and reporting of the highest level of annual shadow flicker within 50 m of the centre of a dwelling reported.

Based upon the *Draft National Guidelines*, the 30 hours/year shadow flicker duration limit is applicable to dwellings located within 1047 m of the nearest wind turbine generator.

The rate of flicker for a three-bladed horizontal axis wind turbine is three times the rotational speed of the wind turbine rotor. For example, the Alstom ECO122 turbine has a rated rotor speed of 12.25 revolutions per minute (rpm) results in a flicker frequency of less than 1 Hz (once per second). According to the EPHC Draft National Guidelines (Section E2.2 p 149) such rates of flicker is considered well below the ranges identified for potential health effects associated with flicker frequency that may trigger epileptic seizures. Seizures are generally triggered by flashing lights between the frequencies of 5 to 30 flashes per second (Hz). It is also noted that the rated rpm for the Alstom ECO 122 is significantly slower than the turbine model that was approved.

4.2.2 NSW Planning Guidelines: Wind Farms (Draft for Consultation December 2011)

The NSW Department of Planning & Infrastructure released the Draft NSW Planning Guidelines: Wind Farms for public comment in December 2011. The draft guidelines have been prepared to provide a regulatory framework to guide investment in wind farms across NSW, while minimising and avoiding potential impacts on local communities. The guidelines in its current state recommend the following be considered for blade glint and shadow flicker:

> *The impact of 'shadow flicker' from wind turbines on neighbours' houses within 2 km of a proposed wind turbine should be assessed. The shadow flicker experienced at any dwelling should not exceed 30 hours per year as a result of the operation of the wind farm.*
>
> *The impact of 'blade glint' from wind turbines on neighbour's houses within 2 km of a proposed wind turbine should be assessed. Blade glint refers to the regular reflection of sun off rotating wind turbine blades. Blades should be finished with a low reflectivity surface treatment to ensure that glint is minimised.*

Based upon these recommendations, shadow flicker has been also been calculated for neighbours' houses located within 2000 m of a proposed wind turbine.

4.2.3 Section 75J Project Approval

Project approval for Glen Innes Wind Farm was granted by the NSW Minister for Planning, subject to the conditions outlined in Schedule 2. The Conditions of Approval associated with Shadow flicker effects state:

> *2.6 Shadow Flicker arising from the operation of the project shall not exceed 30 hours/annum at any residence not associated with the project.*
>
> *Within 6 months of the commencement of operation of the project (or such other period agreed to by the Director-General), the Proponent shall prepare a Shadow Flicker Report for the approval of the Director-General which assesses the impact of blade flicker at Cherry Tree, being Lot 89 DP 753270 and Highfields, being Lot 2 DP 229974.*

4.3 Methodology

Aurecon has undertaken a shadow flicker assessment using GH WindFarmer v4.2.18.0 software package. The model simulates the path of the sun during the year and can calculate the relative positions of the sun, wind turbines, dwellings and terrain to predict the possible shadow flicker durations in the vicinity of the wind farm development from a purely geometrical standpoint. This calculation gives the theoretical number of hours of shadow flicker experienced at the dwelling.

The shadow flicker model was calculated to a distance of 1,047 m and 2,000 m and calculations were performed at 10 minute time intervals with a resolution of 10 m. The turbine orientation was set with

the rotor plane facing the azimuth at 180°. A digital terrain model was used to calculate turbine and sun visibility with visibility line-of-sight algorithm checks set at every 10 m.

It is noted that the modelling represents a worst case assumption for all the provided dwelling locations and has been carried out using the assumptions listed below:

- The sun will always be visible during daylight hours and does not take into consideration cloud cover;
- All turbines will always be visible except those screened by topography (disregards coverage provided by existing vegetation or screening provided by intervening structures such as sheds and water tanks);
- Using a conservative prediction model, the simulation assumes that the rotor is facing the receptor at all times and therefore presenting the widest blade profile (in reality the turbine turns to face the wind and only a fraction of the entire wind swept area will be visible to receiver locations);
- The turbines will always be operating (in reality there will be stationary periods where the wind turbine is not rotating. Reasons for this may include operational and maintenance issues along with periods of extreme high or low wind conditions);

This shadow flicker assessment compares the proposed wind farm layout (Turbine Layout L001 25 ECO110-3MW) which consists of 25 wind turbines with the approved wind farm layout (Turbine Revision August 2010).

4.4 Results

4.4.1 Shadow Flicker caused by Turbines within 1,050 m of a neighbouring residence

The results of the shadow flicker analysis are visually shown in Figure 3, no residences are located within 1,050 m of either the approved or proposed turbine layouts and there will be no increase in the predicted shadow flicker duration for this scenario.

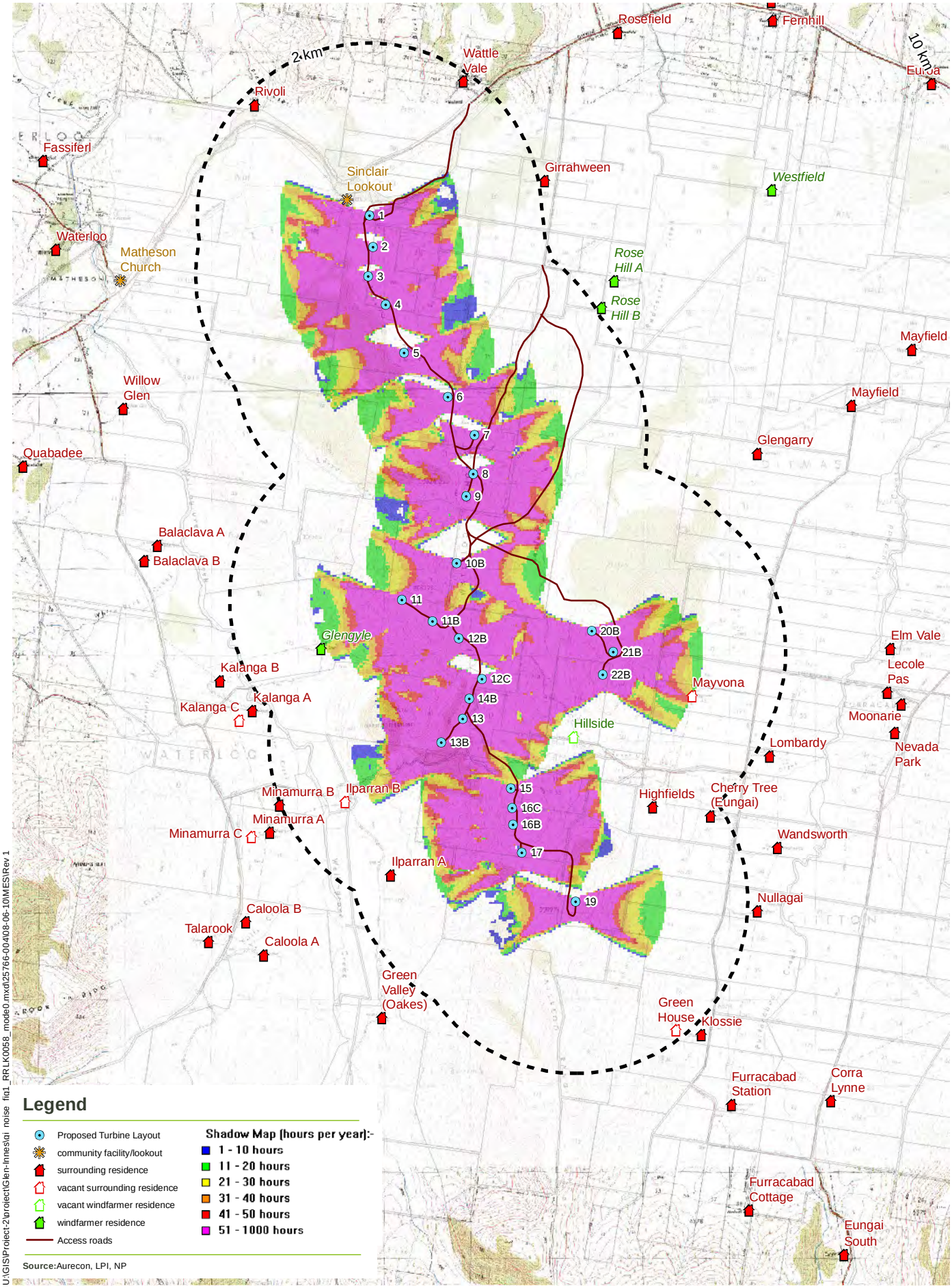
4.4.2 Shadow Flicker caused by Turbines within 2,000 m of a neighbouring residence

In the previous 2008 Environmental Assessment, shadow flicker duration was calculated to a distance of 1,000 m. Shadow flicker durations for both the approved and proposed turbine layouts have been modelled to a distance of 2,000 m in this assessment.

The results of the shadow flicker analysis are shown in Figure 4 and represent the worst-case theoretical hours per year and locations of shadow flicker effects. Table 4 below provides the locations of residential dwellings within 2000 m of either the approved turbine layout or proposed modification layout. There are 10 dwellings in total, two are associated with the project and eight are not involved.

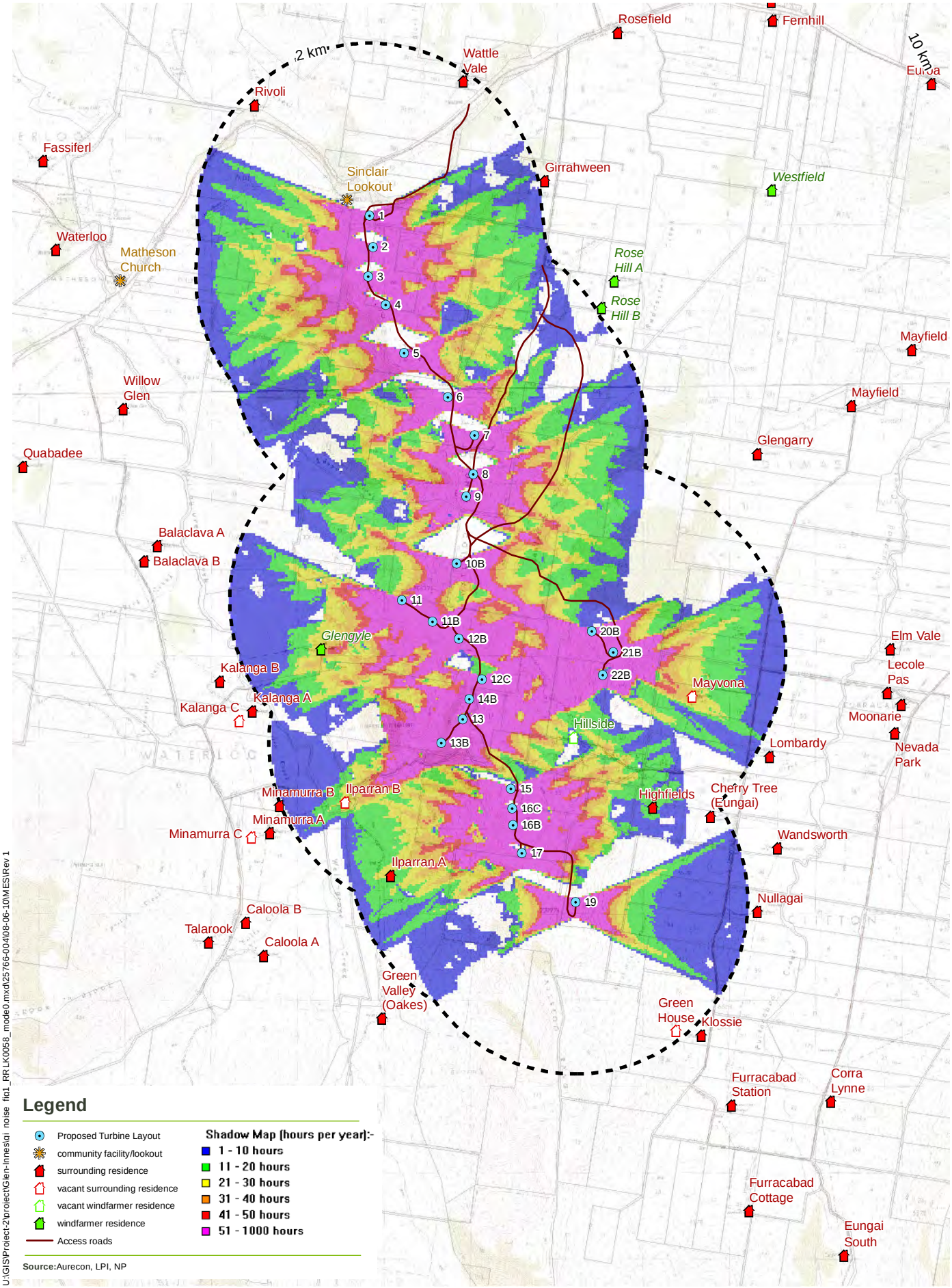
Table 4 – Location of dwellings within 2,000 m of a wind turbine

Residence	Eastings	Northings	Distance to Nearest Turbine			Wind Farm Landowner
			Approved Layout	Proposed Layout	Turbine	
Glengyle	364384	6705252	1,094 m	1,094 m	T11	Y
Ilparran B	364665	6703476	1,349 m	1,307 m	T13B	N
Hillside	367316	6704226	800 m	800 m	T22B	Y
Mayvona	368693	6704706	1,070 m	1,070 m	T22B	N
Ilparran A	365191	6702621	1,534 m	1,534 m	T16B	N
Highfields	368235	6703415	1,419 m	1,419 m	T19	N
Rivoli	363609	6711568	1,849 m	1,849 m	T1	N
Wattle Vale	366037	6711845	1,903 m	1,903 m	T1	N
Green House	368502	6700820	1,899 m	1,899 m	T19	N
Cherry Tree	368903	6703304	1,853 m	1,853 m	T19	N



Glen Innes Wind Farm **Visual Impact Assessment**

FIGURE 9: Theoretical Shadow Flicker Duration to 1047 metres (Proposed Modification)



Legend

- Proposed Turbine Layout
- community facility/lookout
- surrounding residence
- vacant surrounding residence
- vacant windfarmer residence
- windfarmer residence
- Access roads

Shadow Map (hours per year):-

- 1 - 10 hours
- 11 - 20 hours
- 21 - 30 hours
- 31 - 40 hours
- 41 - 50 hours
- 51 - 1000 hours

Source: Aurecon, LPI, NP

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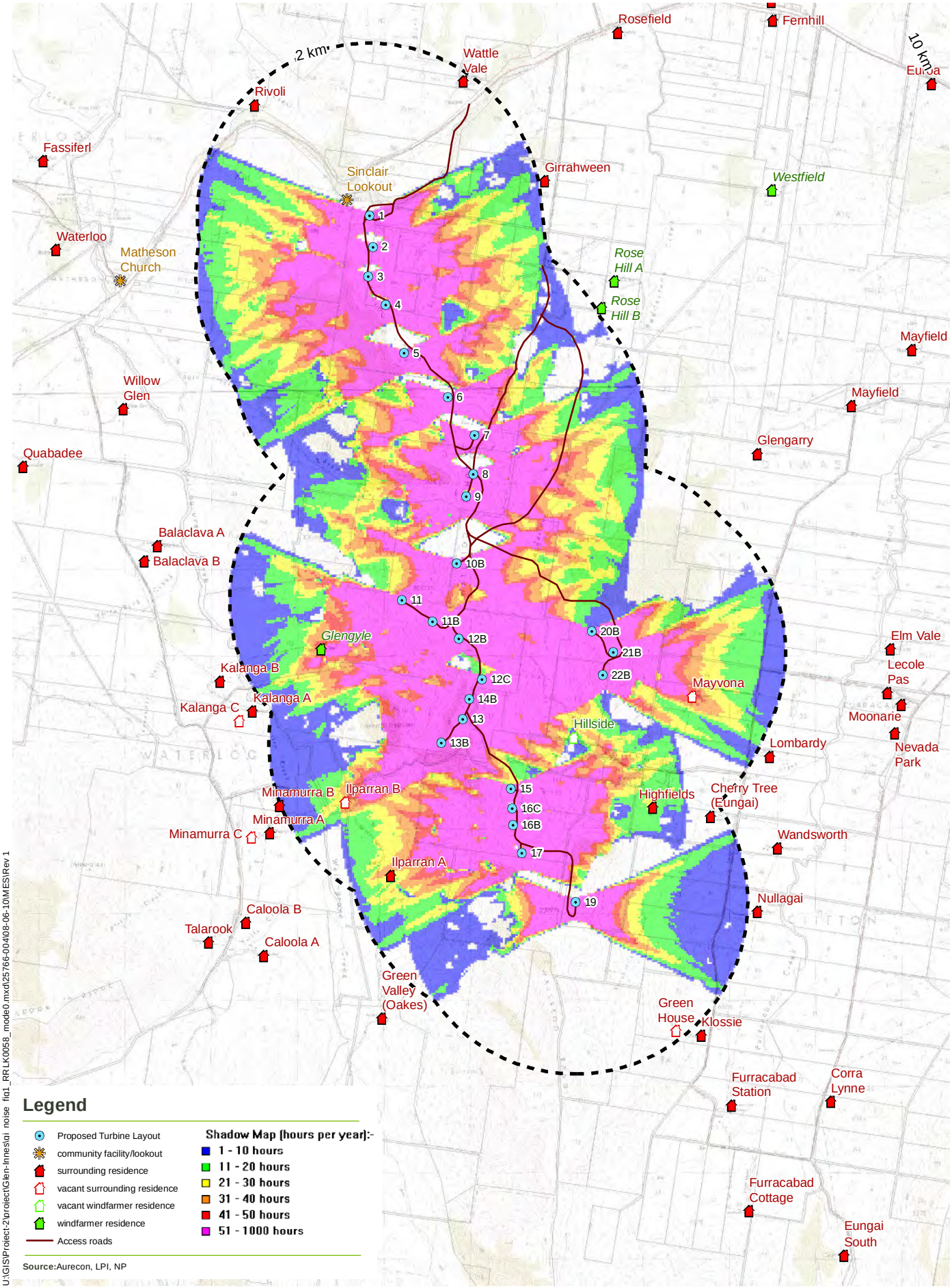
SCALE 1:65,000 @ A4

0 0.5 1 Kilometres

Projection: MGA

Glen Innes Wind Farm **Visual Impact Assessment**

FIGURE 10: Theoretical Shadow Flicker Duration to 2000 metres (Approved)



Glen Innes Wind Farm **Visual Impact Assessment**

FIGURE 11: Theoretical Shadow Flicker Duration to 2000 metres (Proposed Modification)

Of these ten residential dwellings, six will experience some level of shadow flicker caused by a turbine located within 2,000 m of the dwelling. If the ALSTOM ECO122 or a turbine with similar maximum dimensions is chosen, this will result in an increase in theoretical maximum shadow flicker durations at all six residences (Table 5), while the maximum shadow duration experienced at each location in a day would remain unchanged.

Table 5 - Theoretical Shadow Flicker Durations

Residence	Shadow Flicker Hours per annum			Maximum daily Shadow Duration (minutes per day)	Wind Farm Landowner
	Approved	Proposed	Difference		
Glengyle	29	42	13	20	Y
Ilparran B	24	37	13	20	N
Hillside	2	7	5	10	Y
Mayvona	32	42	10	30	N
Ilparran A	19	29	10	20	N
Highfields	13	20	7	20	N
Rivoli	0	0	0	0	N
Wattle Vale	0	0	0	0	N
Green House	0	0	0	0	N
Cherry Tree	0	0	0	0	N

With regards to Section 2.6 of the Conditions of Approval:

- There will be no increase in theoretical shadow flicker duration caused by turbines located within 2000 m of the Cherry Tree dwelling (Lot 89 DP 753270). T19 being the only turbine within 2000 m of this dwelling;
- the Highfields residence (Lot 2 DP 229974) would experience a maximum theoretical increase in shadow flicker hours from 13 hours to 20 hours;
- maximum theoretical shadow flicker duration is predicted to exceed 30 hours per annum at the non-associated Mayvona residence for both the approved and proposed modification assessment;
- maximum theoretical shadow flicker duration is now predicted to exceed 30 hours per annum at the non-associated Ilparran B residence

While the maximum theoretical shadow flicker duration is predicted to exceed 30 hours per annum at two non-associated residences (Ilparran B & Mayvona), it is anticipated that actual *Shadow flicker arising from the operation of the project shall not exceed 30 hours/annum at any residence not associated with the project* due to environmental factors such as existing vegetative screening at both residences.

Nevertheless, it would be prudent to undertake shadow flicker monitoring at Ilparran B and the Mayvona residence to ensure the proposed modifications would be in line with the current conditions of consent.

4.5 Cloud Cover

Cloud cover provides the most substantial reduction in the amount of shadow flicker experienced by receptors. In previous Australian assessments, cloud coverage has been used as a means to achieve compliance with the 30 hour per year limit for receptors. A move towards the international standard of 10 hours per year after taking into consideration cloud coverage has been recommended by the Draft National Guidelines.

In order to more accurately represent the shadow flicker, the mean number of cloudy days can be taken into consideration.

The Australian Bureau of Meteorology calculates the mean number of cloudy days by:

> *Average number of cloudy days in a calendar month or year, calculated over the period of record. This statistic is derived from cloud cover observations, which are measured in oktas (eighths). The sky is visually inspected to produce an estimate of the number of eights of the dome of the sky covered by presence of any trace of cloud in an otherwise blue sky is recorded as 1 okta, and similarly any trace of blue on an otherwise cloudy sky is recorded as 7 oktas. A cloudy day is recorded when the mean of the 9 am and 3 pm cloud observations is greater than or equal to 6 oktas. This definition has changed slightly over time. Prior to this, a cloudy day was defined as having greater than or equal to 5.5 oktas averaged over the 9 am and 3 pm observations.*

The monthly cloud cover readings taken by the Australian Bureau of Meteorology at the weather station located at Glen Innes Post Office 29.74 °S 151.74°E (Site No. 056011) is shown in Table 6.

Table 6 – Cloud Cover at Glen Innes

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Data
Clear Days	6.1	4.3	6.8	9.3	9.4	10.1	12.6	12.9	11.7	8.9	6.9	6.3	105.3	1962 2010
Cloudy Days	13.2	12.2	11.5	9.4	11.0	10.9	9.5	9.2	8.3	10.5	11.8	12.6	130.1	1962 2010

Shadow flicker would only occur when there is sufficient intensity in sunlight to cast a shadow from turbine to nearby receptors. Under cloudy conditions, a shadow would not be cast and the cloudy days shown in the BOM data can be applied to the shadow flicker results to provide a more realistic estimate of shadow flicker.

4.6 Blade Glint

Blade glint refers to the reflection of the sun's light from the surface of wind turbine blades. Blade glint has the potential to be a distraction to drivers if roads are aligned towards turbines. This can be a temporary effect at any particular location. The occurrence of blade glint depends on a number of conditions including the orientation of the nacelle, angle of the blade, and the angle of the sun. The reflectivity of the surface of the blades is also most important, and is influenced to some extent by colour and age of the blade.

Blade glint is an aspect that could be a potential distraction to drivers if roads are aligned towards turbines, particularly where the road is located at a higher altitude to the turbine hub and can be noticed over some distance, as much as 10 km if high reflectivity paint were to be utilised.

This issue is generally managed by ensuring that the finish on the turbine blades will reduce the extent of the effect. To this end, condition 2.3 of the consent for the approved project requires that:

> *"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".*

5. Mitigation

5.1 Visual Impact

As discussed in the EA for the approved project, the three bladed turbine design and the chosen off-white colour are generally accepted as being the most visually acceptable turbine arrangement and colour. However, due to their size and prominent position the wind turbines will be difficult to screen at the site. Existing trees and other features at some surrounding locations may partially obstruct views of the wind farm.

The measures to further mitigate the visual impact that have been incorporated in the wind farm development as proposed and adopted for the approved project will include:

- Use of underground cabling between turbines;
- Access roads located to limit their visibility, to the extent practicable;
- The turbine and its components come in a matte white finish;
- Consultation with Council over where vegetation screening of the wind farm should be positioned along public roads;
- No external night lighting will be associated with the increased turbine size;
- Tree planting as outlined in the Conditions of Consent Section 2.1. Taking into consideration that the average distance between dwellings within 3 km of a turbine is approximately 2115 m, and the vertical view angle of an individual turbine would increase by 0.54°, typical landscape treatments used to visually screen the turbines will have to increase in height marginally. For example:
  - To provide complete screening of a turbine with blade tip height increasing by 20 m, for screening planted 100 m from a viewpoint, the landscape treatment would have to increase in height by approximately 0.94 m.
  - To provide screening from the increased hub height of 9 m, screening planted 100 m from a viewpoint, for screening planted 100 m from a viewpoint, the landscape treatment would have to increase in height by approximately 0.42 m.
  - Landscape treatment heights would decrease where screens are planted closer to a viewpoint and where distance between the turbine and viewpoint is larger;
  - Landscape treatment heights would increase where screens are planted further from a viewpoint and where distance between the turbine and viewpoint is smaller.

5.2 Shadow Flicker

Several possible methods for mitigating shadow flicker in situations where the 30 hour per year limit is exceeded, were discussed in the EA for the approved project, they include:

- Screening of the view to the wind turbine that is causing the flicker, for example through additional landscaping devices such as vegetation planting. If there is no line-of-sight to the wind turbines, there will not be any flicker effect;
- Curtains and other window screening devices can be used during the short periods of shadow flicker to prevent shadow flicker from entering a room;
- It is possible to implement a turbine shut-down protocol and switch off any turbines that are causing more than 30 hours of theoretical shadow flicker per year. “Flicker timers” can be used which are able to automate this process.

6. Conclusions

As noted in the submissions report, the visual impact of the approved wind farm development was an issue which raised a significant proportion of submissions from the local community and is considered a key issue of concern for neighbours.

The proposed modification does not significantly alter the approved layout of the wind farm, with two turbines being micro-sited. Therefore, the horizontal view angles remain unchanged for the majority of viewpoints

If left unmitigated, the increase in turbine dimensions would have minor impacts on residents in the immediate vicinity of the wind farm living within 3 km of the nearest wind turbine. The increase in the maximum blade tip height by 20 m would, on average occupy an additional 0.60° of the cumulative vertical field of view for these residences.

Where the distance between a viewer and the wind farm development increases, the visual impact would decrease. Beyond about 3 km, there is only a small decrease in the vertical view angle as distance increases and the increase in turbine dimensions would become indiscernible. The increase in vertical view angles could be mitigated with vegetative screening and landscape treatments as already recommended by the existing Conditions of Approval.

The updated assessment of shadow flicker maximum theoretical shadow flicker duration is predicted to exceed 30 hours per annum at the non-associated residences Mayvona and Ilparran B. However, it is anticipated that actual Shadow flicker arising from the operation of the project would not exceed 30 hours/annum at any residence not associated with the project due to environmental factors such as cloud cover and existing vegetative screening at both residences.

Nevertheless, shadow flicker monitoring at Ilparran B and the Mayvona residence has been recommended to ensure the proposed modifications would be in line with the current conditions of consent. As discussed in the EA for the approved project, methods are available for mitigating shadow flicker to ensure compliance with the condition of consent.

The existing consent conditions for the external design of the turbines will minimise any potential for glare or reflection (blade glint).

Based on the assessment conducted, it is concluded that the proposed modifications to the Glen Innes Wind Farm development would result in little change to the overall visual impact of what was approved in August 2010.

7. References

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