Night time lighting

Section 11

11.1 Introduction

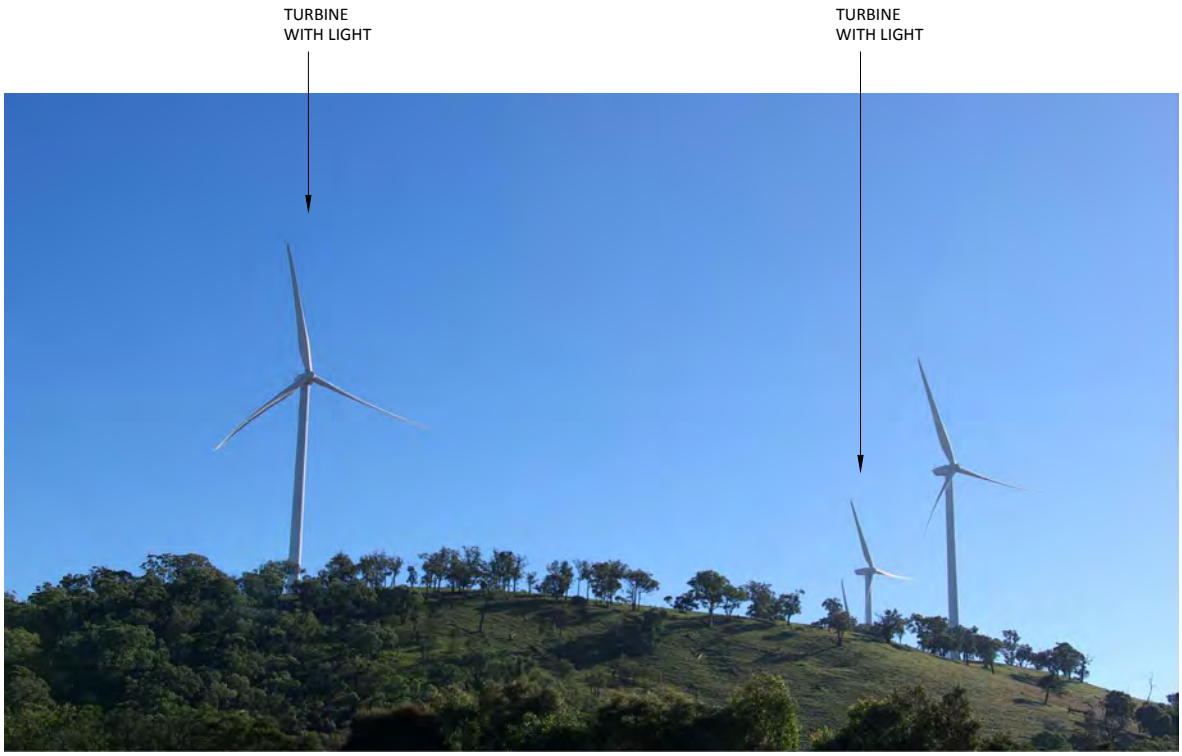
Although not currently proposed, the Liverpool Range wind farm may require obstacle lighting in the future. The future requirement for lighting will be subject to the advice and endorsement of the Civil Aviation Safety Authority (CASA). CASA is currently undertaking a safety study into the risk to aviation posed by wind farms to develop a new set of guidelines to replace the Advisory Circular with regard to lighting for wind turbines that was withdrawn by CASA in mid 2008.

Should future CASA regulations require a lighting assessment; the proponent will undertake an Aeronautical Impact Assessment, to first determine the risks posed to aviation activities by the wind farm. If required, an Obstacle Lighting Assessment will be undertaken by an Aeronautical Impact Assessment expert to stipulate the turbine lighting layout which will mitigate any risks to aviation. The outcomes of the Aeronautical Impact Assessment and the Obstacle Lighting Assessment will then be submitted to CASA for their comment.

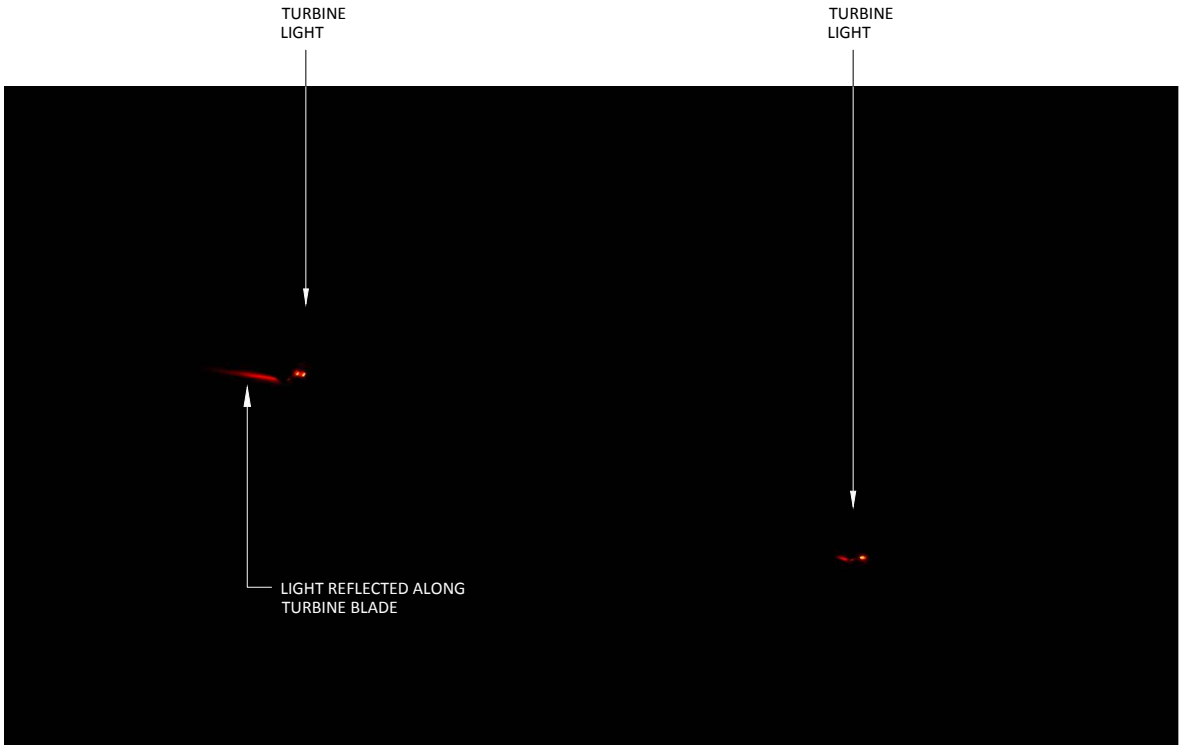
Potential visual impacts associated with obstacle marking and lighting at night time have not been extensively researched or tested in New South Wales, although some site investigations have been carried out at existing wind farms in Victoria. Investigations have generally concluded that although night time lighting mounted on wind turbines could be visible for a number of kilometres from the wind farm Project area, the actual intensity of the lighting appears no greater than other sources of night time lighting, including vehicle head and tail lights.

Previous investigations have also suggested that replacing the more conventional incandescent lights with light emitting diodes (LED) could help to minimise the potential visual impact of the wind turbine lights (Epuron 2008).

In order to illustrate the visual effect of turbine mounted lighting a series of night time photographs were taken of the Cullerin wind farm in the New South Wales Southern Tablelands. These were taken at distances of 500 m, 3.5 km and 17 km from the turbines and are illustrated in **Figures 42, 43** and **44**. Each night time view is presented below a corresponding day time photograph taken from the same photo location. It should be noted that following community consultation, and the preparation



Day time view from Hume highway toward Cullerin wind farm at around 500m



Night time view from Hume highway toward Cullerin wind farm at around 500m

Figure 42
Night lighting Cullerin wind farm at 500m

Cullerin wind farm night time lighting. View approximately 500 m west from Hume Highway

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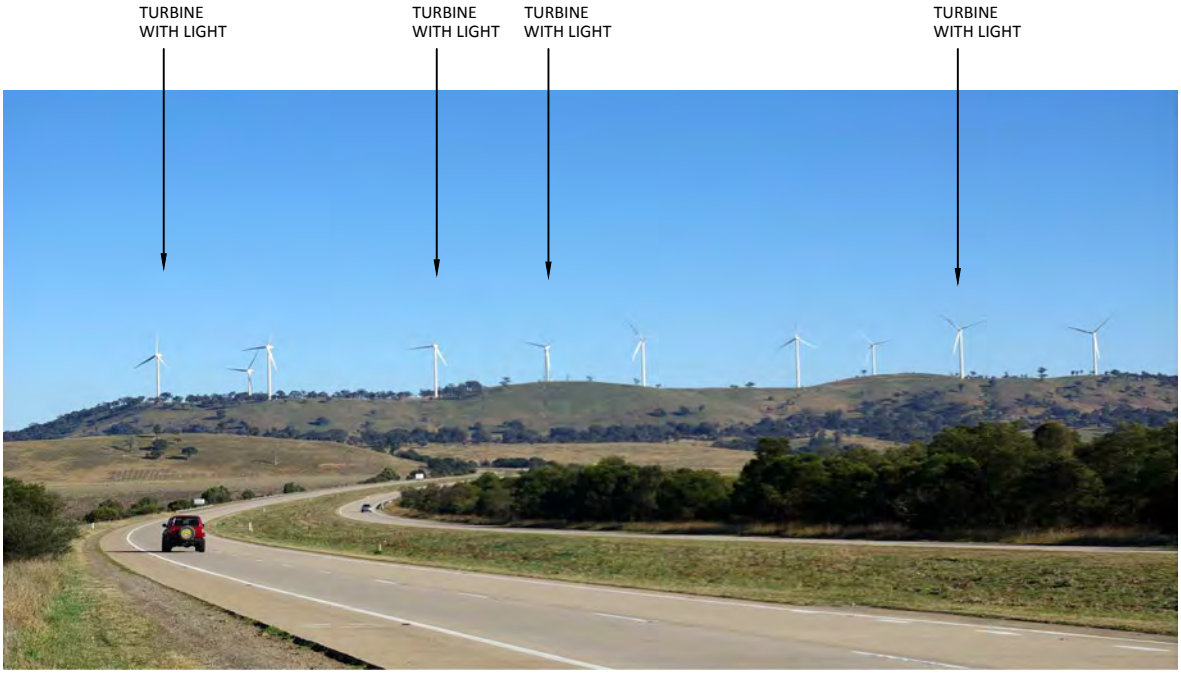
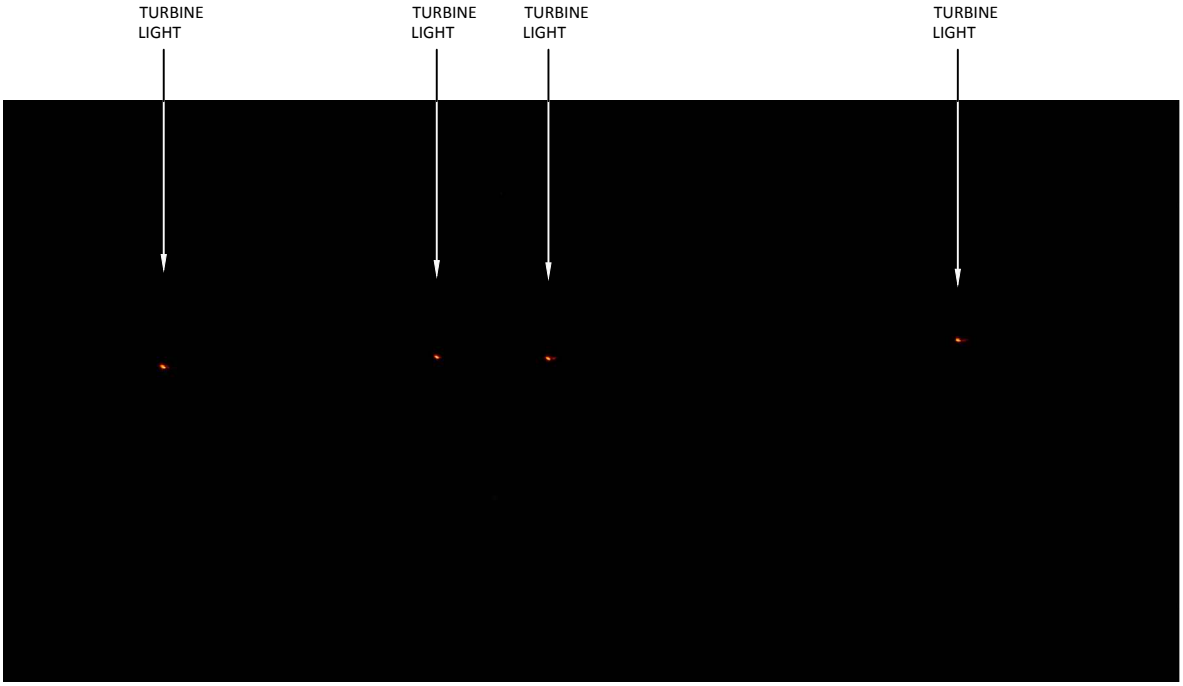


Day time view from Hume highway toward Cullerin wind farm at around 3.5km



Night time view from Hume highway toward Cullerin wind farm at around 3.5km

Cullerin wind farm night time lighting . View approximately 3.5 km west from Hume highway.

Figure 43
Night lighting Cullerin wind farm at 3.5 km

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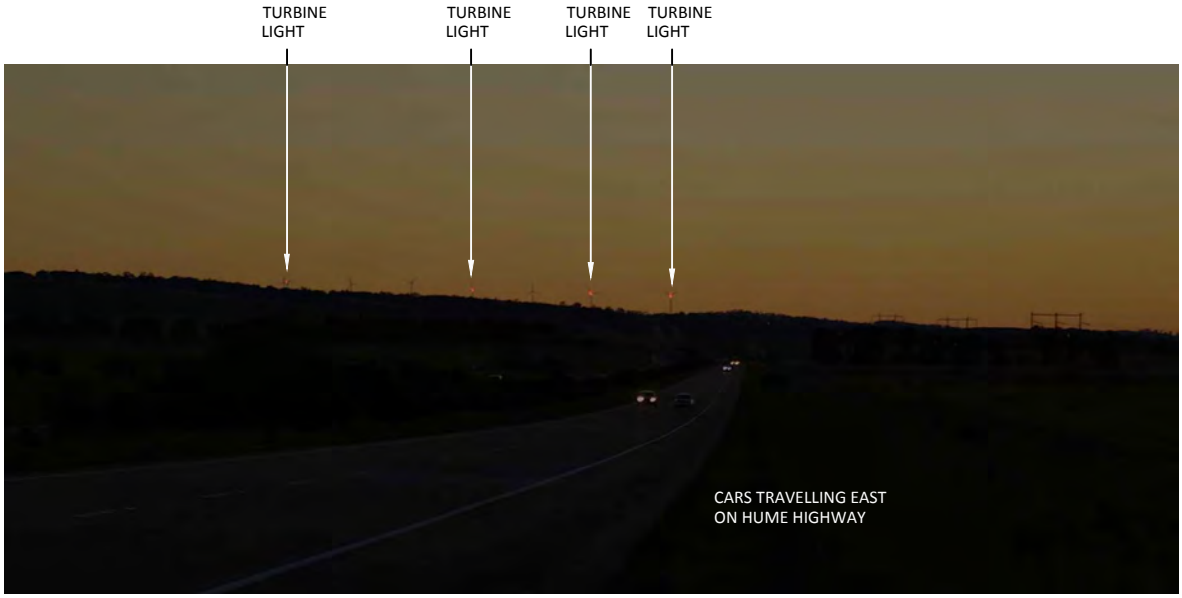
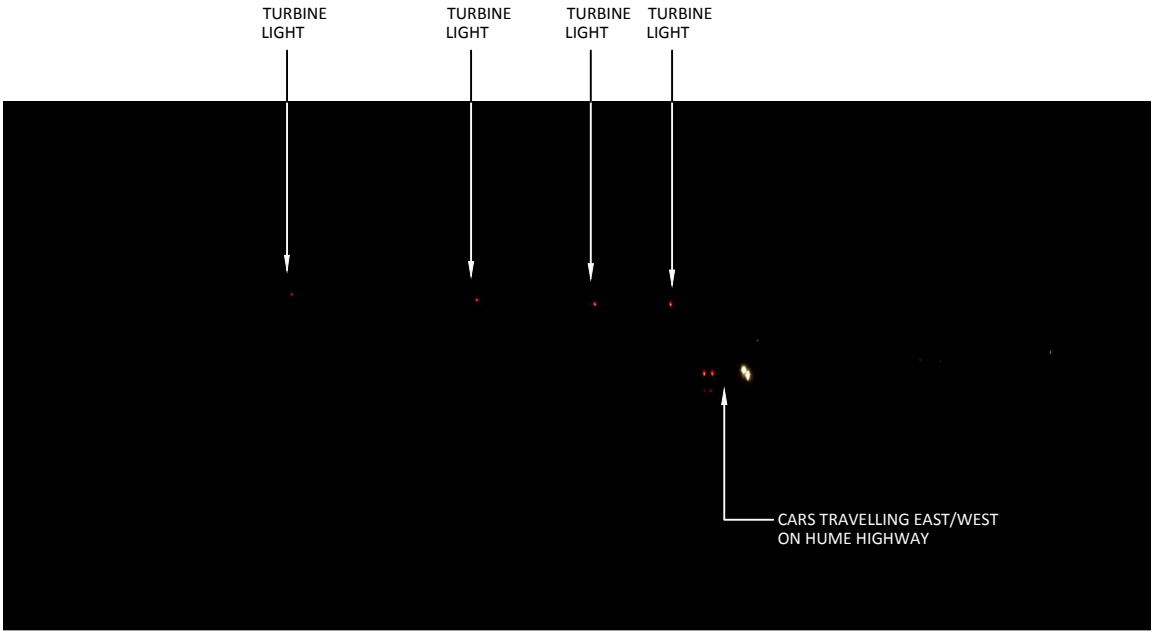


View west at dusk from Hume highway toward Cullerin wind farm at around 17km



View west after dark from Hume highway toward Cullerin wind farm at around 17km

Cullerin wind farm night time lighting . view west from Hume highway at around 17km distance.

Figure 44
Night lighting Cullerin wind farm at 17 km

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of an aviation risk assessment, Origin Energy have removed night time obstacle lighting from the Cullerin wind turbines.

11.2 Existing light sources

A small number of existing night time light sources occur within the Liverpool Range wind farm viewshed, and include rural residential and general lighting within surrounding towns.

Localised lighting is associated with a small number of dispersed homesteads located within the Project boundary, but lighting is unlikely to be visually prominent and does not emit any significant illumination beyond immediate areas surrounding residential and agricultural buildings.

Lights from vehicles travelling along the local roads provide dynamic and temporary sources of light.

11.3 Potential light sources

The main potential light sources associated with the Liverpool Range wind farm will include:

- low intensity night lights for substations, control and auxiliary buildings; and
- night time obstacle lights mounted on some wind turbines (if required in the future).

In accordance with the withdrawn CASA Advisory Circular two red medium intensity obstacle lights were required on specified turbines at a distance not exceeding 900 m and all lights were to flash synchronously. To minimise visual impact some shielding of the obstacle lights below the horizontal plane was permitted. Lighting for aviation safety could also be required prior to and during the construction period, including lighting for large equipment such as cranes.

In addition to the standard level of lighting required for normal security and safety, lighting could also be required for scheduled or emergency maintenance around the control building, substation and wind turbine areas.

As the visibility of the substation and control room will be largely contained by the surrounding landform, it is unlikely that light spill from these sources will be visible from the majority of surrounding view locations including surrounding residences.

11.4 Potential view locations and impact

The categories of potential view locations that could be impacted by night time lighting generally include residents and motorists.

Night time lighting associated with the wind farm is unlikely to have a significant visual impact on the majority of public view locations. Whilst obstacle lighting will be visible to motorists travelling along the local roads, the duration of visibility will tend to be very short and partially screened by undulating landform along some sections of local road corridors and influenced by the direction of travel.

Night time obstacle lighting associated with the wind farm will be visible from a number of the residential view locations surrounding the Liverpool Range wind farm; however, topography and screening by vegetation and screen planting around residential dwellings will screen or partially obscure views toward night time obstacle lighting.

Irrespective of the total number of visible lights, any lighting is more likely to be noticeable from exterior areas surrounding residences rather than from within residences, where internal lighting tends to reflect and mirror views in windows, or where exterior views will be obscured when curtains and blinds are closed.

Electrical works

Section 12

12.1 Introduction

The Liverpool Range wind farm will include a range of electrical infrastructure to collect and distribute electricity generated by the wind turbines. Electrical works will include elements such as:

- up to six collection substations and one connection substation;
- double circuit 330 kV overhead powerline;
- generator transformers (illustrated in **Plate 13**); and
- underground and overhead electrical and control cables.

The general arrangement for the proposed electrical works is illustrated in **Figure 2** and **3**.

A typical design for a wind farm substation is illustrated in **Plate 11** and demonstrates the relatively small scale development required for this component of the electrical infrastructure. A typical illustration of a folded plate double circuit supporting structure and angle poles is presented in **Plate 12**. The majority of electrical connections between the wind turbines will be via underground cabling wherever possible, including areas along ridgelines within the Project boundary. Some sections of 33kV overhead electrical reticulation could be required within the site boundary; however, the scale of these structures will be similar to existing medium voltage electrical distribution utility infrastructure found throughout the landscape.

Plate 11 – Typical wind farm collector substation

Plate 12 –Typical illustration of a 330 kV supporting structure

Plate 13 – Typical of a generator transformer

12.2 Substations

The proposed substation locations are illustrated in **Figures 2** and **3**. Final locations will be selected subject to detail engineering design. The layout of the proposed substation will be developed at the detailed design stage. However, the main visual components of a typical wind farm collection and connection substation will likely comprise:

- incoming and outgoing overhead powerlines;
- a single storey control building;
- electrical housings and buildings
- an access road and parking (or road utilising wind turbine maintenance access track);
- various switch bays and transformers;
- a communications pole;
- lightning masts;
- water tank;
- external lighting for security and maintenance; and
- security fencing including a palisade fence and internal chainmesh fence.

The substation locations will not be significantly visible from areas within the Project area, and will be largely screened by landform and scattered tree within the north, central and south portions of the Project site. Views from individual residential dwellings toward the substations will also be partially screened by localised landform and will not be expected to result in any significant visual impact from surrounding view locations. The proposed connection substation location will be located at the Ulan

colliery site and will not tend to be visually significant within the context of the surrounding industrial mining activities and associated constructed elements. **Plate 14** illustrates a typical view toward an existing 330 kV substation (Macarthur substation, NSW) and the relative high visual absorption capability provided by adjoining tree cover.

Plate 14 –Typical illustration of a 330 kV substation

12.3 330 kV powerline

Electricity generated by the Liverpool Range wind farm will be connected to the grid via an overhead double circuit 330 kV powerline extending across the Project site for around 54 km before extending south for approximately 42 km to a proposed connection substation location at the Ulan colliery site. The landscape characteristics of the wind farm powerline route are generally illustrated in the Photo Sheets 1, 2 and 3 (**Figures 7, 8** and **9**). The landscape characteristics of the powerline route between the wind farm and the Ulan colliery are illustrated in the Photo Sheets 4, 5, 6 and 7 (**Figures 45, 46, 47** and **48**).

The proposed 330 kV power line route across the wind farm site is illustrated in **Figure 49**. The proposed powerline route between the wind farm and the Ulan colliery includes two options which will be finalised subject to detailed site assessment work. The optional 330 kV powerline routes

Ulan Road

Dense roadside tree cover will contain and screen views toward proposed powerline from vehicles traveling along the Ulan Road

Bobadeen Road

(Image source GBD 2013)

Photo Location P10- View south along Ulan Road at Bobadeen Road intersection

Views toward the proposed powerline will be partially screened by tree cover alongside and beyond the Ulan Road corridor

Ulan Road

Durridgerie Road

(Image source GBD 2013)

Photo Location P11 - View north west along Durridgerie Road toward junction with Ulan Road

Ulan Road

Views will extend toward the proposed powerline as it crosses open and cleared grazing pasture

(Image source GBD 2013)

Photo Location P12 - View north west to north from Durridgerie Road

Notes

Individual photographs taken with a Nikon D90 camera with a 50 mm prime lens. This combination of camera and lens results in a photograph equivalent to a 35mm single lens reflex camera with a 75 mm lens.

Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

Figure 45
Photo Sheet 4

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Views will extend toward the proposed powerline as it crosses open and cleared grazing pasture

Summer Hill Road

(Image source GBD 2013)

Photo Location P13- View north east to east from Summer Hill Road

Vinegaroy Road

Golden Highway

(Image source GBD 2013)

Photo Location P14 - View east to south east along Golden Highway

Golden Highway

Vinegaroy Road

(Image source GBD 2013)

Photo Location P15 - View south along Vinegaroy Road toward junction with the Golden Highway

Notes

Individual photographs taken with a Nikon D90 camera with a 50 mm prime lens. This combination of camera and lens results in a photograph equivalent to a 35mm single lens reflex camera with a 75 mm lens.

Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

Figure 46
Photo Sheet 5

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Photo Location P16 - View east from the Golden Highway

Photo Location P17 - View south to south west along Golden Highway

Photo Location P18 - View south west to south from Coolah Road

Notes

Individual photographs taken with a Nikon D90 camera with a 50 mm prime lens. This combination of camera and lens results in a photograph equivalent to a 35mm single lens reflex camera with a 75 mm lens.

Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

Figure 47
Photo Sheet 6

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Turee Vale Road

(Image source GBD 2013)

Photo Location P19 - View north east to south from Turee Vale Road

Ulan Road

Ulan mine

(Image source GBD 2013)

Photo Location P20 - View south to south to south west from Ulan Road

Indicative substation location

Ulan mine

Ulan Road

(Image source GBD 2013)

Photo Location P21 - View west to north north west toward the Ulan Mine

Notes

Individual photographs taken with a Nikon D90 camera with a 50 mm prime lens. This combination of camera and lens results in a photograph equivalent to a 35mm single lens reflex camera with a 75 mm lens.

Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

Figure 48
Photo Sheet 7

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between the wind farm site and the Ulan colliery are illustrated in **Figure 50** which also illustrates the extent of existing tree cover along and beyond the optional powerline corridors.

The key visual components of the 330 kV powerline will comprise:

- single tapered steel poles up to 50 m high;
- aluminium alloy 330 kV conductors;
- an aerial earth wire and communications link; and
- access tracks for maintenance.

12. 4 Visual absorption capability

Visual absorption capability (VAC) is a classification system used to describe the relative ability of the landscape to accept modifications and alterations without the loss of landscape character or deterioration of visual amenity. The application of a VAC classification system is not particularly useful for large scale structures such as wind turbines and has not been applied to the assessment of the landscapes ability to accept the wind turbines; however, it can be applied to smaller ancillary structures, such as powerline infrastructure, where scale and form is more readily absorbed by elements (topography and vegetation) within the surrounding landscape. VAC relates to physical characteristics of the landscape that are often inherent and often quite static in the long term.

Undulating areas with a combination of open views interrupted by groups of trees and small forested areas will have a higher capability to visually absorb the proposed substations and powerline without significantly changing its amenity.

On the other hand, areas of cleared vegetation on level ground with limited screening, or areas spanning across prominent ridgelines without significant vegetation, will have a lower capability to visually absorb the proposed substations and powerline without changing the visual character and potentially reducing visual amenity.

Given the extent and combination of existing natural and cultural character within the wind farm site, the capability of the landscape to absorb the key components of the electrical infrastructure will be primarily dependent upon vegetation cover and landform. For the purpose of this LVIA, the VAC ratings have been determined as:

Legend

- Proposed 330 kV powerline route (wind farm site)
- 1 km and 2 km distance from indicative powerline route
- Potential substation location
- Proposed Liverpool Range wind turbine (indicative layout)
- Involved residential dwelling
- Uninvolved residential dwelling
- Coolah Tops National Park

Visual Absorption Capability (VAC)

- High
- Medium
- Low

Coolah Tops National Park visitor facilties and recreational areas

1. Falls camping site
2. Norfolk Falls picnic site
3. Coxs Creek Falls camping and picnic site
4. Rocky Creek Falls camping and picnic site
5. Pinnacle Lookout
6. Breeza Lookout
7. Shepherd Peak Lookout
8. The Pines camping area
9. Brackens Hut

Figure 49
Proposed 330 kV powerline route VAC (wind farm site)

LIVERPOOL RANGE WIND FARM

0km 10km

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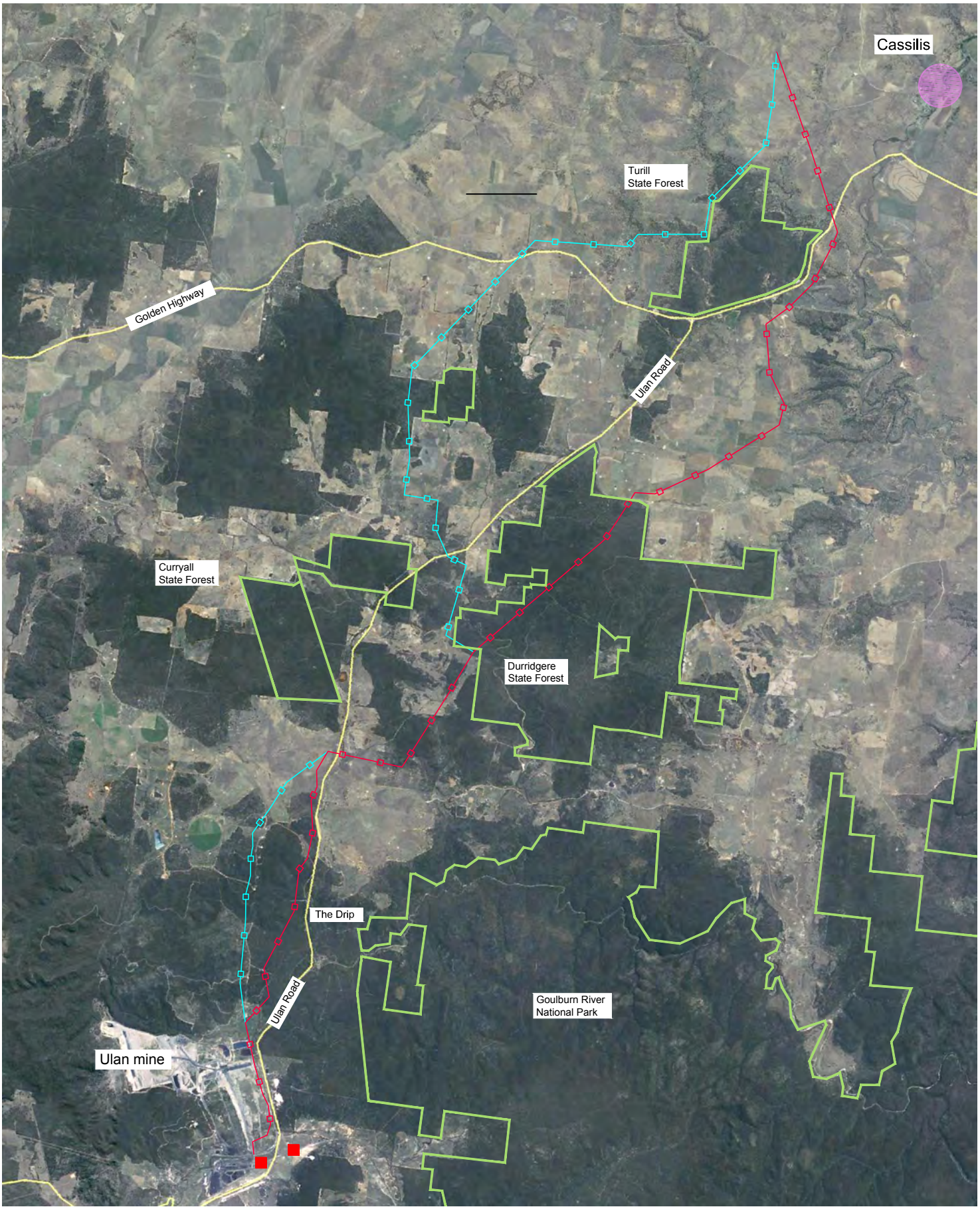

Legend

- Option 1 330 kV powerline route (connection south to Ulan)
- Option 2 330 kV powerline route (connection south to Ulan)
- Potential substation location

0km 2km 4km

Figure 50
Option 1 and Option 2 330 kV powerline route. Vegetation

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Low – electrical infrastructure components will be highly visible either due to lack of screening by existing vegetation or surrounding landform (e.g. open flat farmland cleared of vegetation, or steep hillside crossing ridgeline).

Medium – electrical infrastructure components will be visible but existing vegetation and surrounding landform will provide some screening or background to reduce visual contrast.

High – electrical infrastructure components will be extensively screened by surrounding vegetation and undulating landform.

The landscape VAC along and surrounding the proposed and optional 330 kV powerline routes is illustrated in **Figures 49, 51** and **52**.

12.5 Assessment of visual significance (electrical infrastructure)

Utilising a methodology very similar to the assessment of the wind turbine visual impact, the potential visibility and resultant visual significance of the substations and powerline infrastructure will primarily result from the combination of two factors:

- the extent to which the substation and powerline will be visible from surrounding areas; and
- the degree of visual contrast between the substation and powerline and the surrounding landscape that will be visible from surrounding view locations.

The overall visual impact is generally determined by a combination of factors including:

- the category and type of situation from which people may view the components of the substation and powerline (e.g. resident or motorist);
- the potential number of people with a view toward components of the substation and powerline from any one view location;
- the distance between a person and components of the substation and powerline; and
- the duration of time that a person may view components of the substation and powerline.

The potential view catchment is the extent to which the proposed powerline will be visible from surrounding areas. Identification of the view catchment considers the character of the landscape,

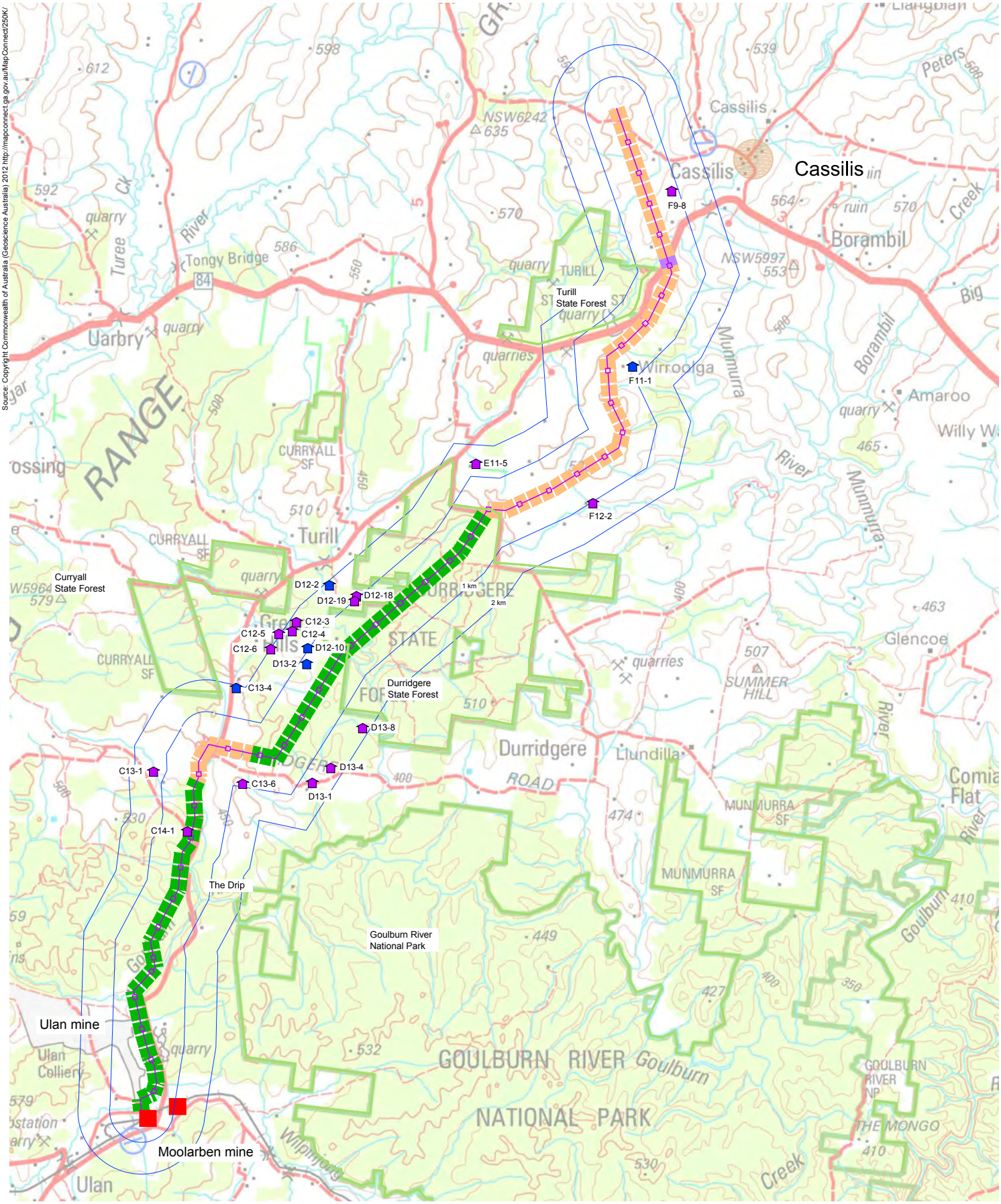

Figure 51
Option 1 330 kV powerline route VAC (connection south to Ulan mine substation)

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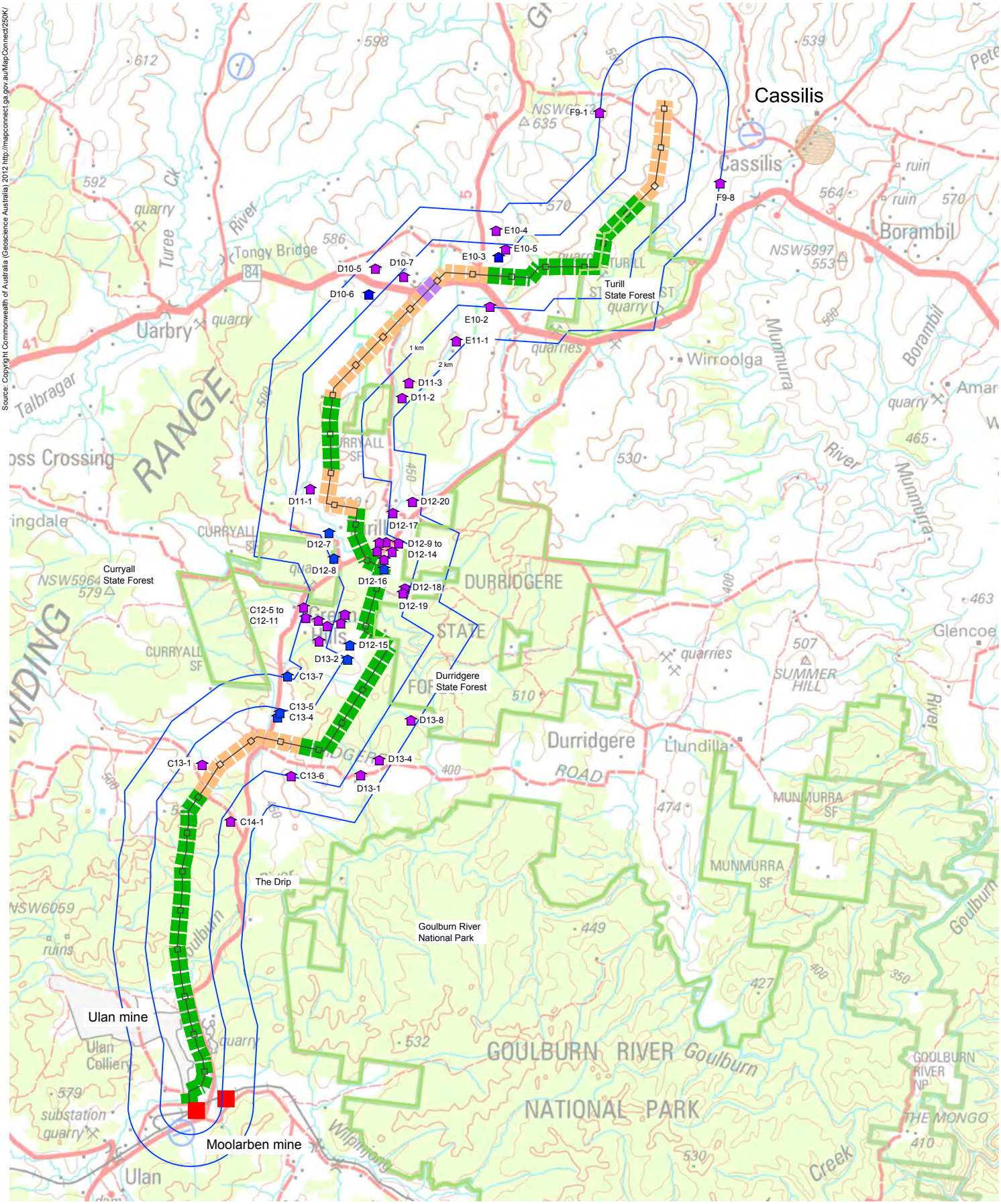

Legend

- Option 2 330 kV powerline route (connection south to Ulan)
- 1 km and 2 km distance from indicative powerline route
- Potential substation location
- Potentially involved residential dwelling (indicative location)
- Uninvolved residential dwelling (indicative location)

Visual Absorption Capability (VAC)

- High
- Medium
- Low

0km 2km 4km

Figure 52
Option 2 330 kV powerline route VAC (connection south to Ulan mine substation)

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landform and existing structural elements with regard to their potential for localised visual screening effects.

For the purpose of this LVIA, the electrical infrastructure view catchment has been determined within an approximate 2 km offset from the proposed substation location or each side of the powerline, beyond which the views will have a greater tendency to be screened by undulating landform or the presence of vegetation for portions of the powerline route. It is also considered that whilst the powerline will be noticeable from areas beyond a 2km distance, the substation and powerlines are unlikely to appear as a dominant visual element within the landscape beyond this distance.

The 2 km view catchment is a generalised assessment, where views toward the proposed powerline could, in some situations, be blocked by out buildings, vegetation or local landform features at specific points within the 2 km offset, and similarly glimpses of the proposed powerline will be available from isolated positions outside the view catchment area. The photograph in **Plate 16** illustrates an existing 330 kV double circuit powerline which demonstrates the influence of distance on visibility and magnitude of visual effect.

Plate 16 Existing 330 kV double circuit powerline

Table 20 presents the view location matrix for electrical infrastructure. Involved and uninvolved residential dwelling locations within 2 km of the electrical infrastructure are illustrated in **Figures 49, 51** and **52**.

The distance criteria for the proposed powerline visual assessment have been adopted as follows:

Category	Distance
Long distance view	>1 km
Medium distance view	500 m – 1 km
Short distance view	200 m – 500 m
Very short distance view	< 200 m

The potential visual significance of the proposed powerline is expressed as a rating of High, Medium, Low or Nil. For the purposes of this LVIA visibility ratings have been defined as:

High – The construction of the powerline may result in a very prominent physical change to the landscape, and includes the potential for proximate views toward extensive portions of the powerline from sensitive receptor locations.

Medium – The construction of the powerline may result in a noticeable physical change to the landscape although the powerline will not appear to be substantially different in scale and character to the existing landscape from surrounding receptor locations.

Low – The construction of the powerline is unlikely to result in a prominent change to the landscape and views from surrounding receptor locations toward the powerline may be difficult to distinguish from elements within the surrounding landscape.

Nil – The construction of the powerline will not create a noticeable change to the existing landscape and will not result in views toward the powerline from surrounding receptor locations.

12.6 Visual significance matrix (electrical infrastructure)

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
Visual significance 330 kV powerline (wind farm site) Refer Figure 49							
D4-3	Involved residential dwelling High	Very low	1,898 m	High	Medium	Long distance views east to south east toward the proposed overhead powerline will be partially screened by a gently rising and undulating landform beyond the dwelling. The proposed substation locations will not be visible from this location.	Low
D4-4	Involved residential dwelling High	Very low	1,898 m	High	Medium	Long distance views east to south east toward the proposed overhead powerline will be partially screened by a gently rising and undulating landform beyond the dwelling. The proposed substation locations will not be visible from this location.	Low
D4-5	Involved residential dwelling High	Very low	520 m	High	Low	Short to medium distance views east toward the proposed overhead powerline. The proposed substation locations will not be visible from this location.	Low to Medium
D4-6	Involved residential dwelling High	Very low	835 m	High	Low	Medium distance views west toward the proposed overhead powerline. The proposed substation locations will not be visible from this location.	Low Medium
D4-7	Involved residential dwelling High	Very low	1,183 m	High	Low	Long distance views west toward the proposed overhead powerline will be partially screened by landform rising to the west of the dwelling. The proposed substation locations will not be	Low Medium

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
						visible from this location.	
E5-1, E5-2 and E6-2	Involved residential dwellings High	Very low	1,591 m	High	Low	Long distance views north toward the proposed overhead powerline will be largely screened by vegetation and landform rising to the north of the dwelling. The proposed substation locations will not be visible from this location.	Low
E5-4, E5-5 and E5-6	Involved residential dwellings High	Very low	1,670 m	High	Low	Long distance views south toward the proposed overhead powerline will be largely screened by vegetation to the south of the dwellings. The proposed substation locations will not be visible from this location.	Low
F6-1, F6-2 and F6-3	Involved residential dwellings High	Very low	796 m	High	Low	Medium distance views east toward the proposed overhead powerline will be screened by established tree cover surrounding and beyond the residential dwellings.	Low
F6-4	Involved residential dwelling High	Very low	174 m	High	Low	Very short distance views will extend north and north west toward the overhead powerline with some partial screening through existing and established tree cover surrounding and beyond the dwelling.	Medium to High
G6-1	Involved residential dwelling High	Very low	1,242 m	High	Low	Long distance views will extend north and north west toward the overhead powerline with some partial screening through existing and established tree cover surrounding and beyond the dwelling.	Low

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
F7-6	Involved residential dwelling High	Very low	2,000 m	High	Medium	Long distance views will extend east toward the overhead powerline with some partial screening through existing and established tree cover surrounding and beyond the dwelling.	Low
F8-1	Uninvolved residential dwelling	Very low	726 m	High	Medium	Medium distance views will extend east toward the overhead powerline with some partial screening through existing and established tree cover surrounding and beyond the dwelling.	Low
F9-1	Uninvolved residential dwelling	Very low	1,306 m	High	Medium	Long distance views north east toward the overhead powerline will be partially screened by existing and established tree cover surrounding and beyond the dwelling.	Nil to Low
Visual significance 330 kV powerline (Option 1) Refer Figure 51							
F9-8	Uninvolved residential dwelling	Very low	780 m	High	Medium	Medium distance views west toward the overhead powerline will be partially screened by scattered tree cover beyond the dwelling.	Nil to Low
F11-1	Uninvolved residential dwelling	Very low	747 m	High	Medium	Medium distance views west toward the overhead powerline will be partially screened by tree cover surrounding and beyond the dwelling.	Nil to Low
F12-2	Uninvolved residential dwelling	Very low	1,048 m	High	Medium	Long distance views north toward the overhead powerline will be partially screened by tree cover surrounding and beyond the dwelling.	Low

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
E11-5	Uninvolved residential dwelling	Very low	1,476 m	High	Medium	Long distance views south to south east toward the overhead powerline will be partially screened by tree cover surrounding and beyond the dwelling.	Low
D12-2	Involved residential dwelling	Very low	1,879 m	High	High	Long distance views south east toward the overhead powerline will be screened by tree cover surrounding and beyond the dwelling.	Nil
D12-18	Uninvolved residential dwelling	Very low	1,040 m	High	High	Long distance views south to south east toward the overhead powerline will be screened by tree cover surrounding and beyond the dwelling.	Nil
D12-19	Uninvolved residential dwelling	Very low	992 m	High	High	Medium distance views south to south east toward the overhead powerline will be screened by tree cover surrounding and beyond the dwelling.	Nil
C12-3 to C12-6	Uninvolved residential dwellings	Very low	1,722 m	High	High	Long distance views south to south east toward the overhead powerline will be screened by tree cover surrounding and beyond the dwellings.	Nil
D12-10	Involved residential dwelling	Very low	998 m	High	High	Medium distance views south to south east toward the overhead powerline will be screened by tree cover surrounding and beyond the dwelling.	Nil
D13-2	Involved residential	Very low	756 m	High	High	Medium distance views south to south east toward the overhead powerline will be screened by tree cover surrounding and beyond	Nil

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
	dwelling					the dwelling.	
D13-8	Uninvolved residential dwelling	Very low	1,796 m	High	High	Long distance views north east toward the overhead powerline will be screened by tree cover surrounding and beyond the dwelling.	Nil
D13-4	Uninvolved residential dwelling	Very low	1,611 m	High	High	Long distance views north east toward the overhead powerline will be screened by tree cover surrounding and beyond the dwelling.	Nil
D13-1	Uninvolved residential dwelling	Very low	1,396 m	High	High	Long distance views north east toward the overhead powerline will be screened by tree cover surrounding and beyond the dwelling.	Nil
C13-6	Uninvolved residential dwelling	Very low	1,000 m	High	Medium	Long distance views will extend north toward the overhead powerline.	Low
C13-4	Involved residential dwelling	Very low	1,920 m	High	Medium to High	Long distance views south and east toward the overhead powerline will be largely screened by scattered and dense tree cover beyond the residential dwelling.	Nil to Low
C13-1	Uninvolved residential dwelling	Very low	1,425 m	High	Medium to High	Long distance views south and east toward the overhead powerline will be largely screened by scattered and dense tree cover beyond the residential dwelling.	Nil to Low
C14-1	Uninvolved residential dwelling	Very low	162 m	High	High	Very short distance views east toward the overhead powerline will be largely screened by scattered and dense tree cover beyond the residential dwelling.	Nil to Low

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
Visual significance 330 kV powerline (Option 2) Refer Figure 52							
F9-1	Uninvolved residential dwelling	Very low	2,000 m	High	Medium	Long distance views east toward the overhead powerline will be screened by scattered tree cover and landform rising to the east of the residential dwelling.	Nil
F9-8	Uninvolved residential dwelling	Very low	2,000 m	High	Medium	Long distance views west toward the overhead powerline will be largely screened by scattered tree cover to the west of the residential dwelling.	Nil to Low
E10-3	Involved residential dwelling	Very low	572 m	High	High	Medium distance views south toward the overhead powerline will be largely screened by scattered tree cover to the south of the residential dwelling.	Nil to Low
E10-5	Uninvolved residential dwelling	Very low	833 m	High	High	Medium distance views south toward the overhead powerline will be largely screened by scattered tree cover to the south of the residential dwelling.	Nil to Low
E10-4	Uninvolved residential dwelling	Very low	1,393 m	High	High	Long distance views south toward the overhead powerline will be largely screened by scattered tree cover to the south of the residential dwelling.	Nil to Low
D10-7	Uninvolved residential dwelling	Very low	814 m	High	Medium to Low	Medium distance views will extend south east toward the overhead powerline.	Low to Medium

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
D10-5	Uninvolved residential dwelling	Very low	1,664 m	High	Medium	Long distance views south toward the overhead powerline will be partially screened by scattered tree cover to the south east of the residential dwelling.	Nil to Low
D10-6	Involved residential dwelling	Very low	1,230 m	High	Medium	Long distance views south and south east toward the overhead powerline will be partially screened by scattered tree cover to the south east of the residential dwelling.	Nil to Low
E10-2	Uninvolved residential dwelling	Very low	1,000 m	High	Medium to High	Long distance views toward the overhead powerline will be largely screened by scattered tree cover and gently undulating landform to the north of the dwelling.	Nil to Low
E11-1	Uninvolved residential dwelling	Very low	1,764 m	High	Medium	Long distance views north and north west toward the overhead powerline will be screened by scattered tree cover and gently undulating landform to the north west of the dwelling.	Nil
D11-3	Uninvolved residential dwelling	Very low	1,595 m	High	Medium	Long distance views toward the overhead powerline will be screened by dense tree cover.	Nil
D11-2	Uninvolved residential dwelling	Very low	1,770 m	High	Medium	Long distance views toward the overhead powerline will be screened by dense tree cover.	Nil
D11-1	Uninvolved residential dwelling	Very low	582 m	High	Medium	Medium distance views will extend east toward the overhead powerline.	Medium

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
D12-20	Uninvolved residential dwelling	Very low	1,742 m	High	Medium	Long distance views toward the overhead powerline will be screened by scattered tree cover and rising landform to the west of the dwelling.	Nil
D12-17	Uninvolved residential dwelling	Very low	1,144 m	High	Medium to High	Long distance views toward the overhead powerline will be screened by scattered tree cover and rising landform to the west of the dwelling.	Nil
D12-7	Involved residential dwelling	Very low	828 m	High	High	Medium distance views east toward the overhead powerline will be screened tree cover to the west of the dwelling.	Nil
D12-8	Involved residential dwelling	Very low	922 m	High	High	Medium distance views east toward the overhead powerline will be screened tree cover to the west of the dwelling.	Nil
D12-9 to D12-14	Uninvolved residential dwellings	Very low	922 m	High	High	Short to medium distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwellings.	Nil to Low
D12-16	Involved residential dwelling	Very low	50 m	High	High	Very short distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwellings.	Nil to Low
D12-18	Uninvolved residential dwelling	Very low	861 m	High	High	Medium distance views toward the overhead powerline will be largely screened by established tree cover surrounding and	Nil

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
						beyond the residential dwelling.	
D12-19	Uninvolved residential dwelling	Very low	838 m	High	High	Medium distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwelling.	Nil
C12-5 to C12-11	Uninvolved residential dwellings	Very low	750 m	High	High	Medium to long distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwellings.	Nil
D12-15	Involved residential dwelling	Very low	652 m	High	High	Medium distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwelling.	Nil
D13-2	Involved residential dwelling	Very low	899 m	High	High	Medium distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwelling.	Nil
D13-7	Involved residential dwelling	Very low	2,000 m	High	High	Long distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwelling.	Nil
D13-8	Uninvolved residential dwelling	Very low	1,807 m	High	High	Long distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwelling.	Nil

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
D13-4	Uninvolved residential dwelling	Very low	1,616 m	High	High	Long distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwelling.	Nil
D13-1	Uninvolved residential dwelling	Very low	1,378 m	High	High	Long distance views toward the overhead powerline will be largely screened by established tree cover surrounding and beyond the residential dwelling.	Nil
C13-6	Uninvolved residential dwelling	Very low	1,000 m	High	Medium to High	Long distance views will extend north toward the overhead powerline.	Low
C13-5	Involved residential dwelling	Very low	876 m	High	Medium	Medium distance views south toward the overhead powerline will be partially screened by scattered tree cover and tree planting surrounding the dwelling.	Nil
C13-4	Involved residential dwelling	Very low	690 m	High	Medium	Medium distance views south toward the overhead powerline will be partially screened by scattered tree cover and tree planting surrounding the dwelling.	Nil
C14-1	Uninvolved residential dwelling	Very low	1,279 m	High	Medium	Long distance views north west toward the overhead powerline will be screened by scattered tree cover and tree planting surrounding the dwelling.	Nil
C13-1	Uninvolved residential	Very low	464 m	High	Medium	Short distance views will extend south east toward the overhead	Medium

Table 21 – Visual significance matrix (Refer **Figures 49**, **50 and 51** for potential dwelling locations)

View location (Refer to Figure 59)	Category of view location	Relative number of people	Approximate distance to closest powerline	Duration of effect	VAC within proximity to powerline	Degree of visibility	Visual significance
	dwelling					powerline.	

12.7 Summary of visual significance – 330 kV powerline

12.7.1 Wind farm site

A total of nineteen residential dwellings have been identified within a 2 km offset from the proposed 330 kV powerline within the wind farm site. Two of the residential dwellings are uninvolved and seventeen are involved. An assessment of visual significance for the 330 kV powerline within the wind farm site determined that:

- 1 of the 19 residential dwellings will have a medium to high visual significance;
- 3 of the 19 residential dwellings will have a low to medium visual significance;
- 14 of the 19 residential dwellings will have a low visual significance; and
- 1 of the 19 residential dwellings will have a nil to low visual significance.

The residential dwelling F6-4 (Refer **Figure 49**) determined to have a medium to high visual significance is an involved dwelling.

12.7.2 Southern connection (Option 1)

A total of twenty residential dwellings have been identified within a 2 km offset from the proposed 330 kV powerline extending south to the Ulan colliery site. Sixteen of the residential dwellings are uninvolved and four are involved. An assessment of visual significance for the 330 kV powerline (southern connection Option 1) determined that:

- 3 of the 20 residential dwellings will have a low visual significance;
- 5 of the 20 residential dwellings will have a nil to low visual significance; and
- 12 of the 20 residential dwellings will have a nil visual significance.

12.7.3 Southern connection (Option 2)

A total of forty four residential dwellings have been identified within a 2 km offset from the proposed 330 kV powerline extending south to the Ulan colliery site. Thirty four of the residential dwellings are uninvolved and ten are involved. An assessment of visual significance for the 330 kV powerline (southern connection Option 2) determined that:

- 2 of the 44 residential dwellings will have a medium visual significance;
- 1 of the 44 residential dwellings will have a low to medium visual significance;
- 1 of the 44 residential dwellings will have a low visual significance;

- 14 of the 44 residential dwellings will have a nil to low visual significance; and
- 26 of the 44 residential dwellings will have a nil visual significance.

12. 8 Substation locations

There are six collector substation locations within the wind farm site (Refer **Figure 49**) and two potential connection substation locations (Refer **Figures 51** and **52**) at the existing Ulan colliery site approximately 35 km south west of the wind farm site.

The wind farm collector substations will be located away from residential dwellings and road corridors and will not be visible from the majority of involved and uninvolved dwellings within the wind farm Project boundary. Uninvolved residential dwelling F8-1 (Refer **Figure 49**) will be located around 850 m west of a collector substation location; however, the substation will be screened by tree cover and landform rising to the east and south east of dwelling F8-1. The potential collector substation locations within the wind farm site will not be visible from residential dwellings within Coolah or Cassilis. The potential connection substation locations at the Ulan colliery site (Refer **Figure 50**) will not be visible from residential dwelling, including those within the Ulan village locality around 2 km to the west of the potential substation locations.

12.9 The Drip

The Drip sandstone gorge, around 10 km north of Ulan, is a local landscape feature with recorded cultural significance. It extends along a section of the Goulburn River immediately to the west of the Goulburn River National Park. Land within and immediately surrounding the sandstone gorge is owned by Moolarben Coal and is utilised by the local community and visitors for a variety of recreational activities including swimming, bushwalking, painting and photography. The proposed 330 kV powerline will be located to the west of Ulan Road (for both Option 1 and Option 2) and will not be visible from areas within or along the Drip gorge.

12.10 330 kV powerline photomontage

A total of four photomontages have been prepared to illustrate views toward the proposed 330 kV powerline. The photomontage locations were selected to represent views from rural locations within or adjoining the wind farm site as well as major and local road corridors. The photomontage locations included:

- T1 - Golden Highway crossing;
- T2 - Coolah Road;
- T3 - Turee Vale Road (including views toward proposed wind turbines); and
- T4 - Ulan Road.

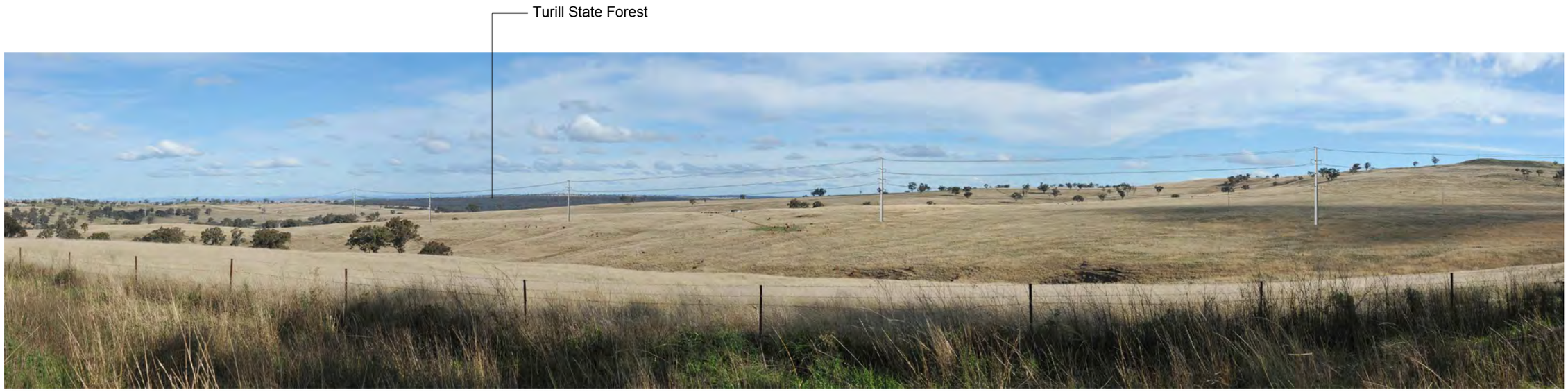
The proposed 330 kV powerline photomontages are illustrated in **Figures 53** and **54**.

12.11 Cumulative powerline impacts

The potential for cumulative visual impacts to result from the proposed 330 kV powerline are generally limited across the majority of the Project site. This is largely due to the absence of any significant extent of similar powerline structures within proximity to the proposed electrical works. Smaller domestic electrical distribution infrastructure is visible in the landscape but, due to its relative scale and limited visibility, is unlikely to result in any significant cumulative visual impact in combination with the proposed electrical works. Some larger scale electrical infrastructure is visible at the Ulan colliery and Moolarben mine site together with other large scale industrial infrastructure. This will result in a limited degree of cumulative visual impact around the proposed connection substation location in the context of existing mining operations.

Plate 17 Illustrating typical electrical infrastructure at the Ulan colliery site.

Photomontage T1 - Proposed view west to north west toward from Golden Highway toward proposed 330 kV powerline



Photomontage T2 - Proposed view west to south west from the Coolah Road toward proposed 330 kV powerline

Notes

Composite panorama photograph taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Individual panorama photograph coordinate map datum is MGAz55 to ± 5 m.

Extent of potential wind turbine visibility and directional bearing illustrated on each photomontage is indicative only.

The Nikon D700 digital SLR camera with a 50mm lens results in a single photograph with a view angle equivalent to a 35mm digital SLR camera photograph taken with a 50mm lens.

Refer Figure 3 for photomontage locations

Figure 53
Proposed Powerline
Photomontage T1 and T2

EPURON

Liverpool Range Wind Farm Pty Ltd

GREEN BEAN DESIGN
landscape architects

LIVERPOOL RANGE WIND FARM

Photomontage T3 - Proposed view east to south east toward from Turee Vale Road toward proposed 330 kV powerline

Photomontage T4 - Proposed view south from the Ulan Road toward proposed 330 kV powerline

Notes

Composite panorama photograph taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Individual panorama photograph coordinate map datum is MGAz55 to ± 5 m.

Extent of potential wind turbine visibility and directional bearing illustrated on each photomontage is indicative only.

The Nikon D700 digital SLR camera with a 50mm lens results in a single photograph with a view angle equivalent to a 35mm digital SLR camera photograph taken with a 50mm lens.

Refer Figure 3 and 18 for photomontage locations

Figure 54
Proposed Powerline
Photomontage T3 and T4

EPURON

Liverpool Range Wind Farm Pty Ltd

GREEN BEAN DESIGN
landscape architects

LIVERPOOL RANGE WIND FARM

Pre-construction and construction

Section 13

13.1 Potential visual impacts

There are potential visual impacts that could occur during both pre-construction and construction phases of the Project. The wind farm construction phase is likely to occur over a period of around 24 to 36 months, although the extent and nature of pre-construction and construction activities will vary at different locations within the Project area.

The key pre-construction and construction activities that will be visible from areas surrounding the proposed wind farm include:

- ongoing detailed site assessment including sub surface geotechnical investigations;
- various civil works to upgrade local roads and access point;
- construction compound buildings and facilities;
- construction facilities, including portable structures and laydown areas;
- various construction and directional signage;
- mobilisation of rock crushing equipment and concrete batching plant (if required);
- excavation and earthworks; and
- various construction activities including erection of wind turbines, monitoring masts and substation with associated electrical infrastructure works.

The majority of pre-construction and construction activities, some of which will result in physical changes to the landscape (which have been assessed in this LVIA report), are generally temporary in nature and for the most restricted to various discrete areas within or beyond the immediate wind farm Project area. The majority of pre-construction and construction activities will be unlikely to result in an unacceptable level of visual impact for their duration and temporary nature.

Plate 18 Illustrating typical activities during wind farm construction and installation.

(Image: Wind Prospect CWP Pty Ltd).

Perception and public consultation

Section 14

14.1 Perception

People's perception of wind farms is an important issue to consider as the attitude or opinion of individual people adds significant weight to the level of potential visual impact.

The opinions and perception of individuals from the local community and broader area were sought and provided through a range of consultation activities. These included:

- public open day;
- dedicated project web site including feedback provisions; and
- individual stakeholder meetings.

The attitudes or opinions of individuals toward wind farms can be shaped or formed through a multitude of complex social and cultural values. Whilst some people may accept and support wind farms in response to global or local environmental issues, others may find the concept of wind farms completely unacceptable. Some may support the environmental ideals of wind farm development as part of a broader renewable energy strategy but do not consider them appropriate for their regional or local area. It is unlikely that wind farm projects will ever conform or be acceptable to all points of view; however, research within Australia as well as overseas consistently suggests that the majority of people who have been canvassed do support the development of wind farms.

Wind farms are generally easy to recognise in the landscape and to take advantage of available wind resources are more often located in elevated and exposed locations. The geometrical form of a wind turbine is a relatively simple one and can be visible for some distance beyond a wind farm, and the level of visibility may be accentuated by the repetitive or repeating pattern of multiple wind turbines within a local area. Wind farms do have a significant potential to alter the physical appearance of the landscape, as well as change existing landscape values.

14.2 Public consultation

A public open day was held at the Cassilis Bowling Club on Thursday 1st November 2012. The open day provided an opportunity for members of the local community to view preliminary photomontages as well as other maps and plans illustrating layouts and potential locations for Project infrastructure. The

open day also provided an opportunity for the local community to provide feedback (via a landscape values questionnaire) on their experience and personal values associated with the surrounding landscape. No completed questionnaires were returned during or following the open day.

14.3 Quantitative research

Whilst published Australian research into the potential landscape and visual impacts of wind farms is limited, there are general corresponding results between the limited number that have been carried out when compared with those carried out overseas.

A recent survey was conducted by ARM Interactive on behalf of the NSW Department of Environment, Climate Change and Water (September 2010). The survey polled 2,022 residents across the 6 Renewable Energy Precincts established by the NSW Government; including the Upper Hunter Region Renewable Energy Precinct. Key findings of the survey indicated that:

- *97% of people across the Precincts had heard about wind farms or turbines, and 81% had seen a wind farm or turbine (in person or the media);*
- *85% of people supported the construction of wind farms in New South Wales, and 80% within their local region; and*
- *76% supported wind farms being built within 10km of residences and 47% of people surveyed supported the construction of wind turbines within 1 to 2km from their residences.*

These general levels of support for wind farm developments have also been recorded for a number of wind farm developments around Australia as well as overseas.

Auspoll research carried out in February 2002 on behalf of a wind farm developer for a wind farm project in Victoria included just over 200 respondents. The results indicated that:

- *Over 92% of respondents agreed that wind farms can make a difference in reducing greenhouse emissions and mitigating the effects of global warming;*
- *Over 88% disagreed with the statement that wind farms are ugly;*
- *Over 93% of respondents identified 'interesting' as a good way to describe wind farms, over 73% nominating 'graceful' and over 55% selecting 'attractive';*

- *Over 79% of respondents thought that the wind farm would have a good impact on tourism, with 15% of respondents believing that the wind farm would make no difference; and*
- *Over 40% of respondents believed that the impact of the wind farm on the visual amenity of the area would be good, with 40% believing that it would make no difference.*

A September 2002 MORI poll of 307 tourists conducted in Argyll (United Kingdom) indicated that:

- *43% maintained that the presence of wind farms had a positive impression of Argyll as a place to visit;*
- *43% maintained that the presence of wind farms had an equally positive or negative effect;*
- *Less than 8% maintained it had a negative effect; and*
- *91% of tourists maintained that the presence of wind farms in Argyll made no difference to the likelihood of them visiting the area.*

There is no published Australian research on community attitudes to the impact of wind farms on landscape and visual issues before and after construction. However, overseas research in the United Kingdom conducted by MORI in 2003 indicated that:

- *Prior to construction 27% of people polled thought problems may arise from wind farm impact on the landscape; and*
- *Following construction the number of people who thought the landscape has been spoiled was 12%.*

The majority of research carried out to date has focussed on public attitudes to wind farms and does not provide any indication for acceptable or agreed thresholds in relation to numbers and heights of turbines, and the potential impact of distance between turbines and view locations.

14.4 The broader public good

Whilst visual perceptions and attitudes of local communities toward wind farm developments are an important issue, and need to be assessed locally in terms of potential landscape and visual impacts, there is also an issue of the greater potential public benefit provided by renewable energy production. Wind farms are expected to make a contribution toward meeting the Government's commitment that 20% of Australia's electricity supply comes from renewable energy sources by 2020.

In the 2006 Land and Environment Court decision to grant, on an amended basis, consent for the construction of a wind farm at Taralga, Chief Judge Justice Preston said in his prologue to the judgement:

"The insertion of wind turbines into a non-industrial landscape is perceived by many as a radical change which confronts their present reality. However, those perceptions come in different hues. To residents, such as members of the Taralga Landscape Guardians Inc. (the Guardians), the change is stark and negative. It would represent a blight and the confrontation is with their enjoyment of their rural setting.

To others; however, the change is positive. It would represent an opportunity to shift from societal dependence on high emission fossil fuels to renewable energy sources. For them, the confrontation is beneficial – being one much needed step in the policy settings confronting carbon emission and global warming.

Resolving this conundrum – the conflict between the geographically narrower concerns of the guardians and the broader public good of increasing the supply of renewable energy – has not been easy. However, I have concluded that, on balance, the broader public good must prevail".

Whilst the exact circumstances between the Taralga wind farm and the Liverpool Range wind farm may differ, the comments provided by the Chief Judge make it clear that, in the circumstances of that case, there was a need for the broader public good to be put before the potential negative impacts on some members of the local community. Similar reasoning can be applied to the Project.

Mitigation measures

Section 15

15.1 Mitigation measures

A broad range of mitigation measures are available to assist in reducing the level of the potential visual significance from view locations surrounding the proposed wind farm development. These mitigation measures can be used to address both wind turbines as well as smaller scale infrastructure associated with the project such as power poles, substations and access roads.

The Draft Guidelines include examples of mitigations measures that wind farm proponents can use to reduce the visual impact of a proposed wind farm. These include measures such as:

- where possible locating wind turbines away from areas with high scenic values and away from areas with high visibility from local residents;
- selecting turbines that look the same, have the same height and rotate the same way and are off white or grey in colour;
- minimising the removal of vegetation;
- planting vegetation to provide a visual screen;
- reducing impacts of night and obstacle lighting by limiting lighting on towers to that required for safe operation and aviation safety and using lighting design to minimise glare;
- undergrounding electricity wires where practical; and
- using alternative power line pole design to minimise visual impact.

15.1.1 Wind turbine location

Where possible the wind turbines have been located away from areas with high scenic values. Much of the wind farm site extends across a rural/agricultural landscape that has been modified over time following European settlement. Views from areas of high scenic value (such as lookouts within the Coolah Tops National Park) do not extend toward or across any significant portion of the wind farm site.

Where possible wind turbines have been located away from areas with high visibility from local residents, including the small town of Coolah and Cassilis village. The significance of views toward wind turbines from these areas are mitigated by a combination of distance and rising/undulating landform.

The location of wind turbines has been subject to ongoing review and consultation with the preferred layout influenced by ridgeline formations. Where possible the preferred layout has avoided the consolidation and dense grouping of turbines and favoured a consistent, repetitive and lineal pattern.

15.1.2 Wind turbine design and colour

The Proponent has indicated that all of the wind turbines will be uniform in design and colour. The rotational direction and speed of the wind turbine blades will also be consistent throughout the wind farm.

Colour is one aspect of the wind turbine design that does provide an opportunity to reduce visual contrast between the turbine structures and the background against which they are viewed. The off white colour that is used on a majority of turbine structures provides the maximum level of visual contrast with the background. This maximum level of visual contrast could be reduced through the use of an appropriate off white colour for the turbines where the visual contrast will be reduced when portions of the turbine were viewed against the sky as well as for those portions viewed against a background of landscape. The final colour selection will, however, be subject to the availability of turbine models on the market at the time of ordering and to aviation safety requirements.

15.1.3 Vegetation removal

Although a significant portion of the Project area has been historically cleared for agriculture, the Project will, wherever possible, minimise the removal of existing trees and established vegetation.

15.1.4 Planting vegetation

The potential visual significance of the Project from sensitive view locations can be mitigated by planting vegetation close to the view locations such as residential dwellings. For example, tree or large shrub planting close to a residence can screen or filter potential views toward wind turbines. Similarly roadside tree planting can screen potential views of turbines from portions of road corridors.

The location and design of screen planting used as a mitigation measure is very site specific and requires detailed analysis of potential views and consultation with surrounding landowners. Planting vegetation will not provide effective mitigation in all circumstances and can reduce the extent of existing views available from residences or other view locations. Planting can also offer significant potential to screen ancillary ‘on site’ infrastructure such as substations.

There is greater potential to mitigate the visual prominence for some of the ancillary structures and built elements associated with the wind farm through the appropriate selection of materials and colours, together with consideration of their reflective properties.

15.1.5 Night time lighting

Although not proposed, night time obstacle lighting would, if required, be designed and installed to minimise potential visual effects for areas of residential dwellings in the surrounding landscape. The installation of obstacle lighting would be limited to the minimum number of towers required for safe operation and aviation safety and utilise lighting design to minimise glare.

Night time lighting around ancillary facilities, such as the substations and control room, will employ low level lighting and light fixtures with directional shields. This will help to minimise opportunities for light spill and avoid direct line of sight from uninvolved residential view locations in the surrounding landscape.

15.1.6 Electrical wires and power pole design

Electrical wires will be undergrounded where it is practicable to do so, including electrical connections between the wind turbines and substation locations. The preferred power pole design is a low profile mono pole design rather than a steel lattice design which is considered to have a lower potential for visual significance within the landscape.

15.2 Broad outline strategy for visual mitigation to residential dwellings

The broad outline strategy to visually screen residential dwellings surrounding the wind farm will ultimately be informed by the visual amenity and landscape requirements set out in the Project Development Consent. Subject to receiving Development Consent, the Proponent will be provided with Administrative Conditions which may include requirements to provide reasonable landscaping treatments to visually screen residential dwellings within a nominated distance from the wind turbines.

Uninvolved residential dwellings with a medium or high visual significance may be consulted by the wind farm owner with regard to impact minimisation measures. The outcomes of this consultation may be used to partly inform a Landscape Plan which will identify appropriate landscape measures within the Project site to mitigate visual impacts arising from the development. It is important to note

that residents or property owners at view locations determined with a moderate to high visual significance may chose not to have landscaping treatments installed on their property.

A site inspection will be arranged once a formal request has been received from a resident or property owner. The site inspection will determine, in consultation with the resident or property owner, a number of site specific issues and preferences such as:

- type of visual mitigation works most appropriate to the situation (e.g. planting works or screen structure);
- screening to block views where possible or partial filtering of views;
- optimal location and extent of visual mitigation works. For example taller tree species may be planted further from a dwelling to achieve the same visual effect as lower trees or shrubs closer to the view point. The effectiveness of planting as a mitigation strategy will depend to some extent on distance and difference in elevation between the view location and wind turbine; and
- preferred planting type and species (e.g. trees or large shrubs, native or introduced). Whilst some authorities prefer native plants an option to include ornamental or introduced plant species may be more appropriate in proximity to residential dwellings.

15.3 Summary of potential mitigation measures

Tables 22 and **23** provide a summary of the potential mitigation measures available for the wind farm and powerline infrastructure. The Tables also identify the stage of development at which mitigation measures may be implemented.

Table 22 – Potential mitigation measures summary

Safeguard	Implementation			
	Design	Site Preparation	Construction	Operation
Consider options for use of colour to reduce visual contrast between Project structures and visible background.	✓			
Avoid use of advertising, signs or logos mounted on turbine structures, except those required for safety purposes.			✓	✓

Table 22 – Potential mitigation measures summary

Safeguard	Implementation			
	Design	Site Preparation	Construction	Operation
If necessary, design and construct site control building and facilities building sympathetically with nature of locality.	✓		✓	
If necessary, locate substations away from direct views from roads and residential dwellings.	✓		✓	
Enforce safeguards to control and minimise fugitive dust emissions.		✓	✓	
Restrict the height of permanent stockpiles to minimise visibility from outside the site.		✓	✓	
Minimise construction activities that may require night time lighting, and if necessary use low lux (intensity) lighting designed to be mounted with the light projecting inwards to the site to minimise glare at night.		✓	✓	
Minimise cut and fill for site tracks and revegetate disturbed soils as soon as possible after construction.		✓	✓	
Maximise revegetation of disturbed areas to ensure effective cover is achieved.			✓	
Consider options for planting screening vegetation in vicinity of nearby residences and along roadsides to screen potential views of turbines. Such works to be considered in consultation with local residents and authorities.	✓	✓	✓	
Undertake revegetation and off-set planting at areas around the site where required in consultation and agreement with landholders.	✓	✓	✓	

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Table 23 – Substation and powerline summary of mitigation measures

Safeguard	Implementation			
	Design	Site Preparation	Construction	Operation
A careful and considered access route selection process to avoid sensitive view locations and loss of existing vegetation where possible.	✓		✓	
Wherever possible, select angle positions in strategic locations to minimise potential visual impact (e.g. avoiding, where possible, skyline views) and to provide a maximum setback from residential dwellings and road corridors.	✓		✓	
Selection of suitable component materials with low reflective properties.	✓		✓	
Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary.			✓	
Design for strategic tree or shrub planting between view locations and the powerline if required.	✓		✓	

Table 24 outlines some of the key mitigations measures with regard to their potential:

- feasibility;
- effectiveness;
- reliability; and
- potential residual impacts.

For the purpose of this LVIA the following definitions have been applied to terms feasibility, effectiveness, reliability and residual impact.

Feasibility – the degree to which the measure is capable of being implemented;

Effectiveness – the degree to which the measure can accomplish visual mitigation;

Reliability – the degree to which the measure can perform its required function over time; and

Residual impacts – the degree to which visual impacts remain following mitigation.

Table 24 – Key mitigation measures: feasibility, effectiveness, reliability and residual impacts

Key mitigation measure	Feasibility	Effectiveness	Reliability	Residual Impacts
Wind turbine design and layout	High	Medium to High	High	Medium
Colour application	High	Medium to High	Medium to High	Low to Medium
Screen planting (on site)	High	Medium to High	Medium	Medium
Screen planting (off site)	High	Medium	Medium	Medium
Night time lighting (on site ancillary infrastructure)	High	High	High	Low
Undergrounding electrical works	High	High	High	Nil

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Conclusion Section 16

16.1 Summary

In summary, this LVIA concludes that the Liverpool Range wind farm Project will have an overall low to medium visual significance on the majority of uninvolved residential view locations within the 10 km viewshed as well public view locations (from sections of local roads and amenities within urban localities). This LVIA has determined that the Project will have a high visual significance for one uninvolved residential view location. This LVIA has also determined that the Project will have a medium or medium to high significance for eighteen residential dwellings within 2 km of the proposed turbines. All of these dwellings are involved with the Project.

This LVIA determined the overall landscape character sensitivity to be medium to high. Some recognisable characteristics of the LCA's will be altered by the proposed Project, and result in the introduction of visually prominent elements that will alter the perceived characteristics of the LCA's but will be partially mitigated by existing landscape elements and features within the LCA's. The main characteristics of the LCA's, patterns and combinations of landform and landcover will still be visually evident from within and beyond the Project site boundary.

The LCA's identified and described in this LVIA are generally well represented throughout the surrounding Local Government Areas and more generally within other regions across the Upper Hunter Region Renewable Energy Precinct. This LVIA has determined that the landscape surrounding the Project will have some ability to accommodate the physical changes associated with the wind farm and its associated structures.

Many of the residential dwellings surrounding the wind farm have been positioned within the landscape to mitigate exposure to inclement weather, or have adopted measures to reduce these impacts by planting and maintaining windbreaks around residential dwellings. The extent of windbreak planting reduces the potential visibility of the wind farm from a number of residential view locations in the surrounding landscape.

This LVIA has determined that views toward the Liverpool Range wind turbines will generally result in a low impact for the majority of motorists travelling through the area due to the short duration and transitory nature of effects.

This LVIA has determined that the construction of the Project will not result in any significant 'direct', 'indirect' or 'sequential' cumulative impacts when considered against any existing or proposed wind farm developments within the planning system located in the Upper Hunter Renewable Energy Precinct.

The potential substation locations and the 330 kV powerline corridors are unlikely to result in a significant visual impact for the majority of surrounding residential or public view locations. A combination of distance, undulating landform and tree cover between substation and powerline components to surrounding view locations will tend to result in a moderate to high visual absorption capability and reduction in overall visibility.

Both pre-construction and construction activities are unlikely to result in an unacceptable level of visual impact due to the temporary nature of these activities together with proposed restoration and rehabilitation strategies. The preferred location for some of the construction activities, including the on-site concrete batch plant and rock crushing equipment, will be located away from publicly accessible areas, with the closest residential view locations generally comprising involved landowners.

Although not proposed, and if required in the future, night time obstacle lighting will have the potential to be visible from surrounding view locations, as well as areas beyond the Project 10 km viewshed. The level of visual impact will diminish when viewed from more distant view locations, with a greater probability of night time lighting being screened by landform and/or tree cover. It should also be noted that the night time lighting installed on the Cullerin wind farm (as illustrated in this LVIA) has been decommissioned by Origin Energy following a risk based aviation assessment. A number of recent wind farm developments in New South Wales have also been approved without a requirement for night time lighting, including the Gullen Range and Glen Innes wind farms. A number of other operational wind farm developments, including some in Victoria, have also had night lighting decommissioned.

Although some mitigation measures are considered appropriate to minimise the visual effects for a number of the elements associated with the wind farm, it is acknowledged that the degree to which the wind turbines will be visually mitigated is limited by their scale and position within the landscape relative to surrounding view locations.

The Proponent has engaged in ongoing consultation with local residents and made adjustments to the location of individual turbines and associated infrastructure to minimise visual impacts where possible.

Subject to any conditions of approval, the proponent will commit to negotiating and implementing landscape treatments to screen and mitigate the potential visual impact of the wind farm for individual neighbouring dwellings within an appropriate distance from the wind farm Project area, subject to consultation and agreement with individual property owners.

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Limitations

GBD has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Epuron Australia Pty Ltd and only those third parties who have been authorised in writing by GBD to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the GBD Proposal dated 5th September 2012.

The methodology adopted and sources of information used are outlined in this report. GBD has made no independent verification of this information beyond the agreed scope of works and GBD assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to GBD was false.

This report was prepared between September 2012 and March 2014 and is based on the conditions encountered and information reviewed at the time of preparation. GBD disclaims responsibility for any changes that may have occurred after this time.

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Appendix A – Draft NSW Planning Guidelines: Wind Farms. Meeting Assessment requirements, Landscape and visual amenity