Liverpool Range Wind Farm

Proposed view toward Liverpool Range wind farm from the Warung Forest Road

LANDSCAPE & VISUAL IMPACT ASSESSMENT

Prepared for:

EPURON

Prepared by:

GREEN BEAN DESIGN
landscape architects

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Green Bean Design – Capability Statement

Green Bean Design (GBD) is an experienced landscape architectural consultancy specialising in landscape and visual impact assessment. As an independent consultancy GBD provide professional advice to a range of commercial and government clients involved in large scale infrastructure project development.

GBD owner, and Principal Landscape Architect Andrew Homewood, is a Registered Landscape Architect and member of the Australian Institute of Landscape Architects and the Environmental Institute of Australia and New Zealand.

Andrew has over 20 years continuous employment in landscape consultancy and has completed numerous landscape and visual impact assessments for a range of large scale and State significant infrastructure and renewable energy projects, including wind energy and solar power developments. GBD has been commissioned for over 20 wind energy projects across New South Wales, Victoria, South Australia, Queensland and Tasmania, including assessments for:

Silverton Wind Farm	Boco Rock Wind Farm	Collector Wind Farm
Crookwell 3 Wind Farm	Sapphire Wind Farm	Willatook Wind Farm
Eden Wind Farm	Birrema Wind Farm	Rye Park Wind Farm
Paling Yards Wind Farm	Port Kembla Wind Farm	Bango Wind Farm
Deepwater Wind Farm	White Rock Wind Farm	Liverpool Range Wind Farm
Conroy's Gap (Mod 4)	Mt Emerald Wind Farm	Granville Harbour Wind Farm

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Glossary

This LVIA has adopted the following definitions, including those outlined in the Landscape Institute and Institute of Environmental Management & Assessment, Guidelines for Landscape and Visual Impact Assessment, Second Edition (2002) and Third Edition (2013).

Table 1 Glossary

Term	Meaning
Cumulative effects	*The summation of effects that result from changes caused by a development in conjunction with other past, present or reasonably foreseeable actions.*
Cultural significance	*The aesthetic, historic, scientific, social or spiritual value for past, present or future generations.*
Element (landscape)	*A component part of the landscape (for example roads, residences, parks or industrial buildings).*
Indirect Impacts	*Impacts on the environment, which are not a direct result of the development but are often produced away from it or as a result of a complex pathway.*
Landscape	*An area, as perceived by people, the character of which is the result of the action and interaction of natural and/or human factors.*
Landcover	*Combinations of land use and vegetation that cover the land surface.*
Landform	*Combinations of slope and elevation that produce the shape and form of the land.*
Landscape character area	*These are single unique areas which are the discrete geographical areas of a particular landscape type.*
Landscape feature	*A prominent eye catching feature, for example a rock outcrop or built feature.*
Landscape and visual sensitivity	*A term applied to specific receptors, combining judgements of the susceptibility of the receptor to the specific type f change or development proposed and the value related to that receptor.*
Landscape and visual	*A measure of the importance or gravity of the environmental effect,*

Table 1 Glossary

Term	Meaning
significance	*defined by significance criteria specific to the environmental topic.*
Magnitude	*A combination of the scale, extent and duration of an effect.*
Mitigation	*Measures, including any processes, activity or design to avoid, reduce, remedy or compensate for adverse landscape and visual effects of a development project.*
Photomontage	*Computer simulation or other technique to illustrate the appearance of a development.*
Viewshed	*An area of land surrounding and beyond the project area which may be potentially affected by the Project.*
Visibility	*A relative determination at which a wind turbine or group of wind turbines can be clearly discerned and described.*
Visual absorption capability	*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.*
Visual amenity	*The value of a particular area or view in terms of what is seen.*
Visual envelope	*Extent of potential visibility to or from a specific area or feature.*
Visual Impact Assessment	*A process of applied professional and methodical techniques to assess and determine the extent and nature of change to the composition of existing views that may result from a development*
Visual receptor	*Individuals and/or defined groups of people who have the potential to be affected by a proposal.*
Zone Visual Influence (ZVI)	*A theoretical area of landscape from which the Project structures may be visible.*

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Executive summary

Green Bean Design (GBD) was commissioned by Epuron Pty Ltd (the Proponent) to undertake a Landscape and Visual Impact Assessment (LVIA) for the Liverpool Range wind farm and associated development infrastructure (the Project).

The Project will have up to 288 wind turbines, and for the purpose of this LVIA, the proposed wind turbines have been assessed with a maximum blade tip height of 165 m from ground level to tip of blade and a maximum rotor size of up to 130 m. Associated electrical works include a proposed 330 kV overhead powerline connection across the wind farm site continuing south to a proposed substation and grid connection at the Ulan colliery.

This LVIA involved desktop studies and site inspections to collect and analyse information to describe and define the characteristics of the landscape in which the Project will be located. This LVIA has determined that the landscape surrounding the Project has an overall medium to high sensitivity to accommodate change, and represents a landscape that is reasonably typical of landscape character areas that are commonly found in the surrounding areas of the New South Wales Upper Hunter Renewable Energy Precinct.

As a landscape with an overall medium to high sensitivity to accommodate change, some recognisable characteristics of the landscape will be altered by the Project and result in the introduction of visually prominent elements that will alter some perceived landscape characteristics. Alterations to perceived characteristics may be partially mitigated by existing landscape elements and features within the landscape. The main characteristics of the landscape, patterns and combinations of landform and landcover will still be evident.

The Liverpool Range wind farm visibility was determined within the 10 km Project viewshed and illustrated by panorama photographs and three Zone of Visual Influence (ZVI) diagrams.

The ZVI diagrams demonstrate the influence of topography on visibility and identify areas from which the wind farm turbines will be visible.

This LVIA assessed the potential visual significance of the Liverpool Range wind farm for involved and uninvolved residential dwellings within the 10 km viewshed as well as impacts for motorists travelling

Executive summary

along local roads within and surrounding the Project area. A number of criteria were considered and assessed to determined levels of visual significance.

One residential dwelling within the Liverpool Range 2 km viewshed has been determined to have low visual significance. Three residential dwellings within the Liverpool Range 2 km viewshed will have a low to medium visual significance. Nine residential dwellings have been determined to have a medium visual significance and nine a medium to high visual significance (all involved residential dwellings). One involved residential dwelling will have a high visual significance.

This LVIA assessed the potential visual significance associated with the 330 kV powerline routes, substations and associated electrical infrastructure and determined that the overall visual impact of these elements is likely to be low due to location relative to existing view locations together with the screening influence of surrounding topography and vegetation.

A cumulative visual assessment identified one approved wind farm development, the Kyoto wind farm development, approximately 70 km to the east of the Liverpool Range wind Project. This LVIA determined that there is unlikely to be any 'direct' or 'indirect' visibility between the Liverpool Range wind farm and other approved wind farm developments within the Upper Hunter Renewable Energy Precinct.

Night time obstacle lighting, if implemented, will have the potential to create a visual impact for residential view locations surrounding the Liverpool Range wind farm. This LVIA notes that further to the withdrawal of the CASA Advisory Circular there are no guidelines by which to define criteria for wind farm night time obstacle lighting.

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 at some locations by their scale and position within the landscape relative to surrounding view locations.

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Introduction

Section 1

1.1 Introduction

This LVIA addresses one of the key requirements of the Liverpool Range wind farm Environmental Assessment (EA) to be submitted and assessed under Part 3A of the Environmental Planning & Assessment Act 1979 (EP&A Act). This LVIA addresses and responds to the Director General's Requirements (DGR's) dated 31st March February 2011, for the assessment of potential landscape and visual impacts of the Project. **Table 2** outlines the relevant landscape and visual impact assessment requirements of the DGR's and the corresponding section in which they are addressed within this LVIA report.

Table 2 Director General's Requirements

DGR's	Report Reference
• provide a comprehensive assessment of the landscape character and values and any scenic or significant vistas of the area potentially affected by the project, including an assessment of the significance of landscape values and character in a local and regional context. This should describe community and stakeholder values of the local and regional visual amenity and quality, and perceptions of the project based on surveys and consultation.	Refer LVIA **Sections 6** and **14**
• assess the impact of shadow "flicker", blade "glint" and night lighting from the wind farm.	Refer Liverpool Range wind farm EA **Section 14**,
• identify the zone of visual influence including consideration of night lighting (no less than 10 kilometres) and assess the visual impact of all project components on this landscape.	Refer LVIA **Sections 7** and **11**.
• include an assessment of any cumulative visual impacts from transmission line infrastructure.	Refer LVIA **Section 9**.
• include photomontages of the project taken from potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights), settlements and significant public view points, and provide a clear description of proposed visual amenity mitigation and management measures for both the wind farm and the powerline. The photomontages must include representative views of turbine night lighting if proposed.	Refer LVIA **Sections 10** and **15**.
• provide an assessment of the feasibility, effectiveness and reliability of proposed mitigation measures and any residual	Refer LVIA **Section 15**.

Table 2 Director General's Requirements

DGR's	Report Reference
impacts after these measures have been implemented.	

The Liverpool Range wind farm will be located across four local government areas:

- Upper Hunter Shire;
- Warrumbungle Shire;
- Liverpool Plains Shire; and
- Mid Western Regional Shire Local Government Areas.

Although not directly applicable to the Liverpool Range EA, GBD has also reviewed the Upper Hunter Shire Council's Development Control Plan (DCP) for Wind Power Generation (July 2011) and confirm that this LVIA addresses a number of key DCP requirements with regard to consideration of visual assessment.

GBD is cognisant of the Australian Wind Energy Association and Australian Council of National Trust's publication Wind Farms and Landscape Values National Assessment Framework, June 2007, and have encompassed the general assessment framework outlined in the National Assessment Framework within the LVIA methodology. In addition to the National Assessment Framework, the preparation of this LVIA has also included a review of the Draft NSW Planning Guidelines Wind Farms (December 2011).

This LVIA involved a comprehensive evaluation of the landscape character in which the Liverpool Range wind farm and ancillary structures will be located, and an assessment of the potential landscape and visual impacts that could result from the construction and operation of the wind farm, taking into account appropriate mitigation measures. This LVIA is based on wind farm technical and design information provided by the Proponent to GBD.

1.2 Draft NSW Planning Guidelines: Wind Farms (December 2011)

The NSW DoP&I issued the Draft Planning Guidelines: Wind Farms (Draft Guidelines) in December 2011. The Draft Guidelines provide guidance and information for wind farm applicants, consent authorities as well as communities and stakeholder groups. The Draft Guidelines were placed on

public exhibition between December 2011 and March 2012; however, had not been finalised or formally adopted by the New South Wales Government prior to completion of this LVIA.

The Draft Guidelines set out key considerations for the upfront assessment of landscape and visual impact for residential dwellings within a 2 km radius of proposed wind turbines (through the Gateway Process and Site Compatibility Certification) and specific assessment requirements that may be set out in the NSW DoP&I Director General's Requirements on a project by project basis. The Draft Guidelines also set out a comprehensive framework for the assessment of landscape and visual impacts including residential dwellings within 2 km proximity of proposed wind turbines. Landscape and visual issues are outlined in Appendix A of the Draft Guidelines 'Meeting assessment requirements - Landscape and visual amenity' (Refer **Appendix A** of this LVIA).

This LVIA has considered and given regard to the Draft Guidelines to the fullest extent practicable, and addresses the key landscape and visual amenity aspects set out in the NSW DoP&I checklist issued to the Proponent in the NSW DoP&I correspondence dated 18 April 2012. The key landscape and visual amenity aspects are set out in **Table 3**.

Table 3 NSW DoP&I Landscape and visual amenity checklist

Key aspects	LVIA Reference/Response
Provide photomontage from all non-host dwellings within 2 km of a proposed wind turbine	Photomontages have been prepared from all non host dwellings within 2 km of a proposed wind turbine, as well as 6 residential dwellings subject to negotiations for neighbour agreements (Refer LVIA **Section 10**).
Identify the zone of visual influence of the wind farm (no less than 10 km) and likely impacts in community and stakeholder values.	This LVIA has identified a 10 km zone of visual influence surrounding the proposed wind farm development and assessed likely impacts in community and stakeholder values (Refer LVIA **Sections 7, 8** and **15**).
Consider cumulative impacts on landscape and views.	This LVIA has considered potential cumulative landscape and visual impacts (Refer LVIA **Section 9**).
Outline mitigation measures to avoid or manage impacts.	This LVIA has outlined mitigation measures to minimise potential impacts (Refer LVIA **Section 15**).

1.3 National Assessment Framework

GBD is cognisant of the Australian Wind Energy Association and Australian Council of National Trust's publication Wind Farms and Landscape Values National Assessment Framework (NAF), June 2007, and have encompassed the general assessment framework outlined in the NAF within the LVIA methodology. **Table 4** outlines the relevant requirements of the NAF and the corresponding section in which they are addressed within this LVIA report.

Table 4 NAF Recommendations

NAF Tasks (through Steps 1 to 4)	LVIA Reference/Response
Step 1 Assess the Landscape Values **1A Preliminary Landscape Assessment** • 1A.1 Desktop Review • 1A.2 Seek information from Local Authority • 1A.3 Identify potential community and stakeholder interests • 1A.4 Site survey • 1A.5 Preliminary assessment of landscape values **1B Full Landscape Assessment** • 1B.1 Define the study area for assessment, including the zone of visual influence • 1B.2 Landscape Character Analysis • 1B.3 Natural and cultural values analysis • 1B.4 Involve communities and stakeholders in identifying landscape values • 1B.5 Document values and analyse significance	This LVIA has been prepared through a comparable methodology to that outlined in the NAF and has included a desktop review (pre site inspection) to determine potential view locations as well as establishing the extent and types of landscape characteristics within the 10km viewshed. Early telephone discussions with the relevant Local Authorities determined that no additional wind farm developments were current other than those notified on the DoP&I website: (http://majorprojects.planning.nsw.gov.au/page/project-sectors/transport--communications--energy---water/generation-of-electricity-or-heat-or-co-generation/) Community and stakeholder interests have been identified by an ongoing process of direct consultation between the Proponent and relevant stakeholders. The results of the consultative process are included in this LVIA as well as other relevant sections of the **EA**. Site survey and preliminary assessment work has been undertaken and incorporated into this LVIA. The preparation of a separate preliminary assessment of landscape values is not a requirement under the NSW DoP&I DGR's. This LVIA addresses the requirements of Step 1B and presents an analysis of key considerations included in

Table 4 NAF Recommendations

NAF Tasks (through Steps 1 to 4)	LVIA Reference/Response
	the NAF.
Step 2 Describe and Model the Wind Farm in the Landscape • 2.1 Describe the development • 2.2 Model the development • 2.3 Prepare a visual assessment report	This LVIA has described and modelled the Liverpool Range wind farm development and selected view points from a range of view locations including uninvolved residential dwellings and road corridors within the 10km viewshed.
Step 3 Assess the Impacts of the Wind Farm on Landscape Values • 3.1 Seek community input to potential impacts • 3.2 Identify and describe impacts • 3.3 Identify potential cumulative impacts • 3.4 Identify other relevant factors • 3.5 Evaluate impacts	Community and stakeholder interests have been identified by an ongoing process of direct consultation between the Proponent and relevant stakeholders. The results of the consultative process are outlined and included in this LVIA as well as other relevant sections of the **EA**. This LVIA has identified and described potential landscape and visual impacts associated with the Liverpool Range wind farm development as well as potential cumulative impacts resulting from other wind farm projects within the Upper Hunter Region Renewable Energy Precinct.
Step 4 Respond to Impacts • 4.1 Changes to location or siting of the wind farm or ancillary infrastructure • 4.2 Layout and design considerations • 4.3 Minor changes and mitigation measures • 4.4 Recommend changes to the development	The development of the Liverpool Range wind farm turbine layout has been reviewed and adjusted throughout the preparation of this LVIA. Changes to the layout have occurred as a result of stakeholder consultation and specific concerns directed toward the visual impact of the wind farm from surrounding view locations. Significant changes have occurred throughout the development of the preferred design layouts including the removal and repositioning of turbines within site boundary.

The NAF is noted by its authors as a framework document and does not set out a detailed or prescribed method to undertake an assessment of landscape values. This LVIA has; however, followed

the majority of techniques and has tested and determined outcomes for the principal issues that have been raised in the NAF.

1.4 Auswind Best Practice Guidelines (December 2006)

The Auswind Best Practice Guidelines were developed to assist wind farm proponents to implement best practice in regards to the location and siting of wind energy facilities and to conduct wind farm investigations and impact assessments. The guidelines have been subject to revisions following technical reviews and consultation with both industry and broader stakeholder input.

The Guidelines, developed between (the former) Auswind and the National Trust, provide a landscape assessment approach to describe, assess and evaluate the potential landscape and visual impact of a proposed wind energy project. A summary of the approach includes:

- consultation with experts in the analysis of the environments visual characteristics e.g. Landscape Architects;
- preparation of 'Zone of Visual Influence' or 'Seen Area Diagrams';
- preparation of photomontages (also referred to as Visual Simulations);
- determination of cumulative impact from existing wind energy projects;
- investigation of impacts with associated infrastructure elements, including substation, service roads and power lines; and
- assessment of Shadow Flicker.

The Auswind Best Practice Guidelines offer best practice advice and are not a mandatory requirement for wind farm developments within Australia and have been incorporated into this LVIA.

1.5 Methodology

This LVIA methodology included the following activities:

- desktop study addressing visual character and identification of view locations within the surrounding area;
- fieldwork and photography;
- preparation of ZVI diagrams;
- assessment and determination of landscape sensitivity;

- assessment of significance of visual impact; and
- preparation of photomontages and illustrative figures.

1.6 Desktop study

A desktop study was carried out to identify an indicative viewshed for the Liverpool Range wind farm. This was carried out by reference to 1:25,000 scale topographic maps as well as aerial photographs and satellite images of the Project area and surrounding landscape. A preliminary ZVI diagram was also produced prior to the commencement of fieldwork in order to inform the likely extent and nature of areas within the nominated 10km viewshed of the Project.

Topographic maps and aerial photographs were also used to identify the locations and categories of potential view locations that could be verified during the fieldwork component of the assessment. The desktop study also outlined the visual character of the surrounding landscape including features such as landform, elevation, landcover and the distribution of settlements.

1.7 Preparation of ZVI diagrams

The Proponent prepared three ZVI Diagrams to illustrate the potential visibility of the wind turbines within the Project 10km viewshed. ZVI Diagrams included visibility from tip of blade, hub height and whole turbine. The ZVI are illustrated in **Figures 12, 13**, and **14** and detailed in **Section 7** of this LVIA.

1.8 Fieldwork and photography

The fieldwork involved:

- three days of site inspections (2nd November 2012, 3rd November 2012 and 4th August 2013) to determine and confirm the potential extent of visibility of the Project and ancillary structures;
- determination and confirmation of the various view location categories and locations from which the Project structures could potentially be visible; and
- preparation of a record for each view location inspected and assessed.

1.9 Assessment of landscape sensitivity

The capability of the landscape to accommodate the wind farm will result primarily from the nature and degree of perceptual factors that can influence interpretation and appreciation of the landscape, including landform, scale, topographic features, landcover and human influence or modifications.

1.10 Significance of visual impact

The potential significance for visual impact of the Project on surrounding view locations will result primarily from a combination of the potential visibility of the wind turbines and the characteristics of the landscape between, and surrounding, the view locations and the wind farm. The potential degree of visibility and resultant visual impact will be partly determined by a combination of factors such as:

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

An underpinning rationale for this LVIA is that if people are not normally present at a particular location, such as agricultural areas, or they are screened by landform or vegetation, then there is likely to be a nil visual impact at that location.

If, on the other hand, a small number of people are present for a short period of time at a particular location then there is likely to be a low visual impact at that location, and conversely, if a large number of people are present then the visual impact is likely to be higher.

Although this rationale can be applied at a broad scale, this LVIA also considers, and has determined, the potential visual impact for individual view locations that will have a higher degree of sensitivity to the wind farm development, including the potential impact on individual residential dwellings situated in the surrounding landscape. The determination of a visual impact is also subject to a number of other factors which are considered in more detail in this LVIA.

Whilst this LVIA addresses a number of static elements associated with the Project, the assessment acknowledges and has considered the potential visual impact associated with the movement of the wind turbine rotors.

1.11 Photomontages

Photomontages have been prepared from eleven view locations to illustrate the potential visibility of the Liverpool Range wind farm following construction. The photomontages locations included three uninvolved residential dwellings within 2 km of the Liverpool Range wind turbines, in accordance with the requirements of the NSW Draft Guidelines.

The uninvolved residential and public photomontage locations were photographed by GBD. The public photomontage locations were selected to provide representative views from the vicinity of residential dwellings as well as publically accessible areas and road corridors. The photomontage locations are illustrated in **Figure 18** and the photomontages in **Figures 19** to **40**. The heights of the proposed turbines within the photomontages prepared by the Proponent were subject to peer review and verification by GBD. The photomontage methodology verification is illustrated in **Figure 41**.

1.12 Shadow flicker & blade glint

The Proponent prepared a shadow flicker assessment and report for the Liverpool Range wind farm. The results of the shadow flicker assessment are included in **Section 14** of the EA.

Location

Section 2

2.1 Location

The Project will be located on the west extent of the Liverpool Range mountain range which runs for approximately 100 km from the Barrington Tops volcanic plateau to merge with the Warrumbungle Range west of the Coolah Tops National Park. The location of the Liverpool Range wind farm is illustrated in **Figure 1**.

The Project will extend across a series of ridgelines running in an approximate north to south alignment from the Liverpool Range. The Project area will incorporate around 21 participating rural residential and farming properties covering an area around 50,900 hectares across portions of the:

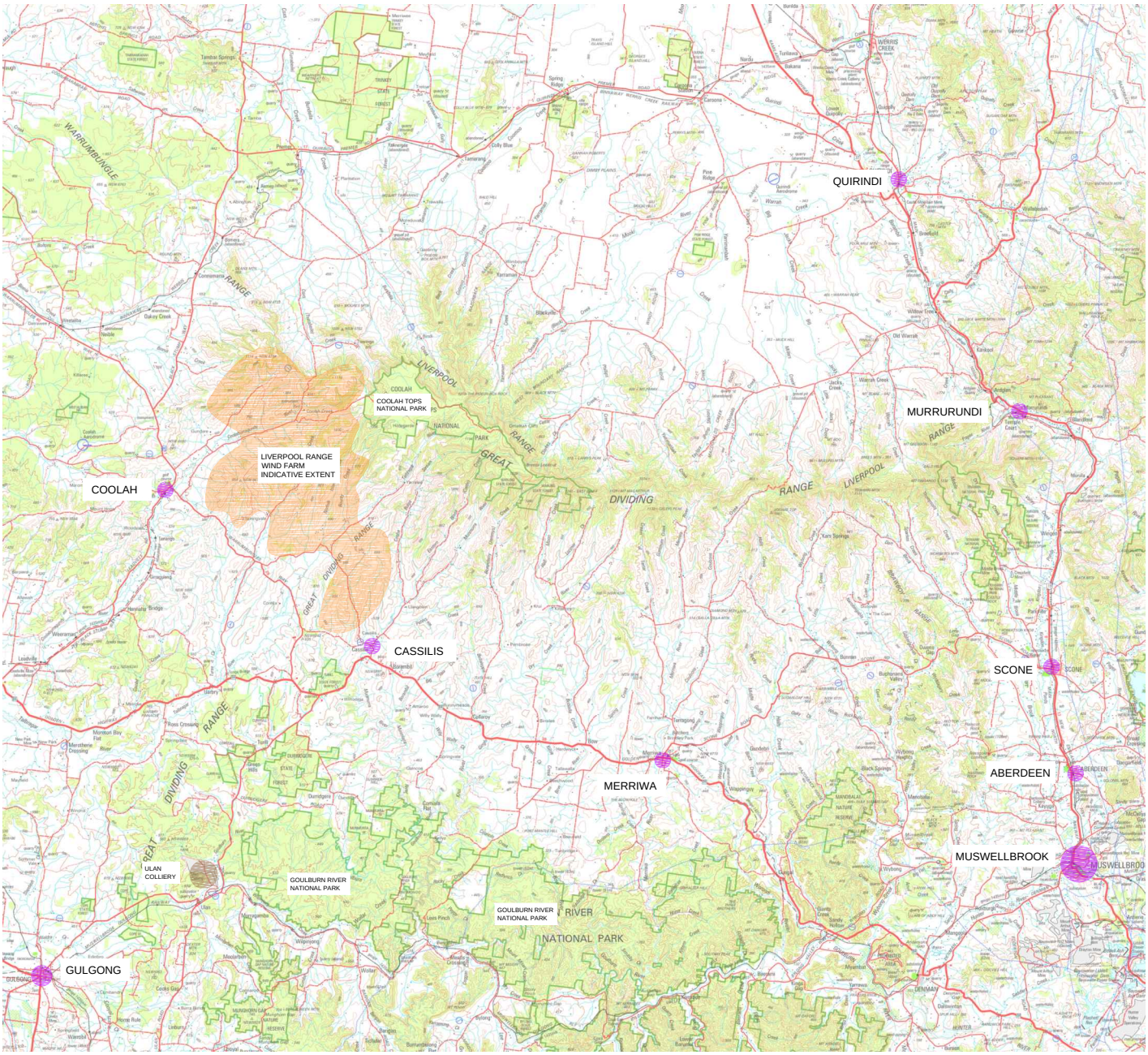
- Upper Hunter Shire;
- Warrumbungle Shire;
- Liverpool Plains Shire; and
- Mid Western Regional Shire.

Small towns and localities within and beyond the 10 km viewshed include:

- Coolah (approximately 6.5 km to the south west). Population 798;
- Cassilis (approximately 4.2 km to the south east). Population 350;
- Dunedoo - (approximately 42 km to the south west). Population 836;
- Gulgong (approximately 56 km to the south west). Population 1,866; and
- Merriwa (approximately 40 km to the south east). Population 973.

Population figures from the Australian Bureau of Statistics 2011 Census.

The Coolah Tops National Park and a small number of State Forests are located within the vicinity of the Project. The Coolah Tops National Park adjoins the north portion of the Project site boundary. Covering an area of approximately 12,000 hectares, the Park is noted as a prominent landscape feature in the region, and forms a contrasting backdrop to surrounding farmland. The northern edge of the Park provides a number of lookout locations which provide panorama views to the north of the Park. There are no designated lookouts along the south edge of the Park overlooking the wind farm site. The Park offers a small number of low key visitor opportunities such as:



LIVERPOOL RANGE WIND FARM -
LOCATION PLAN, REGIONAL CONTEXT (Not to scale)

LIVERPOOL RANGE WIND FARM -
LOCATION PLAN, STATE CONTEXT (Not to scale)

Figure 1
Location Plan

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- Camping;
- Day use areas (for picnics);
- Walking or cycling; and
- Horse riding.

The NSW National Parks and Wildlife Service note that the Park is isolated and unlikely to ever receive very high visitor numbers. The location of the Park, and the key camping and day use areas are illustrated in **Figure 49**.

Project description

Section 3

3.1 Project description

The key visual components of the Project will comprise:

- up to 288 wind turbines;
- up to 288 individual 33kV external kiosk transformers and switchgear with associated control systems to be located in the vicinity of the wind turbine towers (in some turbine models transformer equipment will be integrated within the tower or nacelle);
- underground and overhead electrical and communication cable network linking turbines to each other within the Project boundary;
- up to six new 22 or 33/330 kV collection substations and one connection substation located across the wind farm and at the Ulan colliery site respectively;
- a new overhead powerline rated at up to 330 kV (nominal) capacity. The new powerline will be mounted on a single pole type structure and may be single-circuit or double-circuit as required;
- up to 10 permanent wind monitoring masts. The permanent monitoring masts may be either static guyed or un-guyed structures and will be to a minimum height of the wind turbine hubs;
- on site access tracks for construction, operation and ongoing maintenance; and
- wind farm signage and maintenance facilities.

Temporary works associated with the construction of the wind farm that may be visible during construction and operational phases include:

- construction compounds;
- laydown and storage areas;
- crane hardstand areas; and
- mobile concrete batching plant and rock crushing facilities.

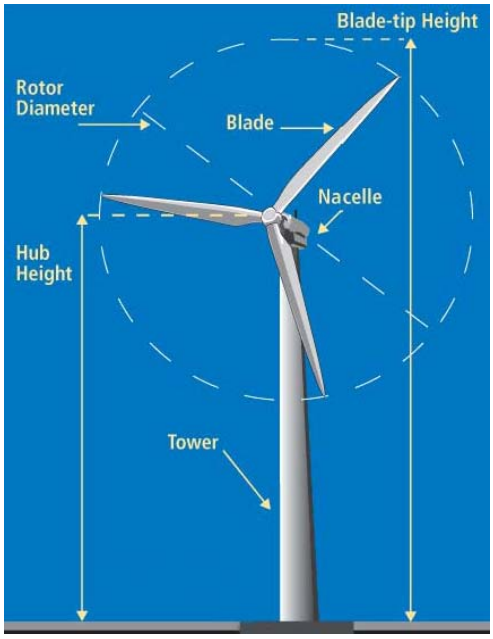
3.2 Wind turbines

The specific elements of the wind turbines comprise:

- concrete foundations;
- tubular tapering steel or concrete towers;

- nacelles at the top of the tower housing the gearbox and electrical generator;
- rotors comprising a hub (attached to the nacelle) with three blades; and
- three fibreglass / carbon fibre blades attached to each hub.

The following diagram identifies the main components of a typical wind turbine:



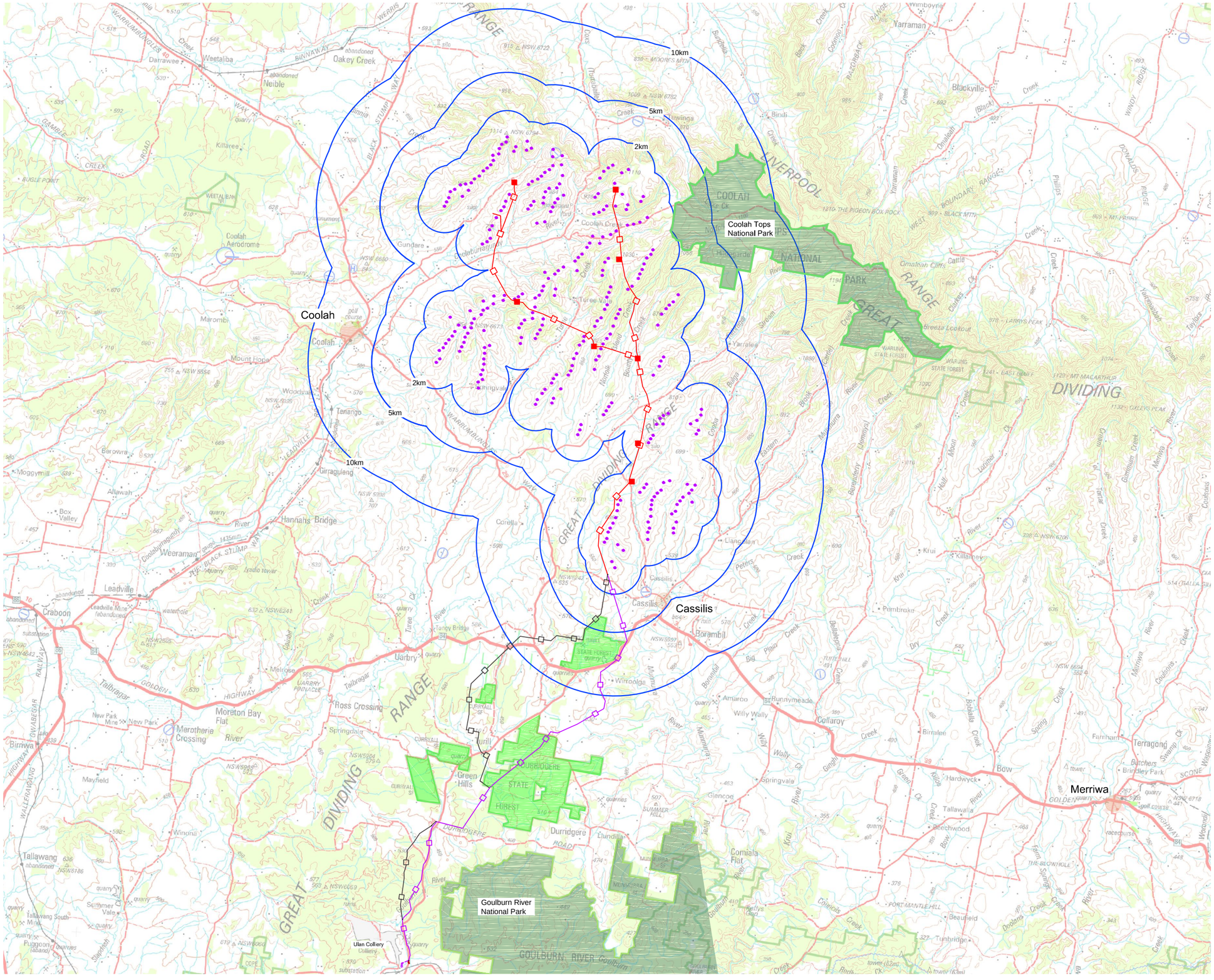
Configuration and components of a typical wind turbine

Table 5 outlines the main design parameters for the proposed Liverpool Range wind turbine layout:

Table 5 Liverpool Range wind turbine details:

Element	Description
Tower height	100 m
Rotor Diameter	130 m
Overall height from ground level to tip of blade	165 m
Proposed number of Liverpool Range wind turbines	288 turbines

As new turbines come onto the market, it is possible that the final turbine selected may exceed, in minor respects, the assessed maximum turbine envelope. Minor increases in envelope size are unlikely to alter the determination of visual significance for residential view locations included in this LVIA. The indicative Liverpool Range wind farm design layout is illustrated in **Figure 2**. The proposed 330 kV powerline route options to the Ulan colliery are illustrated in **Figure 3**.



Legend

- Proposed Liverpool Range wind turbine (indicative layout)
- Distance from proposed Liverpool Range wind turbine
- Proposed 330 kV powerline route
- Option 1 330 kV powerline route (connection south to Ulan)
- Option 2 330 kV powerline route (connection south to Ulan)
- Proposed substation location under investigation
- National Park
- State Forest

0km 10km

Figure 2
Site layout

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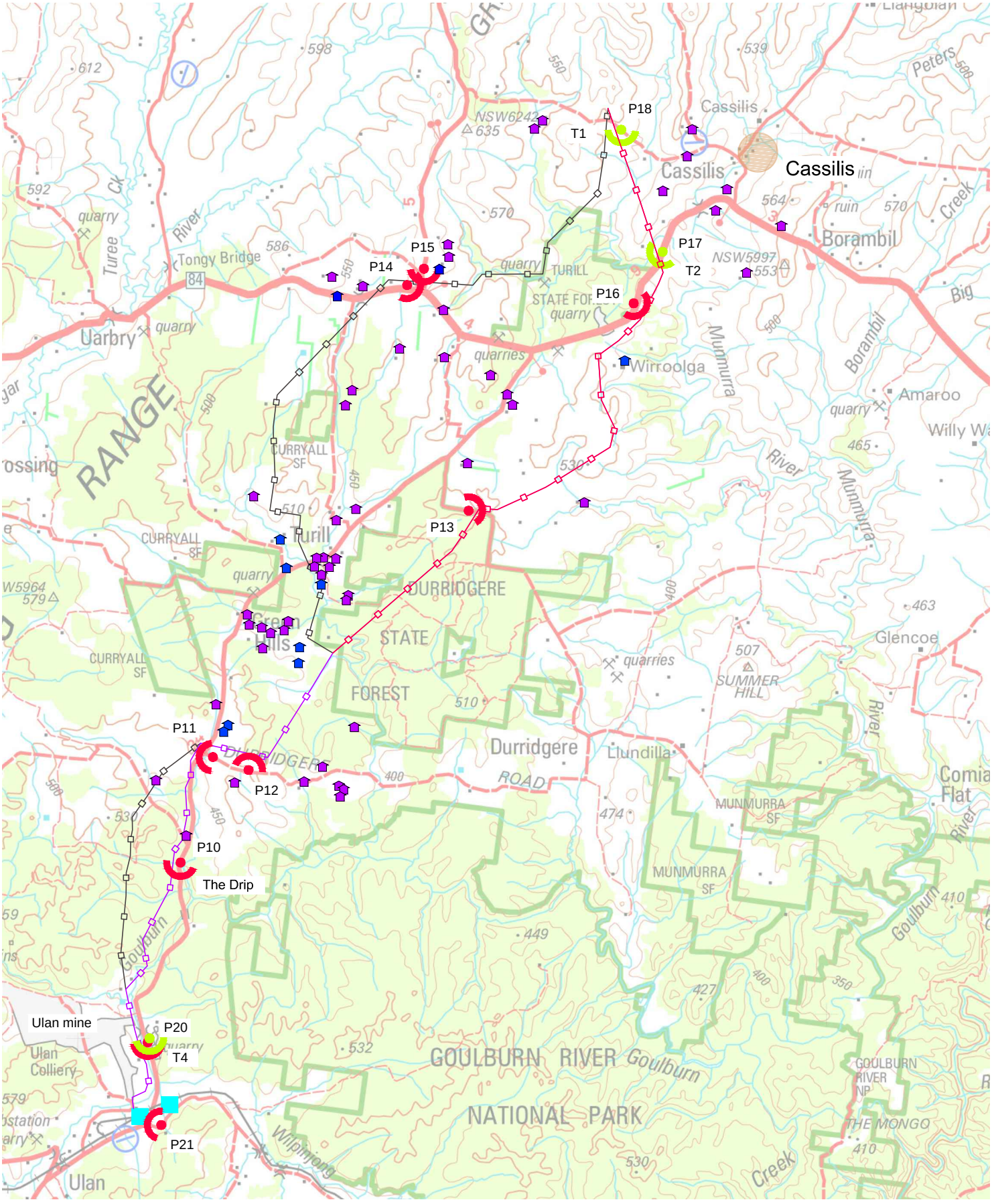

Legend

- Option 1 330 kV powerline route (connection south to Ulan)
- Option 2 330 kV powerline route (connection south to Ulan)
- Potential substation location
- Potentially involved residential dwelling (indicative location)
- Residential dwelling (indicative location)
- Photo location (refer photo sheets 4 to 7)
- Powerline photomotage location (refer Figures 53 and 54)

Figure 3
Proposed powerline Ulan Colliery connection (Option 1 and 2)

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3.3 Wind monitoring masts

Up to 10 permanent wind monitoring masts will be installed on-site, extending to a minimum height of the wind turbine hubs (around 100 m in height). The wind monitoring masts will be of a guyed or un-guyed, narrow lattice or tubular steel design. The wind monitoring masts will be unlikely to create a significant visual impact, and are similar in scale, or smaller than a number of surrounding communication masts visible in the landscape surrounding the wind farm Project area.

Plate 1 – View toward a typical guyed wind monitoring mast

3.4 On-site access tracks

On-site access tracks will be constructed to provide access to turbine locations across the site during construction and operation. During construction the majority of access tracks will be up to 5-6 m wide (wider at bends) to allow for vehicle manoeuvring. Post construction, these access tracks will be partially rehabilitated up to 6 m width to facilitate access for maintenance vehicles during the operational phase. The final access track design will be developed on a number of environmental grounds, including minimising the potential for visual impact by considering:

- overall length and extent;
- need for clearing vegetation;
- potential for erosion;

- extent of cut and fill; and
- potential to maximise rehabilitation at the completion of the construction phase.

3.5 Electrical works

The majority of cabling works, including the installation of control cables linking the turbines to the control building will be installed underground. For various technical, commercial and landform reasons some cabling may be required to be installed on medium voltage overhead powerline supported by single low profile tubular poles.

Grid connection will be achieved via a connection to the existing TransGrid 330 kV powerline which is located at the Ulan colliery, approximately 35 km south of the wind farm site. The wind farm turbines will be connected to on-site collection substations, control room and facilities for the grid connection. The proposed electrical works are described in **Section 12**.

Local environmental factors

Section 4

4.1 Climatic and atmospheric conditions

Local climatic and atmospheric conditions have the potential to influence the visibility of the Project from surrounding view locations, and more significantly, from distant view locations. Meteorological data collected over the past 100 years at Dunedoo (Post Office) indicates that there are:

- 101 clear days (annual mean average);
- 94 cloudy days (annual mean average); and
- 63 days of rain (annual mean average).

Rainfall will tend to reduce the level of visibility from a number of view locations surrounding the Project with the degree of visibility tending to decrease over distance. Rain periods will be likely to reduce the number of visitors travelling through the areas from which the Project could be visible, and potentially decrease the duration of time spent at a particular public view location with a view toward the Project.

Cloud cover will also tend to reduce the level of visibility of the Project and lessen the degree of contrast between the wind turbine structures and the background against which the wind turbines will be visible.

On clear or partly cloudy days, the position of the sun will also have an impact on the degree of visibility of the Project. The degree of impact will be largely dependent on the relationship between the position and angle of the sun relative to the view location. Late afternoon and early evening views toward the west will result in the wind turbines silhouetted above the horizon line, and with increasing distance will tend to reduce the contrast between the wind turbine structures and the surrounding landform.

The extent to which weather conditions can influence visibility toward turbine structures is illustrated in **Figure 4**.

4.2 Topography and drainage

The landform of the wind farm site falls gently from the north to the south across a series of ridgelines sloping from the Liverpool Range mountain range toward the localities of Coolah and

PHOTOGRAPH A - Day time view from Hume highway toward Cullerin wind farm at around 3.5km (13th June 2010)

PHOTOGRAPH A
Illustrates the visibility of wind turbines against a clear and blue sky backdrop with sunlight from above and to the right of the wind turbines creating a shadow line along the left hand side of the towers as well as portions of the rotor blades.

PHOTOGRAPH B - Day time view from Hume highway toward Cullerin wind farm at around 3.5km (10th June 2010)

PHOTOGRAPH B
Illustrates the visibility of wind turbines against a partly cloudy and overcast backdrop. The wind turbines in cloud shadow appear off white to grey in colour.

PHOTOGRAPH C - Day time view from Hume highway toward Cullerin wind farm at around 3.5km (7th July 2010)

PHOTOGRAPH C -
Illustrates the visibility of wind turbines in fog/low cloud cover.

Figure 4
Visibility and weather

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Cassilis. A number of ephemeral drainage lines occur across the Project site, draining to broader valleys west and east of the wind farm site. Landform and elevation within and surrounding the Project site are illustrated in **Figure 5**.

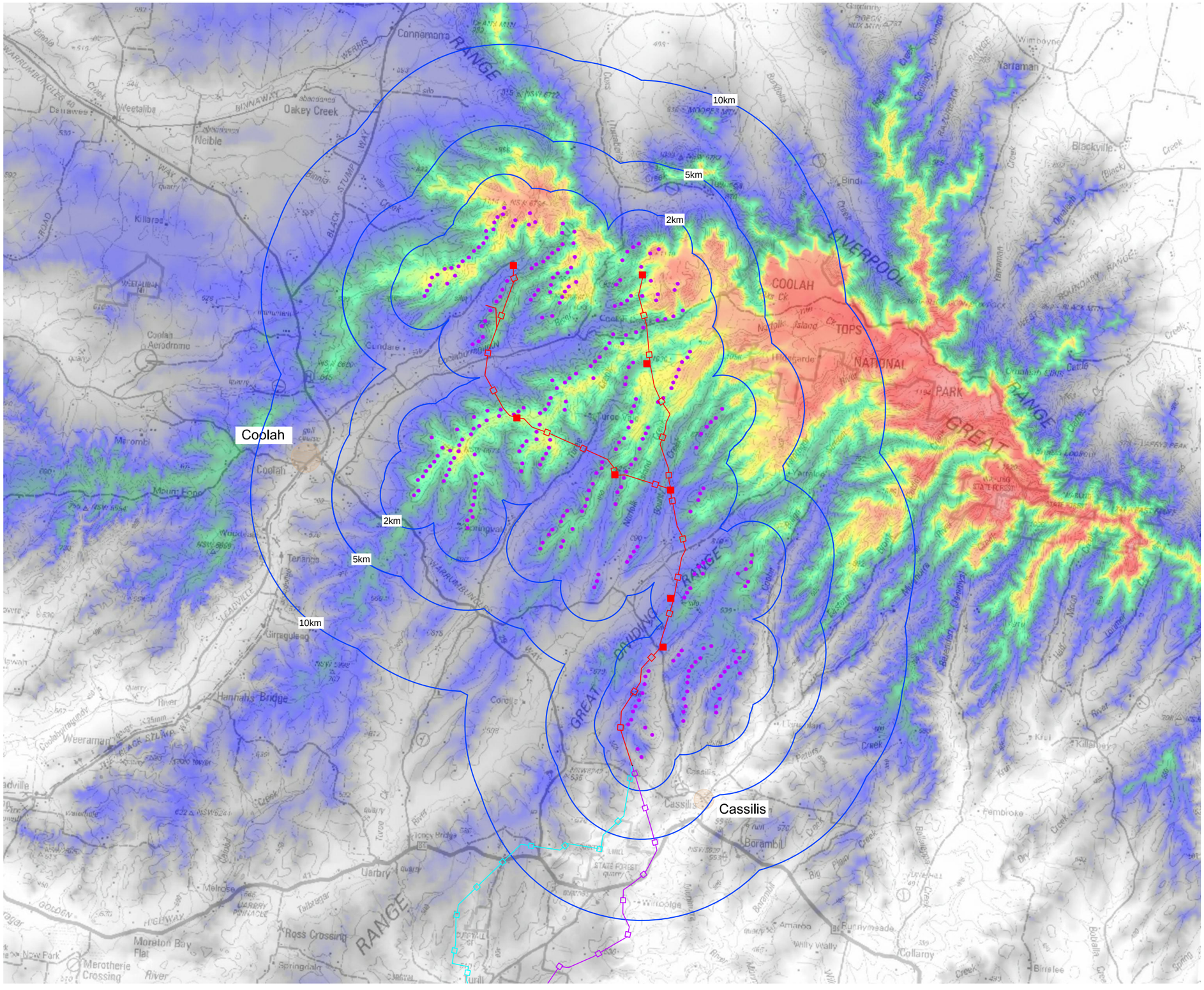
4.3 Vegetation

A detailed survey of existing vegetation has been carried out as part of the biodiversity assessment for the Project EA and is summarised in the **Section 11** of the EA.

In general the landscape within the Project site contains vegetation associated with woodland, drainage lines, small ponds/dams and cleared land for pasture and agricultural crop cultivation. Stands of remnant woodland occur within the wider context of a modified landscape which continues to be managed through a variety of farming activities.

Timbered areas have some potential to provide partial or full screening toward the Project area from surrounding public and residential view locations. The screening potential tends to increase when combined with the local topography of hills and undulating landform.

The landscape within and surrounding the Project site is illustrated in the panorama photographs presented in **Figures 7**, **8** to **9**.



Legend

- Proposed Liverpool Range wind turbine
- Distance from proposed Liverpool Range wind turbine
- Proposed 330 kV powerline route within project area
- Option 1 330 kV powerline route (project area to Ulan substation)
- Option 2 330 kV powerline route (project area to Ulan substation)

Elevation (meters)

- 1,240
- 1,137
- 1,034
- 931
- 828
- 725
- 622
- 519

0km 10km

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Figure 5
Topography

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Panorama photographs

Section 5

5.1 Panorama Photographs

A series of digital photographs were taken during the course of the fieldwork to illustrate existing views in the vicinity of a number of view locations inspected and assessed as part of this LVIA. Individual photographs were digitally stitched together to form a segmented panorama image to provide a visual illustration of the existing view from each photo location.

The panorama photographs presented in this LVIA have been annotated to identify key features or structures located within the existing view. They also indicatively illustrate the general extent and location of potentially visible wind turbines or portions of turbine structures for the Project.

The panorama photograph locations are illustrated in **Figure 6**, and the panorama photographs illustrated in **Figures 7**, **8** to **9**. The panorama photographs are not to be confused with the photomontages. The panorama photographs do not include a representation or model of the wind turbine structures. The photomontages are discussed in **Section 10** of this LVIA, and are illustrated in **Figures 19** to **40**.

Legend

- Panorama photo location
- Powerline panorama photo location (refer photo sheet 7)
- Proposed Liverpool Range wind turbine (indicative layout)
- Distance from proposed Liverpool Range wind turbine
- Proposed 330 kV powerline route
- Option 1 330 kV powerline route (connection south to Ulan)
- Option 2 330 kV powerline route (connection south to Ulan)
- Coolah Tops National Park

0km 10km

Figure 6
Photo locations

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Photo Location P1- View north east to north west from Rotherwood Road (Approximate distance to closest wind turbine 3 km)

Photo Location P2 - View north west to north from Rotherwood Road (Approximate distance to closest wind turbine 4 km)

Photo Location P3 - View west to north west from Rotherwood Road (Approximate distance to closest wind turbine 2 km)

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 7
Photo Sheet 1

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Photo Location P4 - View north from Turee Vale and Cassilis Road intersection (Approximate distance to closest wind turbine 4 km)

Photo Location P5 - View north east to east from Turee Vale Road (Approximate distance to closest wind turbine 2 km)

Photo Location P6 - View north east to east from Cassilis Road, Coolah (Approximate distance to closest wind turbine 6 km)

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 8
Photo Sheet 2

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Photo Location P7 - View north east from Mauualey-Coolah and Gundaree Road intersection (Approximate distance to closest wind turbine 6.5 km)

Photo Location P8 - View north east to east from Gundaree Road (Approximate distance to closest wind turbine 4.3 km)

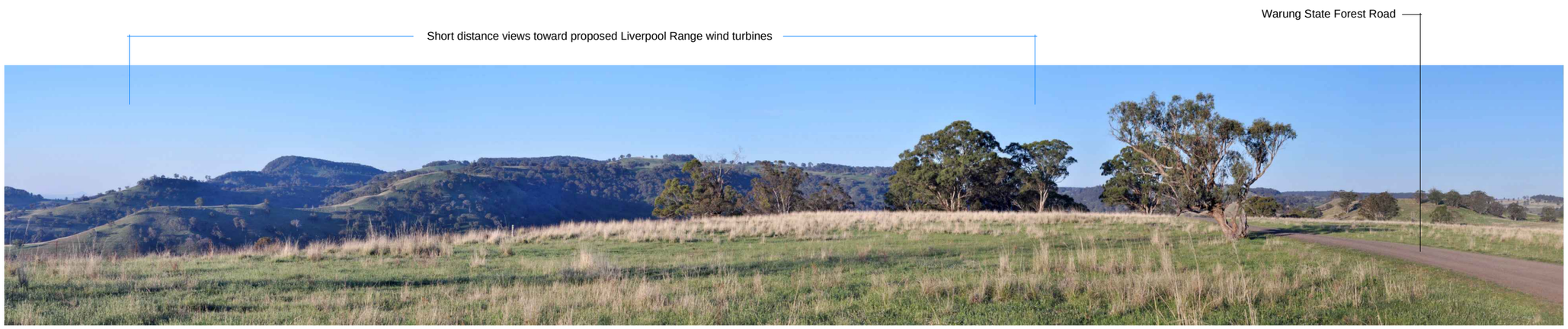

Photo Location P9 - View north from the Warung State Forest Road (Approximate distance to closest wind turbine 2 km)

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 9
Photo Sheet 3

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Landscape character areas

Section 6

6.1 Landscape character areas

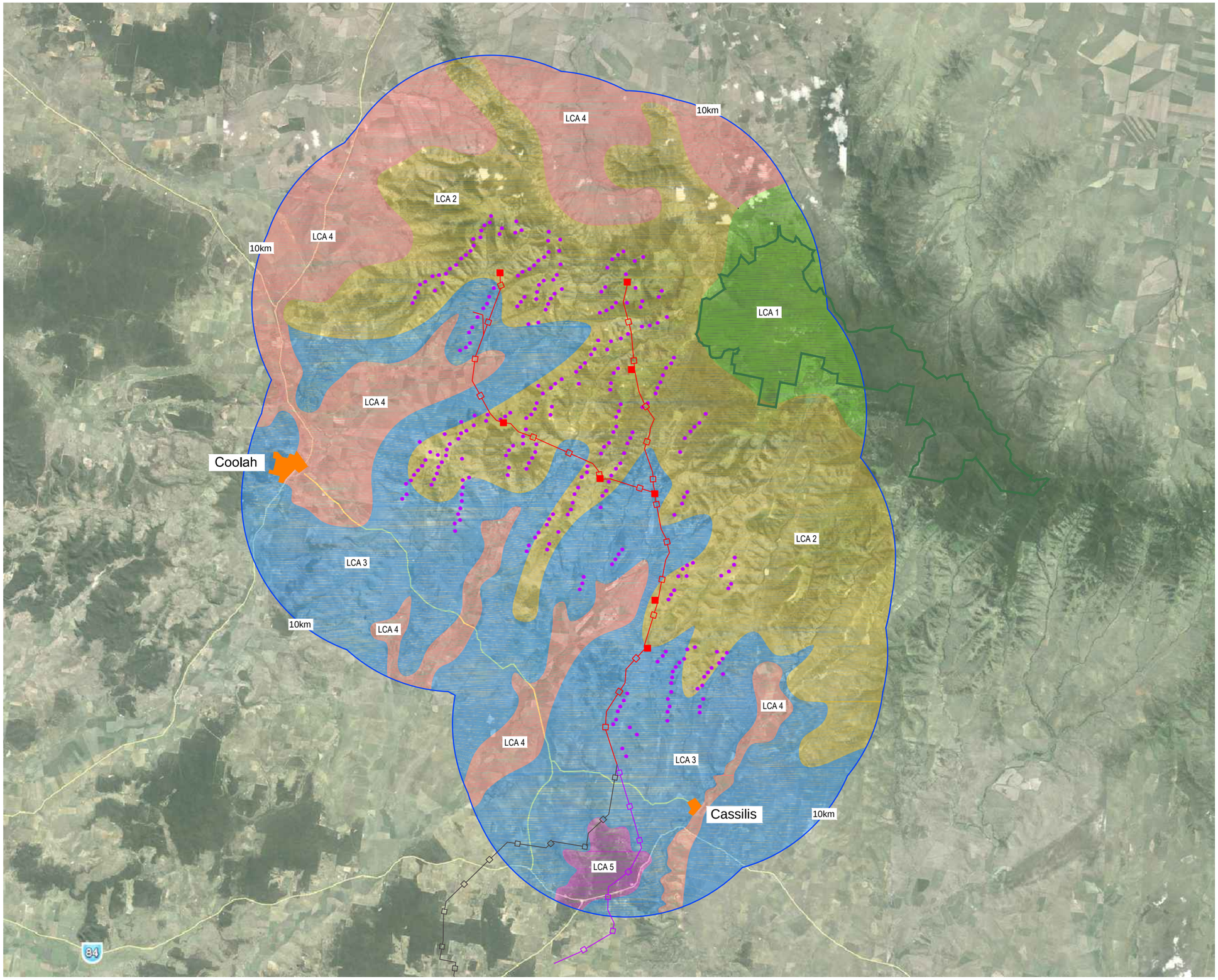
A fundamental part of this LVIA is to understand and describe the nature and sensitivity of different components of the landscape within the Project 10 km viewshed, and to assess the landscape character in a clear and consistent process. For the purpose of this LVIA, landscape character is defined as '*the distinct and recognisable pattern of elements that occur consistently in a particular type of landscape'* (The Countryside Agency and Scottish Natural Heritage 2002).

This LVIA has identified six Landscape Character Areas (LCA's), which occur within the Project 10 km viewshed. The six LCA's represent areas that are relatively consistent and recognisable in terms of their key visual elements and physical attributes; which include a combination of topography/landform, vegetation/landcover, land use and built structures (including settlements and local road corridors).

The six LCA's have been identified through a desk top assessment and described during the landscape assessment fieldwork (carried out over three days) for the Liverpool Range wind farm LVIA. The six LCA have been determined and illustrated in **Figure 10**. The LCA's are not considered to be discrete areas, and characteristics within one LCA may occur within adjoining or surrounding LCA's. For the purpose of this LVIA the six LCA are:

- LCA 1 – Upper plateau (forested);
- LCA 2 – Plateau spur (ridge and gully complex);
- LCA 3 – Slope and hill;
- LCA 4 – Cultivated agricultural land;
- LCA 5 – Woodland; and
- LCA 6 – Settlement.

An overview of each LCA is presented below, with further description and assessment provided in **Tables 7** to **12**.



Legend

- Proposed Liverpool Range wind turbine (indicative layout)
- Distance from proposed Liverpool Range wind turbine
- Proposed 330 kV powerline route
- Option 1 330 kV powerline route (connection south to Ulan)
- Option 2 330 kV powerline route (connection south to Ulan)
- Proposed substation location under investigation
- Coolah Tops National Park
- LCA 1 - Upper plateau (forested)
- LCA 2 - Plateau spur (ridge and gully complex)
- LCA 3 - Slopes and hills
- LCA 4 - Cultivated agricultural land
- LCA 5 - Woodland
- LCA 6 - Settlement

0km 10km

Figure 10
Landscape Character Areas

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6.1.1 Upper plateau (forested)

The upper plateau LCA is located in the north-west portion of the 10 km viewshed and incorporates a moderate to densely forested plateau that extends across the western section of the Coolah Tops National Park.

The physical attributes and landscape sensitivity of the upper plateau LCA are described and assessed in **Table 7**.

6.1.2 Plateau spur (ridge and gully complex)

The plateau spur LCA comprises a series of complex ridges and gullies that occur in a west to south west and south direction from the narrow plateau above. The plateau spur is located in the north west to south east portion of the 10 km viewshed. The gullies are moderate to deep incised features which form a large number of ephemeral drainage lines flowing toward creeks within narrow valleys between ridgelines. The plateau spur incorporates moderate to dense stands of tree cover on steeper side slopes and alongside riparian areas.

The physical attributes and landscape sensitivity of the plateau spur LCA are described and assessed in **Table 8**.

6.1.3 Slope and hill

The slopes and hills LCA comprises low rolling hills, ridgelines and broad valleys below areas of steeper topography within the plateau spur LCA. The slopes and hills LCA extends through the central and south to south west portion of the 10 km viewshed. The slopes and hills incorporate small areas of dense timber stands as well as broader areas of scattered tree cover.

The physical attributes and landscape sensitivity of the slopes and hills LCA are described and assessed in **Table 9**.

6.1.4 Cultivated agricultural land

The cultivated agricultural land LCA comprises gently sloping to relatively level areas of land within the north portion of the 10 km viewshed and isolated valley bottoms between slopes and hills in the west and southern portion of the viewshed.

The physical attributes and landscape sensitivity of the cultivated agricultural land LCA are described and assessed in **Table 10**.

6.1.5 Woodland (State Forest)

The woodland (State Forest) LCA comprises gently sloping and undulating areas of land within the south portion of the 10 km viewshed. The LCA generally encompasses the Turill State Forest which is a moderate to densely timbered area north of the Golden Highway.

The physical attributes and landscape sensitivity of the woodland (State Forest) LCA are described and assessed in **Table 11**.

6.1.6 Settlement (Coolah and Cassilis)

The settlement LCA comprises the Coolah township and Cassilis village. Coolah is located within the western portion of the 10 km viewshed and Cassilis within the south.

The physical attributes and landscape sensitivity of the settlement LCA are described and assessed in **Table 12**.

6.2 Landscape sensitivity assessment

The British Landscape Institute describes landscape sensitivity as '*the degree to which a particular LCA can accommodate change arising from a particular development, without detrimental effects on its character'*.

The assessment of landscape sensitivity is based upon an evaluation of the physical attributes identified within each LCA, both singularly and as a combination that gives rise to the landscape's overall robustness and the extent to which it could accommodate the wind farm development. The criteria used to determine landscape sensitivity are outlined in **Table 6** and are based on current good practice employed in the assessment of wind farm developments. This LVIA draws on the Land Use Consultants report on landscape sensitivity for wind farm developments on the Shetland Islands (March 2009) as well as the Western Australian Planning Commission manual for Visual Landscape Planning (2007). Landscape sensitivity is a relative term, and the intrinsic landscape values of the surrounding landscape could be considered of a higher or lower sensitivity than other areas in the Upper Hunter region.

Whilst the assessment of landscape sensitivity is largely based on a systematic description and analysis of landscape characteristics, this LVIA acknowledges that some individuals and other members of the local community will place higher values on the local landscape. These values could transcend preferences (likes and dislikes) and include personal, cultural as well as other parameters.

Table 6 – Landscape Sensitivity Criteria

Landscape Sensitivity Assessment Criteria			
Landscape Characteristic	**Aspects indicating lower sensitivity to the wind farm development**	↔	**Aspects indicating higher sensitivity to the wind farm development**
Landform and scale: patterns, complexity and consistency	• Large scale landform • Simple • Featureless • Absence of strong topographical variety	↔	• Small scale landform • Distinctive and complex • Human scale indicators • Presence of strong topographical variety
Landcover: patterns, complexity and consistency	• Simple • Predictable • Smooth, regular and uniform	↔	• Complex • Unpredictable • Rugged and irregular
Settlement and human influence	• Concentrated settlement pattern • Presence of contemporary structures (e.g. utility, infrastructure or industrial elements)	↔	• Dispersed settlement pattern • Absence of modern development, presence of small scale, historic or vernacular settlement
Movement	• Prominent movement, busy	↔	• No evident movement, still
Rarity	• Common or widely distributed example of landscape character area within a regional context	↔	• Unique or limited example of landscape character area within a regional context
Intervisibility with adjacent landscapes	• Limited views into or out of landscape • Neighbouring landscapes of low sensitivity • Weak connections, self contained area and views • Simple large scale backdrops	↔	• Prospects into and out from high ground or open landscape • Neighbouring landscapes of high sensitivity • Contributes to wider landscape • Complex or distinctive backdrops

The landscape sensitivity assessment criteria listed in **Table 6** have been evaluated for each of the six LCAs by applying professional judgement to determine a rating on a sliding scale between 1 and 5.

The lowest rating of 1 indicates a landscape characteristic with a lower sensitivity to the wind farm development (and will be more likely to accommodate the wind farm development). The highest rating of 5 indicates a landscape characteristic with a high level of sensitivity to the wind farm development (and less likely to accommodate the wind farm development).

The landscape sensitivity rating for each of the six LCA is outlined in **Tables 7** to **12** and is set out against each landscape characteristic identified in **Table 6**.

The overall sensitivity rating for each LCA has been determined by adding the individual rating determined for each landscape characteristic identified in **Tables 7** to **12**. The overall sensitivity rating is expressed as a total score out of 30 (i.e. 6 characteristics for each LCA with a potential top scale of 5). Each landscape characteristic is assessed separately and the criteria set out in **Table 6** are not ranked in equal significance.

The overall landscape sensitivity for each of the six LCA has been determined as either:

High (Scale of 24 to **30)** – key characteristics of the LCA will be impacted by the proposed Project, and will result in major and visually dominant alterations to perceived characteristics of the LCA which may not be fully mitigated by existing landscape elements and features. The degree to which the landscape may accommodate the proposed Project development will result in a number of perceived uncharacteristic and significant changes.

Medium to High (Scale of 16 to **23)** – recognisable characteristics of the LCA 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 but may be partially mitigated by existing landscape elements and features within the LCA. The main characteristics of the LCA, patterns and combinations of landform and landcover will still be evident.

Medium (Scale 11 to 15) – distinguishable characteristics of the LCA may be altered by the proposed Project, although the LCA may have the capability to absorb some change. The degree to which the LCA may accommodate the proposed Project will potentially result in the introduction of prominent elements to the LCA, but may be accommodated to some degree.

Low Rating (Scale of 6 to **10)** – the majority of the LCA characteristics are generally robust, and will be less affected by the proposed Project. The degree to which the landscape may accommodate the wind farm will not significantly alter existing landscape character.

Very Low or Negligible Rating (Less than 6) the characteristics of the LCA will not be impacted or visibly altered by the proposed Project.

6.3 Analysis of landscape sensitivity

The following section of this LVIA provides an analysis of landscape sensitivity within the viewshed of the wind farm development and considers each of the six LCA's.

6.3.1 LCA 1 Upper plateau (forested)

Plate 2 – Typical view toward upper plateau (forested) LCA

Table 7 – LCA 1 – Upper plateau (forested) -Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
Rating	Low	Low to Med	Medium	Med to High	High
Landform and Scale	1	2	3	4	5
	The upper plateau LCA is a medium to large landscape with a moderate undulating landform. The structure of the landform is simple containing few distinct features and has some variety in topographical elements.				
Landcover	1	2	**3**	4	5
	The landcover is predominantly simple and predictable within the context of the broader Upper Hunter regional landscape. The overall landscape pattern created by the upper plateau forested areas is smooth, regular and uniform.				
Settlement and human influence	1	2	**3**	4	5
	There is a general absence of modern development throughout this LCA. A small number of minor structures are located within the Coolah Tops National Park.				
Movement	1	2	3	**4**	5
	Movement through the LCA is generally restricted to areas within the Coolah Tops National Park.				
Rarity	1	2	3	**4**	5
	Upper plateau areas are a limited feature in the regional area of the Upper Hunter landscape.				
Intervisibility	1	2	**3**	4	5
	Upper plateau areas appear as a simple backdrop in views from surrounding elevated areas. Undulating landform can retain and constrict views within the landscape, but generally contributes to the wider landscape.				
Overall Sensitivity Rating	Medium to High (Score 21 out of 30)				

6.3.2 LCA 2 Plateau spur (ridge and gully)

Plate 3 – Typical view across plateau spur LCA

Table 8 – LCA 2 – Plateau spur – Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
Rating	Low	Low to Med	Medium	Med to High	High
Landform and Scale	1	2	**3**	4	5
	The plateau spur (ridge and gully) is a moderate to large scale landform. The structure of the landform is simple containing few distinct features and has some variety in topographical elements.				
Landcover	1	2	**3**	4	5
	Landcover is predominantly simple and predictable within the context of widespread ridge and gully landscapes across the broader regional area of the Upper Hunter. The overall landscape pattern is smooth, regular and uniform, although occasional timbered stands along drainage lines create some diversity and contrast in pattern.				
Settlement and human influence	1	2	**3**	4	5
	There is low density settlement within this landscape with a small and dispersed number of agricultural structures (some abandoned), minor access tracks and fences occurring throughout.				
Movement	1	2	**3**	**4**	5
	A lack of any significant movement gives this landscape an overall still character.				
Rarity	1	**2**	3	4	5
	Ridge and gully landforms are generally well represented and a common feature across the broader regional area of the Upper Hunter landscape.				
Intervisibility	1	2	**3**	4	5
	Intervisibility is limited as views from within this landscape are often contained by sloping landform rising above and beyond cultivated areas.				
Overall Sensitivity Rating	Medium to High (Score 18 out of 30)				

6.3.3 LCA 3 Slopes and hills

Plate 4 – Typical views along slopes and hills LCA

Table 9 – LCA 3 – Slopes and hills - Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
Rating	Low	Low to Med	Medium	Med to High	High
Landform and Scale	1	**2**	3	4	5
	Slope and hill areas are represented by a generally open and large scale landform with distant views available from elevated areas within this landscape. The landform is simple containing few distinct features and has a general absence of any strong topographical elements.				
Landcover	1	**2**	3	4	5
	Landcover is predominantly simple and predictable within the context of similar areas across the Upper Hunter. The overall landscape pattern created by grass pasture within this landscape is smooth, regular and uniform, although mosaics of timbered areas on surrounding slopes and cultural planting surrounding dwellings create some diversity and contrast in pattern.				
Settlement and human influence	1	2	**3**	4	5
	Settlement is occasional and dispersed within this landscape and does not generally occur along the top of ridgelines or on elevated and exposed slopes. The main influences of human activity are the effects of agricultural improvement within the landscape.				
Movement	1	2	**3**	**4**	5
	Movement is generally limited to local roads and access tracks.				
Rarity	1	**2**	**3**	4	5
	Simple slopes and ridgelines are generally well represented and a common feature across the broader regional area of the Upper Hunter.				
Intervisibility	1	2	**3**	4	5
	Intervisibility is limited as views from within this landscape are often contained by undulating or sloping landform rising to ridgelines, however, potential distant views do occur from elevated landform to provide links to adjoining landscape areas.				
Overall Sensitivity Rating	Medium to High (Score 16 out of 30)				

6.3.4 LCA 4 Cultivated agricultural land

Plate 5 – Typical view across cultivated agricultural land LCA

Table 10 – LCA 4 – Cultivated agricultural land - Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
Rating	Low	Low to Med	Medium	Med to High	High
Landform and Scale	1	**2**	3	4	5
	The agricultural landscape is a medium to large scale open landscape with a gently undulating landform. The structure of the landform is simple containing few distinct features and has a general absence of any strong topographical elements.				
Landcover	1	**2**	3	4	5
	Landcover is predominantly simple and predictable within the context of similar cultivated areas across the Upper Hunter. The overall landscape pattern created by the grass pasture is smooth, regular and uniform. Areas of cultural planting surround many rural dwellings in the form of evergreen windbreaks.				
Settlement and human influence	1	2	**3**	4	5
	A dispersed settlement pattern occurs across the landscape and comprises rural farm homesteads. There is a general absence of modern development throughout this landscape, excluding agricultural structures and local roads and access tracks.				
Movement	1	2	**3**	4	5
	Movement is generally restricted to occasional passing traffic, livestock as well as agricultural machinery.				
Rarity	1	**2**	**3**	4	5
	Cultivated agricultural areas are reasonably well represented and an established feature across broader regional areas of the New South Wales Upper Hunter landscape.				
Intervisibility	1	2	**3**	4	5
	Cultivated agricultural areas appear as a simple backdrop in views from surrounding elevated areas. The landform can retain and constrict views within the landscape, but generally contributes to the wider landscape.				
Overall Sensitivity Rating	Medium (Score 15 out of 30)				

6.3.5 LCA 5 Woodland (State Forest)

Plate 6 – Typical view toward Turill State Forest

Table 11 – LCA 5 – Settlement - Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
Rating	Low	Low to Med	Medium	Med to High	High
Landform and Scale	1	2	3	**4**	5
	Woodland areas occur across a range of landform types that are generally defined by gently sloping or undulating landform resulting in a moderate scale landform. The landform is simple containing few distinct features and has an absence of any strong topographical elements.				
Landcover	1	**2**	3	4	5
	Landcover is predominantly simple and predictable within the context of similar woodland areas across the Upper Hunter. The overall landscape pattern created by woodland areas creates diversity and contrast to the smooth, regular and uniform grass pasture and cultivated areas within the surrounding landscape. The darker coloured foliage of timbered areas contrast against the surrounding backdrop of lighter toned pasture and cultivated areas.				
Settlement and human influence	1	2	**3**	4	5
	Settlement is limited within timbered areas with the majority of dwellings visually screened from surrounding landscape areas. The main influences of human activity are the effects of agricultural improvement within the landscape.				
Movement	1	2	3	**4**	5
	Movement is generally limited to local roads and access tracks.				
Rarity	1	**2**	3	4	5
	Timbered areas are reasonably well represented and an established feature across broader regional areas of the New South Wales Upper Hunter.				
Intervisibility	1	2	**3**	4	5
	The level of intervisibility between this landscape and adjoining areas is generally determined by the location and extent of wooded areas relative to view locations, but on the whole is limited as views from within this landscape are contained by vegetation.				
Overall Sensitivity Rating	Medium to High (Score 18 out of 30)				

6.3.6 LCA 6 Settlement

Plate 7 – Typical view toward Coolah

Table 12 – LCA 6 – Settlement - Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
Rating	Low	Low to Med	Medium	Med to High	High
Landform and Scale	1	2	**3**	4	5
	Rural settlement is generally surrounded and contained by gently sloping and low undulating landform resulting in an overall small scale rural urban environment.				
Landcover	1	**2**	3	4	5
	The overall landscape pattern is defined by human scale indicators including houses, shops and roads together with a variety of urban structures which create some diversity and contrast in pattern. There are generally no elements that result in the presence of strong topographical variety.				
Settlement and human influence	1	2	**3**	4	5
	Dwellings are dispersed beyond village and township settlement areas and are generally associated with individual farms and rural structures.				
Movement	1	**2**	3	4	5
	Movement occurs within village and township local roads and access tracks.				
Rarity	1	**2**	3	4	5
	Small scale urban settlements are dispersed across the landscape, as well as the broader regional area of the Upper Hunter.				
Intervisibility	1	2	**3**	4	5
	Intervisibility is limited where views are partially contained by buildings and structures, although views from elevated areas of the settlement extend beyond and across adjoining landscape areas.				
Overall Sensitivity Rating	Medium (Score 15 out of 30)				

6.4 Landscape values (local and regional)

6.4.1 What are landscape values?

For the purpose of this LVIA landscape values have been considered as a set of professional judgements on the importance to society of the local and regional landscape surrounding the proposed wind farm development. Societal landscape values may extend across a range of specific interests such as historic, environmental or cultural issues. The purpose of identifying local and regional landscape values is to consider what, if any, losses to landscape features or characteristics may result from the construction and operation of the wind farm development, and how this may impact upon local and regional landscape values.

6.4.2 Historical landscape values

Both the local and regional landscape has a strong association with early European settlement and agricultural production and specifically the establishment of pastoral properties. The European historical and cultural association with settlement and agrarian transition is set against a backdrop of indigenous populations being relocated and ultimately removed from the landscape. The removal of the indigenous population resulted in long held landscape cultural values and practices being replaced by those employed by early settlers in the mid to early 19th century. Landscape change resulting from the abrupt replacement of landscape values (from subsistence to industrial agriculture) has wrought significant alteration to the landscape; however the existing landscape pattern is one that most people at the local and regional scale would recognise as typical and representative of a rural agricultural landscape. A detailed consideration and assessment of the relationship between landscape and indigenous populations is described in the Aboriginal Cultural Heritage Assessment Report within the EA.

6.4.3 Existing landscape values

Whilst the landscape is likely to hold more significant value at a local level, for those who both work and reside within the landscape surrounding the proposed wind farm development, there are no specific references to designations or policies which indicate or recognise a 'high value' landscape. There are no 'iconic' landscape elements (including constructed or natural features) that occur within the local or regional landscape which have a broader public value or that are recognised at a national

level. The majority of land within and surrounding the wind farm development is privately owned and, at a local and regional scale, opportunities for the broader public to access and explore the landscape and obtain distant and panoramic views are largely limited to existing rights of way such as road corridors. The proposed wind farm development is not considered to have the potential to have a significant impact on existing landscape values.

6.5 Summary

In terms of overall landscape sensitivity, this LVIA has determined that the landscape within the viewshed of the proposed Liverpool Range wind farm has a medium to high sensitivity to accommodate change, and represents a landscape that is reasonably typical of landscape types found in surrounding areas of the Upper Hunter.

As a landscape with an overall medium to high sensitivity to accommodate change, recognisable characteristics of the LCA 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 but may be partially mitigated by existing landscape elements and features within the LCA. The main characteristics of the LCA, patterns and combinations of landform and landcover will still be evident.

Despite being 'naturalistic' in appearance large portions of the Upper Hunter landscape have been heavily modified by agricultural improvement for pasture and arable production post European settlement. In more recent times large scale mining operations have emerged. Irrespective of the extent and nature of modifications to the landscape, it is not correct to assume that the landscape surrounding the wind farm should be any less valued as a result of modification. Physical change in the appearance of the landscape is an ongoing and constant process from both human and environmental influences and can result in both positive and negative effects.

Viewshed, zone of visual influence and visibility Section 7

7.1 Introduction

A key component of this LVIA is defined by the description, assessment and determination of the viewshed, zone of visual influence and visibility associated with the wind farm. It is a combination of these issues that sets out the framework for determining the significance and magnitude of potential visual impact of the wind farm on view locations within the landscape.

In order to clarify and explain this component of this LVIA, the relationship between viewshed, zone of visual influence and visibility is outlined and defined in **Table 13**.

Table 13 – Definitions

	Definition	Relationship
Viewshed	An area of land surrounding and beyond the Project area which may be potentially affected by the wind farm.	Identifies the majority of this LVIA study area that incorporates view locations that may be subject to a degree of visual impact.
Zone of Visual Influence (ZVI)	A theoretical area of landscape from which the wind farm structures may be visible.	Determines areas within a viewshed from which the wind turbines may be visible.
Visibility	A relative determination at which a wind turbine or cluster of wind turbines can be clearly discerned and described.	Describes the likely number and relative scale of wind turbines visible from a view location.

An overview of viewshed, zone of visual influence and visibility is discussed in the following sections.

7.2 Viewshed

For the purpose of this LVIA viewshed is defined as the area of land surrounding and beyond the Project area which could be potentially affected by the wind farm. In essence, the viewshed defines this LVIA study area. The viewshed for the Project has been divided into a series of concentric bands (at 2 km, 5 km and 10 km distance offsets) extending across the landscape from the wind turbines. The viewshed extent can vary between wind farm projects, and be influenced or informed by a number of criteria including the height of the wind turbines together with the nature, location and height of landform that could limit visibility.

It is important to note that the wind turbines will be visible from some areas of the landscape beyond the 10 km viewshed; however, within the general parameters of normal human vision, a wind turbine

at around 165 m to the tip of the rotor blade will occupy a relatively small proportion of a person's field of view from distances in excess of 10 km.

The viewshed is used as a framework and guide for visibility assessment, as the degree of visual significance will tend to be gradated with distance although there are unlikely to be any distinct or abrupt noticeable changes between the nominated distances.

7.3 Zone of Visual Influence

The ZVI diagrams are used to identify theoretical areas of the landscape from which a defined number of wind turbines, or portions of turbines, could be visible within the viewshed. They are useful for providing an overview as to the extent to which the Project could be visible from surrounding areas.

ZVI diagrams have been prepared to include:

- ZVI Diagram 1 from tip of blade;
- ZVI Diagram 2 from hub height; and
- ZVI Diagram 3 toward the whole turbine.

The extent to which the wind turbines may be visible are illustrated in **Figure 11**, and the ZVI Diagrams in **Figures 12, 13** and **14**.

7.4 ZVI methodology

The methodology adopted for the ZVI is a purely geometric assessment where the visibility of the Project is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.

Calculations have been made to determine the visibility of the wind turbines:

- to blade tips (a view toward any part of the wind turbine, including views toward the tips of blades above ridgelines);
- to hub height (a view toward any part of the wind turbine, including a view toward half the swept path of the wind turbine blades); and
- to the whole turbine (a view toward the whole turbine).

The calculations also take into account the terrain relief and earth curvature.

This assessment methodology is conservative as:

- the screening effects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not be visible at many of the locations indicated on the ZVI diagrams due to the local presence of trees or other screening materials.
- additionally, the number of turbines visible is also affected by the weather conditions at the time. Inclement or cloudy weather tends to mask the visibility of the proposed Project.

Accordingly, while ZVI diagrams are a useful visualisation tool, they are very conservative in nature.

7.5 ZVI summary

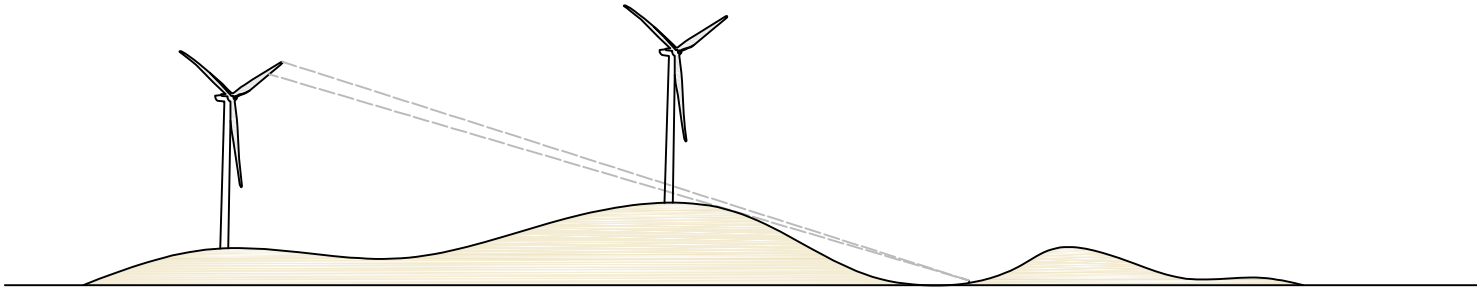
The most extensive and continuous area of visibility toward the Project turbines will generally occur where the tips of the wind turbine rotor blades are visible above surrounding ridgelines or vegetation; however, views toward the tips and upper portions of the wind turbine rotors are likely to become less noticeable at reasonably short distances from the wind farm due to the screening influence of topography and dense tree cover. Views toward tip of blade are visually negligible from medium to longer distance view locations.

The ZVI diagrams for 'tip' and 'hub height' cover similar extents of landscape surrounding the wind farm, and extend toward isolated pockets of rural landscape beyond 10 km of the nearest wind turbine. The number and distribution of turbines visible between 'tip' and 'hub' height is influenced by ridgelines and surrounding hills for a number of areas between the 5 km to 10 km distance offsets.

The ZVI diagrams illustrate areas of landscape which are likely to offer views toward the wind turbines and demonstrate that the majority of views generally occur within private property and across tracts of unoccupied rural landscape.

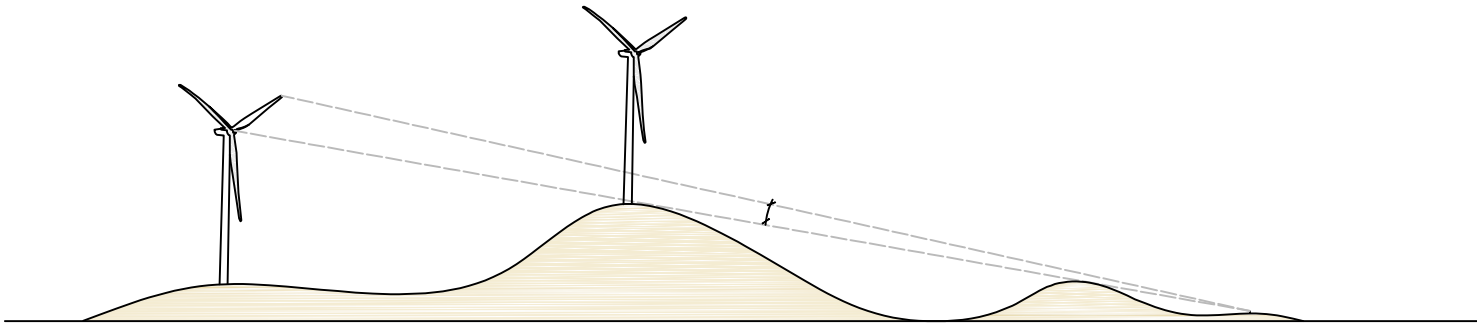
The ZVI diagrams also illustrate a number of discrete pockets within portions of the 5 km to 10 km distance offset from which the wind turbines will not be visible, although this band of the viewshed also represents areas from which a greater number of turbines will also be visible.

The ZVI diagrams illustrate that the influence of surrounding landform begins to disperse visibility from beyond 5 km, although opportunities to view turbines from elevated, but moderately distant and generally unoccupied areas occur from areas beyond 5 km.



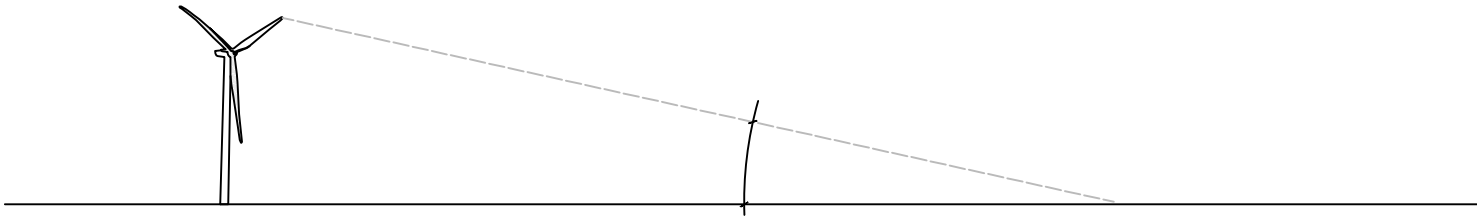
'Tip of blade'

View toward 'tip of blade' - where views extend toward the tip of blades above hill and ridgelines.



'Hub height'

View toward 'hub height' - where views extend toward the upper half of the wind turbine rotor with views toward the lower half of the rotor face and tower screened by landform.



'Whole turbine'

View toward 'whole turbine' - where views extend from the base of the tower to the tip of the rotor blade.

Figure 11
ZVI visibility zones

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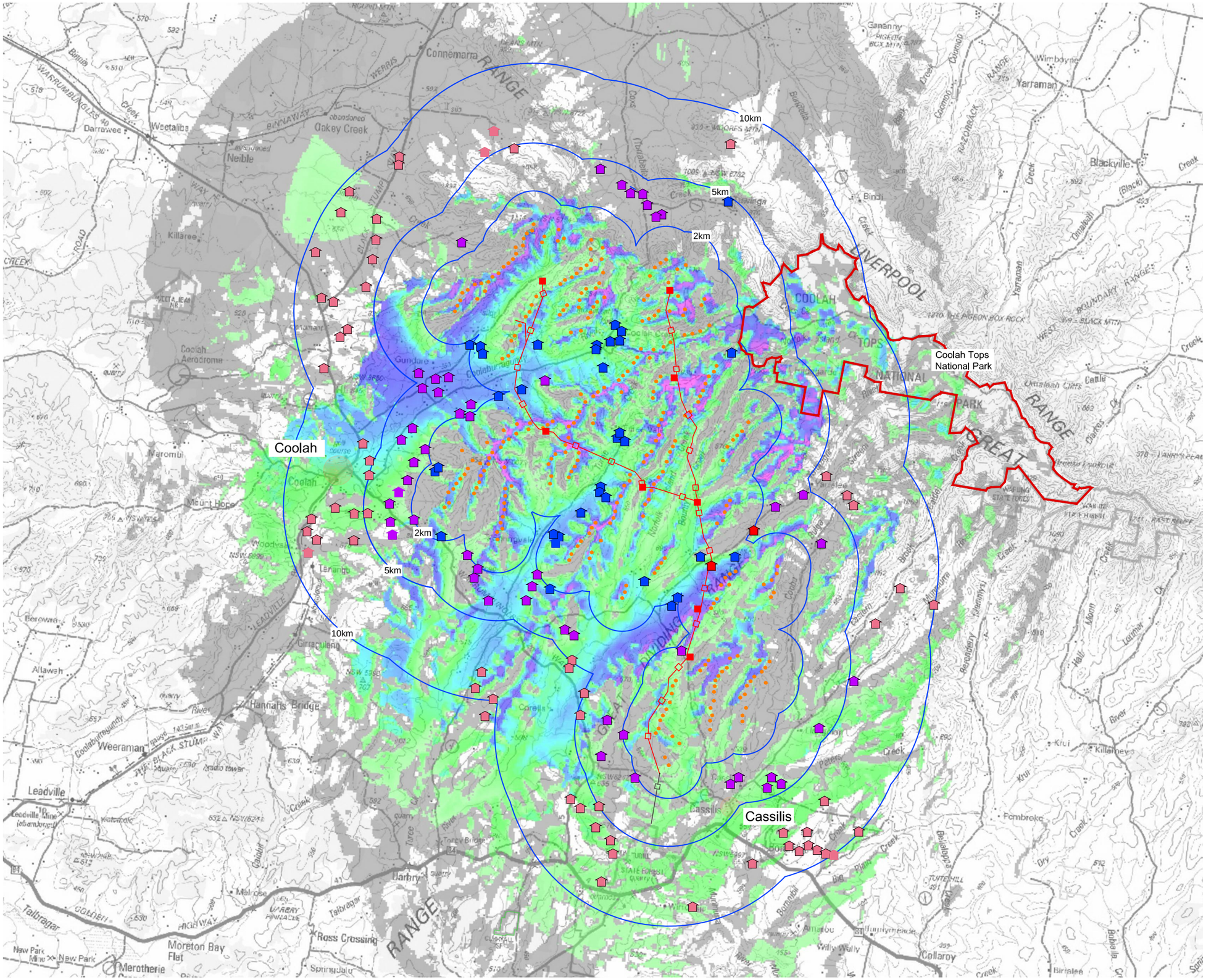

NOTES:

The ZVI methodology is a purely geometric assessment where the visibility of the proposed Liverpool Range wind farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.

This assessment methodology is assumed to be conservative as the screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not visible at many of the locations indicated on the ZVI maps due to the local presence of trees, vegetation or other screening potential. While the ZVI maps are a useful visualisation tool, they are very conservative in nature.

Additionally, the number of turbines visible at any one time is also affected by the weather condition at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.

LEGEND:

Number of wind turbine tip of blade visible

- >260
- 101 - 200
- 81 - 100
- 61 - 80
- 41 - 60
- 21 - 40
- 0 - 20

- Proposed Liverpool Range wind turbine
- Distance from proposed Liverpool Range wind turbine
- Proposed 330 kV powerline
- Involved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling between 2 km and 5 km of wind turbine
- Uninvolved residential dwelling between 5 km and 10 km of wind turbine

Figure 12
ZVI Diagram 1 Tip of blade

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0km 10km

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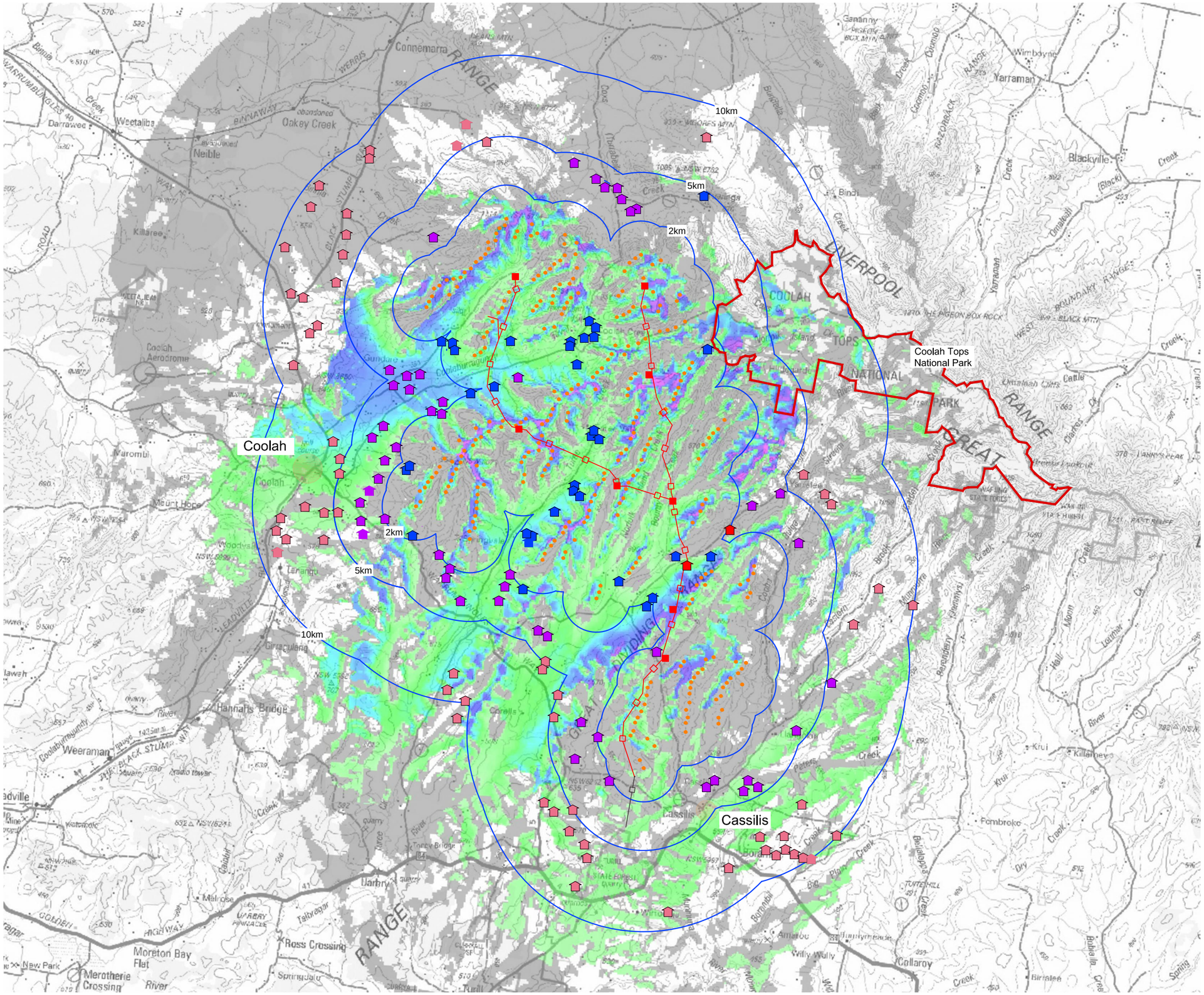

0km 10km

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NOTES:

The ZVI methodology is a purely geometric assessment where the visibility of the proposed Liverpool Range wind farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.

This assessment methodology is assumed to be conservative as the screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not visible at many of the locations indicated on the ZVI maps due to the local presence of trees, vegetation or other screening potential. While the ZVI maps are a useful visualisation tool, they are very conservative in nature.

Additionally, the number of turbines visible at any one time is also affected by the weather condition at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.

LEGEND:

Number of wind turbine visible from hub height

- >260
- 101 - 200
- 81 - 100
- 61 - 80
- 41 - 60
- 21 - 40
- 0 - 20

- Proposed Liverpool Range wind turbine
- Distance from proposed Liverpool Range wind turbine
- Proposed 330 kV powerline
- Involved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling between 2 km and 5 km of wind turbine
- Uninvolved residential dwelling between 5 km and 10 km of wind turbine

Figure 13
ZVI Diagram 2 Hub height

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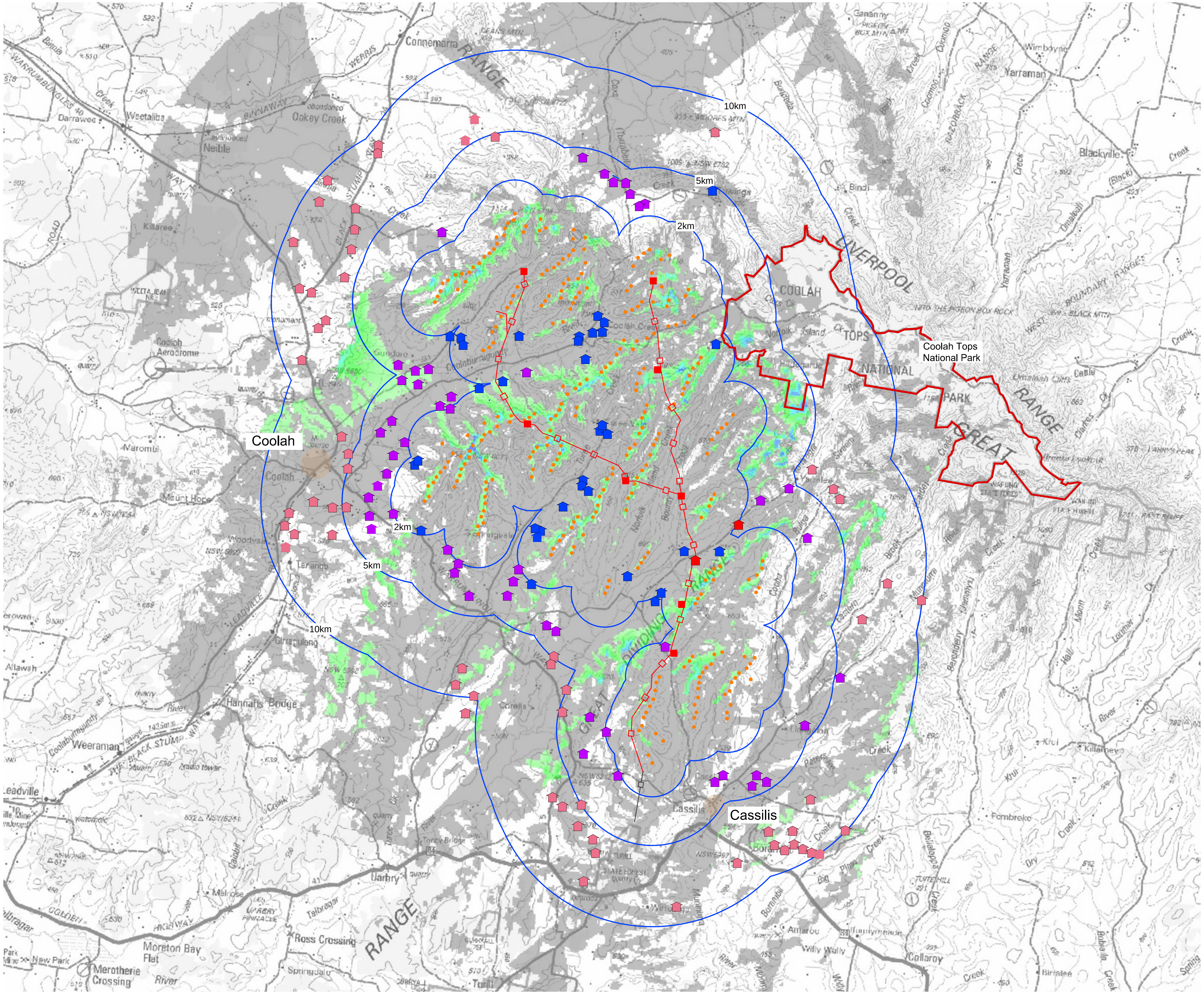

NOTES:

The ZVI methodology is a purely geometric assessment where the visibility of the proposed Liverpool Range wind farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.

This assessment methodology is assumed to be conservative as the screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not visible at many of the locations indicated on the ZVI maps due to the local presence of trees, vegetation or other screening potential. While the ZVI maps are a useful visualisation tool, they are very conservative in nature.

Additionally, the number of turbines visible at any one time is also affected by the weather condition at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.

LEGEND:

Number of whole wind turbine visible

- >260
- 101 - 200
- 81 - 100
- 61 - 80
- 41 - 60
- 21 - 40
- 0 - 20

- Proposed Liverpool Range wind turbine
- Distance from proposed Liverpool Range wind turbine
- Proposed 330 kV powerline
- Involved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling between 2 km and 5 km of wind turbine
- Uninvolved residential dwelling between 5 km and 10 km of wind turbine

0km 10km

Figure 14
ZVI Diagram 3 Whole turbine

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It should be noted that the wind turbines, when viewed from distances of around, or greater than 10 km, will generally be less distinct from other distant elements within the same field of view, and that the majority of land within the viewshed comprises rural agricultural land and areas of dense timber growth.

7.6 Visibility

The level of wind turbine visibility within the Liverpool Range wind farm 10 km viewshed can result from a number of factors such as:

- distance effect;
- movement;
- relative position; and
- weather.

7.6.1 Distance effect

With an increase in distance the proportion of a person's horizontal and vertical view cone occupied by a visible turbine structure, or group of turbine structures, will decline. In order to demonstrate this a series of single frame photographs have been taken from pre-set distances (1.5 km, 4 km, 7 km and 10 km) toward wind turbines at the Capital wind farm in New South Wales. The photographs, illustrated in **Figure 15**, demonstrate the degree to which the apparent visible height of a wind turbine decreases with increasing distance (in a negative exponential relationship), and the increasing amount of horizontal skyline visible with an increasing distance.

As the view distance increases so do the atmospheric effects resulting from dust particles and moisture in the atmosphere, which makes the turbines appear to be grey thus potentially reducing the contrast between the wind turbines and the background against which they are viewed.

Whilst the distance between a view location and the wind turbines is a significant factor to consider when determining potential visibility, there are other issues which may also affect the degree of visibility. **Table 14** outlines the relative effect of distance on visibility and has been based on empirical research conducted by the University of Newcastle (2002) as well as direct observations made during wind farm site inspections.

Capital Wind Farm - View distance 1.5 km

Capital Wind Farm - View distance 4 km

Capital Wind Farm - View distance 7 km

Capital Wind Farm - View distance 10 km

Capital Wind Farm turbines: Suzlon88,
80 m hub height, 88 m rotor diameter

Photographs: Pentax K10D, 50mm lens

Figure 15
Distance effect

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Table 14 – Distance effect

Distance from turbine	Distance effect
>20 km	Wind turbines become indistinct with increasing distance. Rotor movement may be visible but rotor structures are usually not discernible. Turbines may be discernible but generally indistinct within viewshed resulting in **Low** level visibility and **Nil** where influenced or screened by surrounding topography and vegetation.
10 km – 20 km	Wind turbines noticeable but tending to become less distinct with increasing distance. Blade movement may be visible but becomes less discernible with increasing distance. Turbines discernible but generally less distinct within viewshed (potentially resulting in **Low** level visibility).
5 km – 10 km	Wind turbines visible but tending to become less distinct depending on the overall extent of view available from the potential view location. Movement of blades discernible where visible against the skyline. Turbines potentially noticeable within viewshed (potentially resulting in **Low to Moderate** level visibility).
3 – 5 km	Wind turbines clearly visible in the landscape but tending to become less dominant with increasing distance. Movement of blades discernible. Turbines noticeable but less dominant within viewshed (potentially resulting in **Moderate** level visibility).
1 – 3 km	Wind turbines will generally dominate the landscape in which the wind turbine is situated. Potential for high visibility depending on the category of view location, their location, sensitivity and subject to other visibility factors. Turbines potentially dominant within viewshed (potentially resulting in **Moderate to High** level visibility).
<1 km	Wind turbines will dominate the landscape in which they are situated due to large scale, movement and proximity. Turbines dominant and significant within viewshed (potentially resulting in **High** level visibility).

7.6.2 Movement

The visibility of the wind turbines will vary between the categories of static and dynamic view locations. In the case of static views the relationship between a wind turbine and the landscape will not tend to vary greatly. The extent of vision will be relatively wide as a person tends to scan back and forth across the landscape.

In contrast views from a moving vehicle are dynamic as the visual relationship between wind turbines is constantly changing, as is the visual relationship between the wind turbines and the landscape in

which they are seen. The extent of vision can be partially constrained by the available view from within a vehicle at proximate distances.

7.6.3 Relative position

In situations where the view location is located at a lower elevation than the wind turbine, most of the turbine will be viewed against the sky. The degree of visual contrast between a white coloured turbine and the sky will depend on the presence of background clouds and their colour. For example, dark grey clouds will contrast more strongly with white turbines than a background of white clouds.

The level of visual contrast can also be influenced by the position of the sun relative to individual wind turbines and the view location. Where the sun is located in front of the viewer some visible portions of the wind turbine will be seen in shadow. If the background to the wind turbine is dark toned then visual contrast will tend to be reduced. Conversely where the sun is located behind the view location then the visible portion of the wind turbine will be in full sun.

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Significance of visual impact

Section 8

8.1 Introduction

The significance of visual impact resulting from the construction and operation of the Liverpool Range wind farm will result primarily from a combination of:

- the overall sensitivity of visual receptors in the surrounding landscape; and
- the scale or magnitude of visual effects presented by the wind farm development.

The sensitivity of visual receptors has been determined and described in this LVIA by reference to:

- the location and context of the view point;
- the occupation or activity of the receptor; and
- the overall number of people affected.

This LVIA notes that although a large number of viewers in a category that will otherwise be of low or moderate sensitivity may increase the sensitivity of the receptor, it is also the case that a small number of people (such as residents) with a high sensitivity may increase the significance of visual impact. The following table illustrates examples of view categories and their relative sensitivity. The sensitivity of view location categories are also described in **Table 18**.

Table 15 – View Location Sensitivity

View Category	Sensitivity
Residential Properties	***Highest Sensitivity***
Pedestrians (recreational)	▽
Public Recreational Space	▽
Rural employment/farming	▽
Motorists	▽
Business (commercial)	▽
Industry	*Lower Sensitivity*

Table 16 – Numbers of viewers

Criteria	Definition
Number of viewers	
High	> 400 people per day
Medium to high	100 - 399 people per day
Medium	50 - 99 people per day
Low	10 - 25 people per day
Very low	< 10 people per day

The scale or magnitude of visual effects associated with the Project have been determined and described by reference to:

- the distance between the view location and the wind farm turbines;
- the duration of effect;
- the extent of the area over which the wind farm could be theoretically visible (ZVI hub height)
- the degree of visibility subject to existing landscape elements (such as forested areas or tree cover).

An overall determination of visual significance at each view location has also been assessed and determined against the criteria outlined in **Table 17** below:

Table 17 – Sensitivity and magnitude assessment criteria

Criteria	Definition
Distance	
Very short	<1 km
Short	1 – 3 km
Medium	3 km – 5 km
Long	5 km - 10 km +
Duration of effect	
High	> 2 hours
Medium	30 - 120 minutes
Low	10 – 30 minutes
Very low	< 10 minutes
Extent of visibility	
High	201 – 288 wind turbines visible from hub height

Table 17 – Sensitivity and magnitude assessment criteria

Criteria	Definition
Medium	81 – 200 wind turbines visible from hub height
Low	41 – 80 wind turbines visible from hub height
Very low	1 – 40 wind turbines visible from hub height

The levels of view sensitivity and scale or magnitude of change outlined in **Table 17** is used **as a guide** to determine levels of visual significance.

Table 18 Visual significance matrix

			Scale or magnitude of change in view caused by proposed development			
			High	**Medium**	**Low**	**Very Low**
			Very short distance view over a long duration of time. A high extent of wind turbine visibility will tend to dominate the available skyline view and significantly disrupt existing views or vistas.	Short to medium distance views over a medium duration of time. A moderate extent of wind turbine visibility will have the potential to dominate available views with visibility recessing over increasing distance.	Medium to long distance views over a low to medium duration of time. Wind turbines in views, at long distances or visible for a short duration not expected to be significantly distinct in the existing view.	Visible change perceptible at a very long distance, or visible for a very short duration, and/or is expected to be less distinct within the existing view.
Sensitivity of visual receptor	**High**	**Indicator**	High	Medium to High	Medium	Low to Medium
		Large numbers of viewers or those with proprietary interest and prolonged viewing opportunities such as residents and users or visitors to attractive and/or well-used recreational facilities. Views from a regionally important location whose interest is specifically focussed on the landscape				
	Medium	Medium numbers of residents and moderate numbers of visitors with an interest in their environment e.g. visitors to State Forests, such as bush walkers and horse riders etc.… Larger numbers of travellers with an interest in their surroundings	Medium to High	Medium	Low to medium	Low
	Low	Low numbers of visitors with a passing interest in their surroundings e.g. those travelling along principal roads. Viewers whose interest is not specifically focussed on the landscape e.g. workers, commuters.	Medium	Low to Medium	Low	Very low to low
	Very Low	Very low numbers of viewers or those with a passing interest in their surroundings e.g. those travelling along minor roads.	Low to Medium	Low	Very low to low	Very low

This table is used as a guide only. The descriptions of magnitude and sensitivity are illustrative only. Each case is assessed on its own merits using professional judgement and experience, and there is no defined boundary between levels of impacts.

Legend

- Proposed Liverpool Range wind turbine (indicative location)
- Coolah Tops National Park
- Involved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling between 2 km and 5 km of wind turbine
- Uninvolved residential dwelling between 5 km and 10 km of wind turbine
- Area between 2 km and 5 km of wind turbines
- Area between 5 km and 10 km of wind turbines
- Distance from proposed Liverpool Range wind turbine
- Proposed 330 kV powerline route within wind farm project area
- Option 1 330 kV powerline route (project area to Ulan substation)
- Option 2 330 kV powerline route (project area to Ulan substation)

Figure 16
Residential dwellings

0km 10km

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8.2 Residential view location matrix

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
H7-1	**Uninvolved landowner** Residential dwelling High sensitivity	Very low	Short 1,778 m	High	Very Low	The property has been purchased as an environmental offset and the residential dwelling is unoccupied. Views toward the closest wind turbines are screened by topography and vegetation surrounding the residential dwelling. Views toward the closest visible turbines occur from the east side of the property at a distance of around 2,900 m.	Low
G6-2	**Uninvolved landowner** Residential dwelling High sensitivity	Very low	Short 1,858 m	High	Very Low	The property has been purchased as an environmental offset and the residential dwelling is unoccupied. Views toward the closest wind turbines are partially screened by vegetation surrounding the residential dwelling.	Low to Medium
G6-1	Involved landowner Residential dwelling High sensitivity	Very low	Short 1,402 m	High	Low	Views south will extend toward wind turbines elevated on hillside. Views north will be partially screened by tree planting surrounding residential dwelling.	Medium
F6-4	Involved landowner Residential dwelling	Very low	Short 1,769 m	High	Very Low	Views from the residential dwelling and surrounding garden will extend toward wind turbines on hills to the west, north and east of the property. Some partial screening will be provided by tree	High

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
	High sensitivity					planting within and surrounding the garden.	
F6-1 to F6-3	Involved landowner Residential dwellings High sensitivity	Very low	Short 1,993 m	High	Low to Medium	Views from the residential dwelling toward wind turbines will be partially screened by tree planting around the dwelling.	Medium
F7-4 to F7-6	Involved landowner Residential dwellings High sensitivity	Very low	Short 1,305 m	High	Low to Medium	Views extend toward wind turbines on hilltops to the west and east of the dwellings with some partial screening provided by tree planting surrounding dwellings.	Medium
F7-1 to F7-3	Involved landowner Residential dwellings High sensitivity	Very low	Very short 810 m	High	Low to Medium	Short distance views will extend to wind turbines south of the residential dwelling with existing tree planting surrounding residential dwelling providing partial screening toward wind turbines north and north east of the dwelling.	Medium
F-81	**Uninvolved landowner** Residential dwelling High	Very low	Short 2,588 m	High	Medium	Elevated and distant views toward wind turbines along hills and ridgelines. Views toward closest wind turbines partially screened by tree planting around residential dwelling.	Medium

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
	sensitivity						
D7-6	Involved landowner Residential dwelling High sensitivity	Very low	Short 2,081 m	High	Very Low	Views toward wind turbines will be partially screened by tree cover surrounding the residential dwelling.	Low to Medium
D6-1 to D6-3	Involved landowner Residential dwellings High sensitivity	Very low	Short 2,184 m	High	Low to Medium	Views toward wind turbines will be partially screened by tree cover surrounding the residential dwelling.	Medium
E6-1	Involved landowner Residential dwelling High sensitivity	Very low	Short 1,681 m	High	Medium	Views toward wind turbines will be partially screened by tree cover surrounding the residential dwelling.	Medium
E5-1, E5-2 and E6-2	Involved landowner Residential dwellings High sensitivity	Very low	Short 1,400 m	High	Low to Medium	Views toward wind turbines will be partially screened by tree cover surrounding the residential dwellings.	Medium

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
E5-3 to E5-6	Involved landowner Residential dwellings High sensitivity	Very low	Very short 730 m	High	Low to Medium	Views toward wind turbines will be partially screened by tree cover surrounding the residential dwellings.	Medium to High
G4-1	Involved landowner Residential dwelling High sensitivity	Very low	Very short 920 m	High	Medium	Very short distance view extends toward wind turbines along surrounding ridgelines.	Medium to High
E4-1 to E4-6, E3-2 and E3-3	Involved landowners Residential dwellings High sensitivity	Very low	Very short 680 m to 2,100 m	High	Low to Medium	Very short distance view extends toward wind turbines along surrounding ridgelines. Some partial screening provided by tree planting around residential dwellings.	Medium to High
E4-4	Involved landowner Residential dwelling High sensitivity	Very low	Short 1,400 m	High	Low	Short distance view extends toward wind turbines along surrounding ridgelines.	Medium to High

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
D4-9	**Uninvolved landowner** Residential dwelling High sensitivity	Very low	Short 2,243 m	High	Medium	Short distance view extends toward wind turbines along surrounding ridgelines.	Medium to High
D4-7	Involved landowner Residential dwelling High sensitivity	Very low	Short 1,324 m	High	Low to Medium	Short distance view extends toward wind turbines along surrounding ridgelines.	Medium to High
D4-6	Involved landowner Residential dwelling High sensitivity	Very low	Short 1,560 m	High	Medium	Short distance view extends toward wind turbines along surrounding ridgelines.	Medium to High
D4-5	Involved landowner Residential dwelling High sensitivity	Very low	Short 1,320 m	High	Medium	Short distance view extends toward wind turbines along surrounding ridgelines.	Medium to High

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
D4-1 to D4-4	Involved landowner Residential dwelling High sensitivity	Very low	Short 1,850 m	High	Low to Medium	Short distance views from residential dwellings toward wind turbines will extend north west to east along parallel ridgelines extending north east from the residential dwellings.	Medium to High
C5-7 and C5-8	Involved landowner Residential dwelling High sensitivity	Very low	Short 1,735 m	High	Very Low	Short distance views toward the closest wind turbines within the central portion of the Project area will be partially screened by landform rising to the east of the dwellings.	Low to Medium
Assessment of residential dwelling between 2 km and 5 km of the proposed Liverpool Range wind turbines (Refer Figure 16 for locations)							
L1	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Short to Medium 2,000 m to 5,000 m	High	Very low	Views toward turbines within the south portion of the Project area will be partially screened through a combination of landform and tree cover.	Low to Medium
L2	**Uninvolved landowners** Residential dwellings High	Very low	Short to Medium 2,000 m to 5,000 m	High	Very Low to Low	Views will extend along and across valleys toward wind turbines located on hilltop and ridgeline areas. Some residential dwellings will have partial screening through tree planting surrounding dwellings.	Medium

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
	sensitivity						
L3	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Short to Medium 2,000 m to 5,000 m	High	Very Low to Low	Views will extend along and across valleys toward wind turbines located on hilltop and ridgeline areas. Some residential dwellings will have partial screening through tree planting surrounding dwellings.	Medium
L4	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Short to Medium 2,000 m to 5,000 m	High	Low to Medium	Views will extend along and across valleys toward wind turbines located on hilltop and ridgeline areas. Some residential dwellings will have partial screening through tree planting surrounding dwellings.	Medium
L5	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Short to Medium 2,000 m to 5,000 m	High	Very Low	Views from residential properties will be largely restricted to wind turbines elevated along the northern edge of the Project area.	Medium
L6	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Short to Medium 2,000 m to 5,000 m	High	Very Low	Views from residential properties will be largely restricted to wind turbines elevated along the northern edge of the Project area.	Low to Medium

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
Assessment of residential dwelling between 5 km and 10 km of the proposed Liverpool Range wind turbines (Refer Figure 16 for locations)							
L7	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Long 5,000 m to 10,000 m	High	Very Low	Views toward wind turbines within the east portion of the Project area from a small number of rural residential properties to the south and west of Cassilis. A number of these dwellings will have some level of screening provided by surrounding landform and existing tree planting surrounding and beyond the dwellings.	Low
L8	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Long 5,000 m to 10,000 m	High	Low	Views will extend toward wind turbines within the south portion of the Project area from a small number of rural residential properties to the south and west of Cassilis. A number of these dwellings will have some level of screening provided by surrounding landform and existing tree planting surrounding and beyond the dwellings.	Low
L9	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Long 5,000 m to 10,000 m	High	Low to Medium	Views will extend toward wind turbines within the central and south portion of the Project area from a small number of rural residential properties to the south of Coolah. A number of these dwellings will have some level of screening provided by existing tree planting surrounding and beyond the dwellings.	Low to Medium
L10	**Uninvolved landowners** Residential dwellings High	Very low	Long 5,000 m to 10,000 m	High	Low	Views will extend toward wind turbines within the south west portion of the Project area from a small number of rural residential properties to the south of Coolah. A number of these dwellings will have some level of screening provided by existing tree planting	Low

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
	sensitivity					surrounding and beyond the dwellings.	
L11	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Long	High	Medium	Views will extend toward wind turbines within the west and north west portion of the Project area from a small number of rural residential properties to the north of Coolah. Tree cover surrounding some dwellings will provide screening potential to residential dwellings.	Low
L12	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	5,000 m to 10,000 m	High	Very Low	Views toward wind turbines within the north west and west portion of the Project area will be partially screened and/or restricted in extent by a combination of landform rising to the south east of the residential properties. A number or rural residential and homesteads will also have views toward the wind turbines restricted, or partially filtered, by tree planting within gardens surrounding residential dwellings.	Low
L13	**Uninvolved landowners** Residential dwellings High sensitivity	Very low	Long 5,000 m to 7,000m	High	Very Low	Views toward wind turbines within the north and north west portion of the Project area will be largely screened by a steep landform rising to the south of the residential properties.	Low
L14	**Uninvolved landowners** Residential	Very low	Long 5,000 m to 10,000 m	High	Very Low	Views toward wind turbines within the north portion of the Project area will be largely screened by landform rising to the south west of the residential properties, together with tree cover along	Low (and primarily Nil)

Table 19 – Residential view location matrix (Refer **Figure 16** for residential view locations)

View location (Refer to Figure 16)	Category of view location and sensitivity	Relative number of people	Approximate distance to closest turbine	Duration of effect	Extent of visibility (ZVI hub height)	Degree of visibility	Visual significance
	dwellings High sensitivity					ridgeline areas extending north to north west from the Coolah Tops National Park.	

8.3 Summary of residential visual significance (within 2 km of wind turbines)

This LVIA identified a total of 23 involved and uninvolved residential view locations within the Liverpool Range wind farm 2 km viewshed. Unoccupied residential dwellings have been included and assessed as part of this LVIA where structures and buildings were considered to be habitable at the time of the field work. An assessment of each potential residential view location indicated that for the Liverpool Range wind turbine design layout:

- 1 of the 23 residential view locations has been determined to have a low visual significance;
- 3 of the 23 residential view locations have been determined to have a low to medium visual significance;
- 9 of the 23 residential view locations have been determined to have a medium visual significance;
- 9 of the 23 residential view locations have been determined to have a medium to high visual significance; and
- 1 of the 23 residential view locations has been determined to have a high visual significance.

The field assessment for the majority of residential view locations was undertaken from the closest publicly accessible location, with a conservative approach adopted where there was no opportunity to confirm the actual extent of the available view from areas within or immediately surrounding the residence. It is anticipated that some visibility ratings will be less than those determined subject to a process of verification from private property.

8.4 Summary of residential visual significance (beyond 2 km of wind turbines)

The majority of residential dwellings located beyond a 2 km distance from the wind turbines are unlikely to be significantly impacted by the wind farm development and have been determined to have an overall low to medium and medium visual significance between 2 km and 5 km of the wind turbines. The localised influence of topography, as illustrated in the ZVI diagrams, has some direct and marked impact on the extent and nature of views within the 2 km and wider viewshed.

8.5 Towns and localities

There are a small number of towns and localities (which include a small number of dwellings), that surround the Liverpool Range wind farm Project area and occur partially or wholly within the 10 km viewshed. Those within the 10 km viewshed include:

- Cassilis (located to the southern boundary of the Project site and around 4 km from the closest wind turbine); and
- Coolah (approximately 4.6 km to the west of the Project site and 6.5 km from the closest wind turbine).

Plate 8 – Royal Hotel, Buccleugh Street - Cassilis

8.5.1 Cassilis

Cassilis is a small village (formerly known as Dalkeith) and is accessed via the Merriwa Road from the Golden Highway around 1.3 km to the south of the village. The village is located on gently to moderately sloping land to the west of the Munmurra River. The closest wind turbine will be located approximately 4.2 km to the north west of the Cassilis Public School and will not be visible from residential dwellings, the Public School or public spaces within Cassilis due to rising landform to the

north west of Cassilis. Views toward wind turbines north of Cassilis will also be screened by undulating landform and scattered tree cover within and beyond the village.

8.5.2 Coolah

Coolah is a small town to the west and approximately 6.5 km from the closest Liverpool Range wind turbine. The town is located to the west of the Coolaburragundy River valley and rises gently to the west toward a timbered undulating landform. There are various opportunities to gain long distance views toward a small number of wind turbines within the central west portion of the wind farm site; however, views from many of the streets within Coolah are screened and partially filtered by street tree planting and trees within residential properties.

The Liverpool Range wind farm is not expected to have a significant visual impact on residential dwellings and public view locations within the Cassilis and Coolah localities. This is primarily due to the screening influence of undulating landform, tree cover within the urban areas, as well as the distance between the wind farm and potential view locations within these rural localities.

Plate 9 – Typical view north toward Cassilis from Golden Highway (wind turbines will be visible at approximately 5 to 6 km above and beyond Cassilis, but largely screened from views within Cassilis by landform and tree cover).

Plate 10 – Typical view west toward Coolah from Coolah Creek Road.

8.6 Future residential dwellings

In general existing residential dwellings in the vicinity of the wind farm are located below surrounding ridgelines to maximise potential for shelter from prevailing wind, and/or where exposed tend to include a degree of shelter from windbreak planting or tree planting around dwellings. The tendency to locate residential dwellings in sheltered situations also acts to limit the extent of available views across the surrounding landscape for the majority of residential view locations, although there are a small number of dwellings that appear to have been located on properties to take advantage of distant and panorama views.

Potential future planning considerations for residential dwellings will be able to take advantage of any approved layout design for the Liverpool Range wind farm when determining the optimal location for residential dwellings on individual portions of land to minimise views toward wind turbines if desired. In some circumstances future residential dwellings could be located to take advantage of local topographic features in order to screen views toward wind turbines or implement in advance mitigation measures such as tree planting for windbreak and/or screening purposes.

Should residential dwellings be constructed on existing portions of land immediately adjacent to the wind farm site, there is likely to be an associated visual impact not only with additional residential structures within the landscape but also a range of domestic infrastructure associated with it.

8.7 Local roads

There are a small number of local roads that pass through the wind farm Project area including the:

- Rotherwood Road;
- Turee Creek Road;
- Coolah Creek Road; and
- Gundaree Road.

Views from vehicles travelling along local roads within the Project site will include a combination of very short to long distance direct and indirect views toward wind turbines. Whilst wind turbines may be visible whilst driving through the Project site, it is likely that the majority of journeys within the Project site will be those undertaken by residents involved with the Project.

Views from the Cassilis, Coolah and Vinegaroy Roads (between the Golden Highway, Cassilis and Coolah) will include direct and indirect views toward wind turbines in the south and central portions of the Project area up to a distance of 2km and 5 km from the wind turbines. The potential visibility of the Project will decrease slightly for vehicles travelling north west to south east.

Views from small portions of the road corridor between Coolah and Cassilis will be screened by landform and/or tree planting alongside or beyond the road corridor. The Liverpool Range wind farm will be unlikely to have a significant visual impact on motorists travelling along the Cassilis and Coolah roads.

The Golden Highway extends east to west below the Project area between a distance of 5 km and 10 km from the closest wind turbine and provides a sequence of contained and open views from the road corridor. Distant and very short duration views toward wind turbines in the south portion of the Project area will occur from a section of the highway between Borambil and Cassilis, but will not tend to result in a significant visual impact.

8.8 Coolah Tops National Park

The Coolah Tops National Park is located to the north east of the wind farm and around 2 km from the closest wind turbine. The Park contains a number of established and formalised camp sites and day use areas. These are located and identified on **Figure 49**. The camp site and day use areas are located within densely timbered areas and views toward the wind farm will be screened by tree cover and landform to the south west of the Park.

There are three scenic lookouts within the Park and include the Pinnacle Lookout, the Breeza Lookout and Shepherd Peak Lookout. The Lookouts are located within the north and east portion of the National Park and provide extensive views across the landscape to the north and north east of the Park. The lookouts will not provide any significant opportunity to view the Liverpool Range wind turbines.

Whilst this LVIA has determined that some recognisable characteristics of the landscape will be altered by the Project and result in the introduction of visually prominent elements that will alter some perceived landscape characteristics, the visual and landscape characteristics of the Coolah Tops National Park, as experienced within the Park, will not be altered by the wind farm.

Cumulative assessment

Section 9

9.1 What is cumulative assessment?

A cumulative impact could result from a proposed wind farm development being constructed in conjunction with other existing or proposed wind farm developments, and could be either associated or separate to it.

Separate wind farm developments could occur within the established viewshed of the proposed wind farm, or be located within a regional context where visibility is dependent on a journey between each site or an individual Project viewshed. Cumulative impacts presented by multiple wind farm developments may be presented as 'direct', 'indirect' or 'sequential' impacts.

- 'direct' cumulative visual impacts could occur where two or more winds farms have been constructed within the same locality, and could be viewed from the same view location simultaneously.
- 'indirect' cumulative visual impacts could occur where two or more winds farms have been constructed within the same locality, and could be viewed from the same view location but not within the same field of view.
- 'sequential' cumulative visual impacts could arise as a result of multiple wind farms being observed at different locations during the course of a journey (e.g. from a vehicle travelling along a highway or from a network of local roads), which could form an impression of greater magnitude and impact within the construct of short term memory.

9.2 State and regional wind farm developments

There are a number of proposed, approved and operating wind farm developments within New South Wales which are illustrated in **Figure 17**. The number and location of wind farms is likely to change as more wind farm projects are announced and enter the state or local planning system.

The Kyoto wind farm development is currently the only approved wind farm development in the Upper Hunter Renewable Energy Precinct. With an approval for up to 34 wind turbines, the Kyoto wind farm development has yet to commence construction. The Liverpool Range wind farm

development will be located approximately 70 km to the west of the Kyoto project site, therefore the opportunity for any significant 'direct' or 'indirect' visual impacts are likely to be negligible.

'Sequential' visual impacts will be limited by the absence of additional wind farm developments within the regional context and will not be expected to be significant between the approved Kyoto wind farm development and the Liverpool Range Project.

GBD is not aware of any smaller wind farm developments that are currently lodged, or being assessed by the relevant local government authorities.

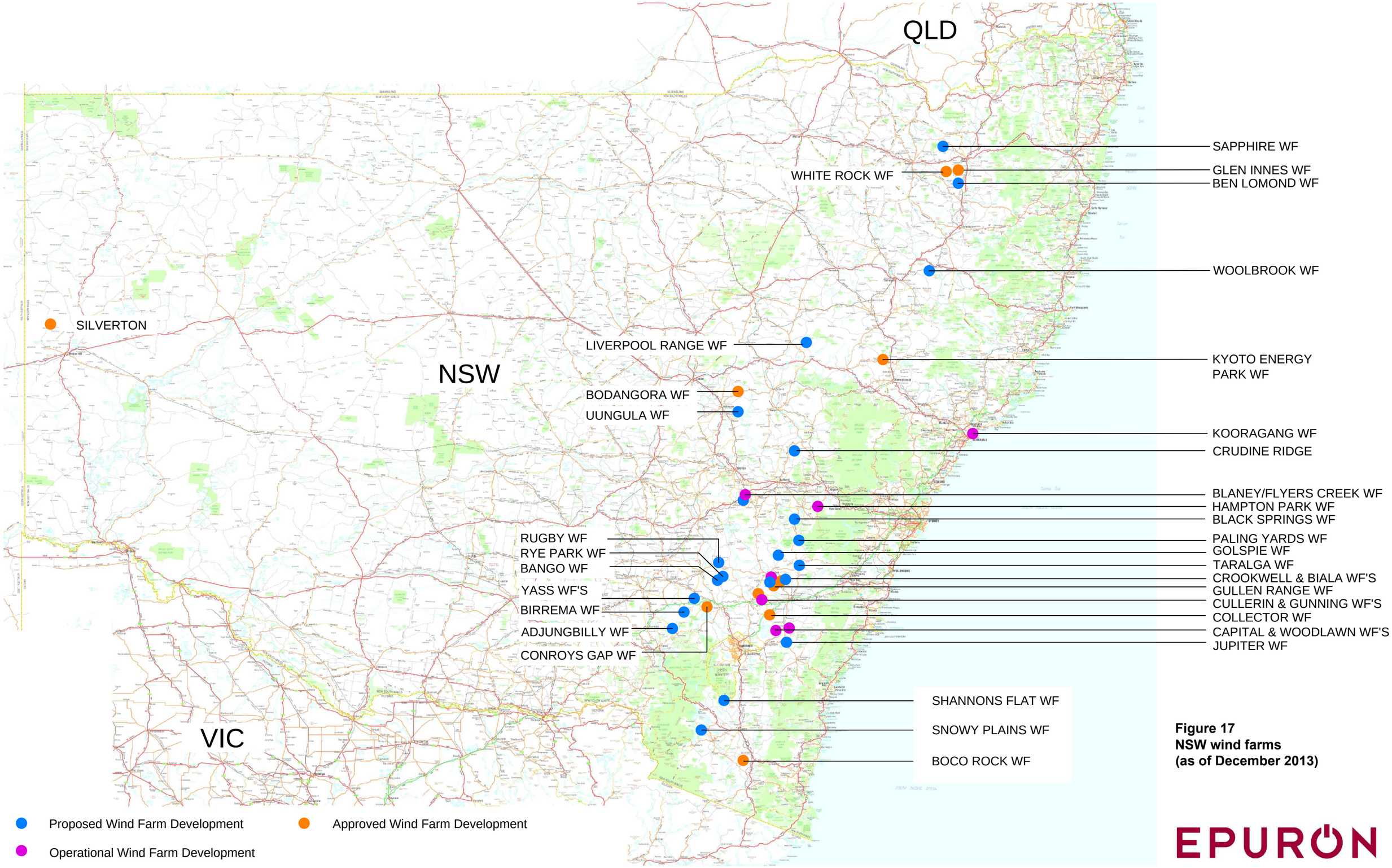

Figure 17
NSW wind farms
(as of December 2013)

LIVERPOOL RANGE WIND FARM

Not to scale

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Photomontages

Section 10

10.1 Photomontages

The DGR's state that the EA must "*include photomontages of the project taken from potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights), settlements and significant public view points…*"

Whilst it is possible for any residential dwelling with a view toward the Project turbines to be potentially affected (with a resultant high, moderate or low impact), it is not feasible or practical to prepare a photomontage for each and every residential dwelling within the Project 10 km viewshed.

A total of 11 photomontage locations were selected to represent uninvolved residential dwellings and public view locations from surrounding road corridors. The photomontages locations are illustrated in **Figure 18** and are presented in **Figures 19** to **40**.

10.2 Photomontage preparation

The photomontages have been prepared with regard to the general guidelines set out in the Scottish Natural Heritage (2006) Visual representation of windfarms: good practice guidance and British Landscape Institute Advice Note 01/11 (March 2011) Photography and photomontage in landscape and visual impact assessment.

Photography for the photomontages was undertaken by GBD using tripod mounted Nikon D700 a digital single-lens reflex (SLR) camera. A 50 mm focal length prime lens was attached to the Nikon D700 and D90 SLR cameras.

The Nikon D700 has a full frame image censor (36 x 23.9 mm Nikon FX format), and when mounted with a 50mm lens results in a single photographic image with a view angle equivalent to a 35 mm SLR camera with a 50 mm lens. The 50 mm lens is commonly utilised, and cited in landscape and visual assessment manuals and guidelines, for the preparation of landscape and visual assessment photomontages. Following site photography the photomontages were generated through the following steps:

- a digital terrain model (DTM) of the Project site was created from a terrain model of the surrounding area using digital contours;

- the site DTM was loaded in the G-L Garrad Hassan 'WindFarmer' software package;
- the layout of the wind farm and 3D representation of the wind turbine was configured in WindFarmer;
- the location of each viewpoint (photo location) was configured in WindFarmer – the sun position for each viewpoint was configured by using the time and date of the photographs from that viewpoint;
- the view from each photomontage location was then assessed in WindFarmer. This process requires accurate mapping of the terrain as modelled, with that as seen in the photographs. The photographs, taken from each photomontage location were loaded into WindFarmer and the visible turbines superimposed on the photographs;
- the photomontage were adjusted using Photoshop CS3 to compensate for fogging due to haze or distance, as well as screening by vegetation or obstacles; and
- the final image was converted to JPG format and imported and annotated as the final figure.

Table 20 identifies the eleven photomontage locations, property names (where relevant), corresponding reference number identified in the residential view matrix (**Table 19**) as well as the status of each photomontage location.

Table 20 – Photomontage details

Photomontage Location	Figure Reference	Status: Residential (uninvolved) Road corridor
L2 Rotherwood Road	**Figure 19** and **20**	Unsealed road corridor (minor local road)
L3 Rotherwood Road	**Figure 21** and **22**	Sealed road corridor (minor local road)
L5 Glenwood	**Figure 23** and **24**	Uninvolved and unoccupied residential dwelling
L7 Bill's block	**Figure 25** and **26**	Uninvolved residential dwelling
L8 Turee Vale Road	**Figure 27** and **28**	Sealed road corridor (minor local road)

Table 20 – Photomontage details

Photomontage Location	Figure Reference	Status: Residential (uninvolved) Road corridor
L9 Cassilis Road	**Figure 29** and **30**	Sealed road corridor (local road)
L10 Coolah	**Figure 31** and **32**	Sealed road corridor (local road)
L11 Cooks Road	**Figure 33** and **34**	Sealed road corridor (minor local road)
L13 Warung State Forest Road	**Figure 35** and **36**	Unsealed road corridor (minor local road)
L14 Pandoras Road	**Figure 37** and **38**	Unsealed road corridor (minor local road)
L23 St Antoine	**Figure 39** and **40**	Uninvolved and unoccupied residential dwelling

The horizontal and vertical field of view within the majority of the photomontages exceeds the parameters of normal human vision. However, in reality the eyes, head and body can all move and, under normal conditions, the human brain will 'see' a broad area of landscape within a panorama view. Each of the Liverpool Range photomontage panoramas indicates the extent of a single photograph within the full extent of the panorama.

Whilst a photomontage can provide an image that illustrates a photo realistic representation of a wind turbine in relation to its proposed location and scale relative to the surrounding landscape, this LVIA acknowledges that large scale objects in the landscape can appear smaller in photomontage than in real life and is partly due to the fact that a flat image does not allow the viewer to perceive any information relating to depth or distance.

The British Landscape Institute states that '*it is also important to recognise that two-dimensional photographic images and photomontages alone cannot capture or reflect the complexity underlying the visual experience and should therefore be considered an approximate of the three-dimensional visual experiences that an observer would receive in the field'.*

10.3 Photomontage verification

Photomontages prepared for wind farm developments are sometimes claimed not to represent the correct relative scale of the wind turbines within the baseline panorama or single photographic images. Whilst modern windfarm industry software, such as WindFarmer, is able to produce correctly scaled turbines within photomontages, GBD undertook to independently verify the scale of the Liverpool Range wind turbines within the photomontages.

The verification process involved the direct photographic comparison of constructed and operational wind turbines at the Gunning wind farm development with those presented in the photomontages.

The results of the verification are illustrated in **Figure 41**, and demonstrate that the wind turbines in the Liverpool Range photomontages are proportional relative to distance when compared to photographs of existing and operation wind turbines photographed at the same distance.

Legend

- Involved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling beyond 2 km of wind turbine
- Photomontage location
- Photomontage location (powerline refer Figure 54)
- Coolah Tops National Park
- Proposed Liverpool Range wind turbine (indicative layout)
- Distance from proposed Liverpool Range wind turbine
- Proposed 330 kV powerline route

L14 L13 L11 L10 L9 L8 L7 L5 L3 L23 L2 T3

Coolah

10km 5km 2km

0km 10km

LIVERPOOL RANGE WIND FARM

Figure 18
Photomontage location

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Public view location L2 Rotherwood Road - Existing view west to north north east. Photo coordinate Easting:780570 Northing:6455467 (MGAz55)

Public view location L2 Rotherwood Road- Proposed view through 120°. Approximate distance to closest visible wind turbine 3 km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 19
Photomontage Location L2 Rotherwood Road

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L2 Rotherwood Road- Proposed view through 47°. Approximate distance to closest visible wind turbine 3 km

Figure 20
Photomontage Location L2
Rotherwood Road

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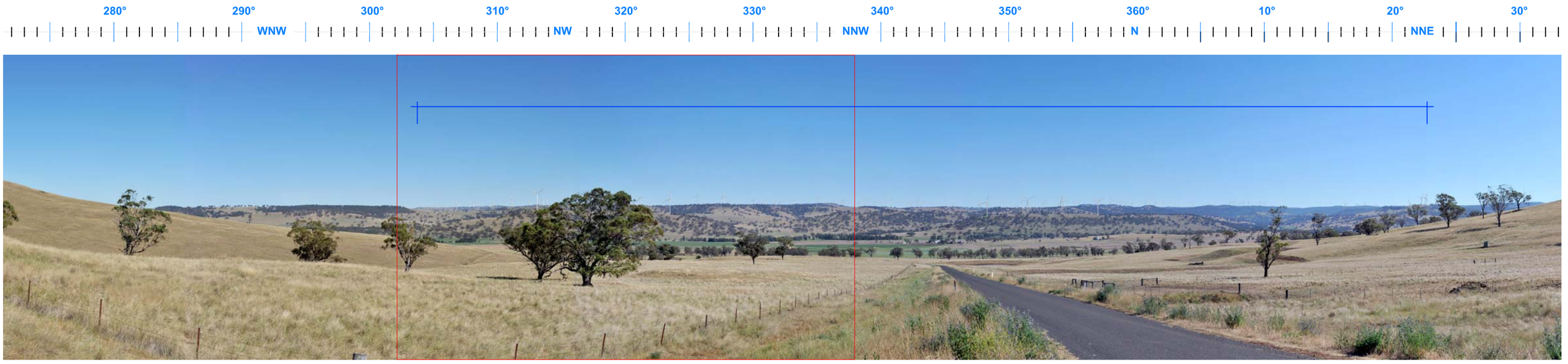
LIVERPOOL RANGE WIND FARM

Public view location L3 Rotherwood Road - Existing view west north west to north north east. Photo coordinate Easting:777806 Northing:6465161 (MGAz55)



Public view location L3 Rotherwood Road- Proposed view through 120°. Approximate distance to closest visible wind turbine 3.9 km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 21
Photomontage Location L3 Rotherwood Road

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L3 Rotherwood Road- Proposed view through 47°. Approximate distance to closest visible wind turbine 3.9 km

Figure 22
Photomontage Location L3 Rotherwood Road

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Public view location L5 Glenwood (unoccupied residential dwelling) - Existing view south west to north east. Photo coordinate Easting:782499 Northing:6471879 (MGAz55)

Public view location L5 Glenwood (unoccupied residential dwelling)- Proposed view through 120°. Approximate distance to closest visible wind turbine 1.8 km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 23
Photomontage Location L5 Glenwood (Uninvolved and unoccupied residential dwelling)

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L5 Glenwood (Uninvolved and unoccupied residential dwelling) - Proposed view through 47°. Approximate distance to closest visible wind turbine 1.8 km

Figure 24
Photomontage Location L5
Glenwood (Uninvolved and unoccupied residential dwelling)

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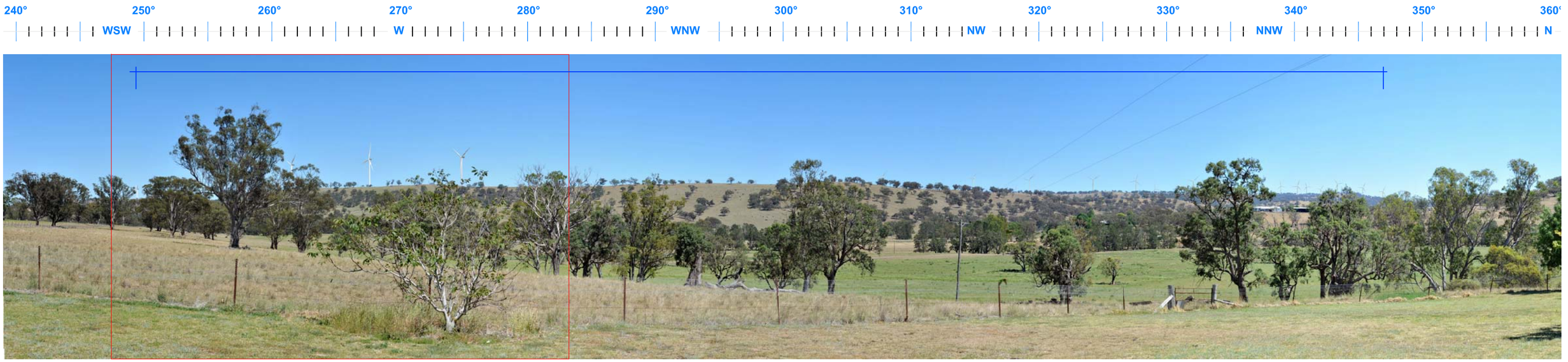
Public view location L7 Bill's block (uninvolved residential dwelling) - Existing view south west to north east. Photo coordinate Easting:779774 Northing:6466870 (MGAz55)



Public view location L7 Bill's block (uninvolved residential dwelling)- Proposed view through 120°. Approximate distance to closest visible wind turbine 2.1km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 25
Photomontage Location L7
Bill's block (uninvolved residential dwelling)

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L7 Bill's block (uninvolved residential dwelling)- Proposed view through 47°. Approximate distance to closest visible wind turbine 2.1 km

Figure 26
Photomontage Location L7
Bill's block (uninvolved residential dwelling)

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LIVERPOOL RANGE WIND FARM

Public view location L8 Turee Vale Road - Existing view north north west to east. Photo coordinate Easting:767449 Northing:6466870 (MGAz55)

Public view location L8 Turee Vale Road - Proposed view through 120°. Approximate distance to closest visible wind turbine 3.8 km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 27
Photomontage Location L8
Turee Vale Road

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L8 Turee Vale Road- Proposed view through 47°. Approximate distance to closest visible wind turbine 3.8 km

Figure 28
Photomontage Location L8
Turee Vale Road

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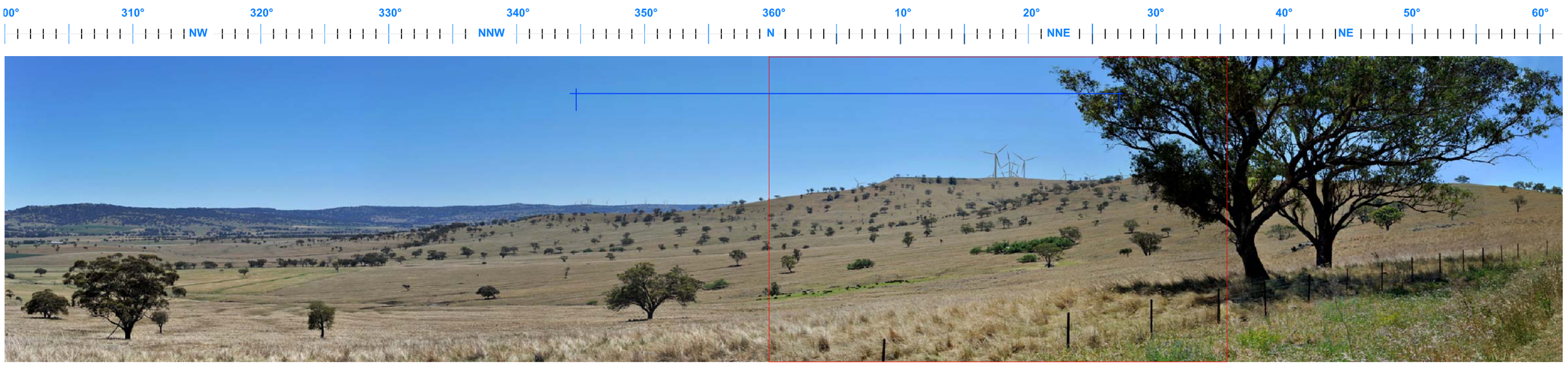
Public view location L9 Cassilis Road - Existing view north north west to east. Photo coordinate Easting:762098 Northing:6472045 (MGAz55)



Public view location L9 Cassilis Road - Proposed view through 120°. Approximate distance to closest visible wind turbine 2.4 km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 29
Photomontage Location L9 Cassilis Road

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L9 Cassilis Road- Proposed view through 47°. Approximate distance to closest visible wind turbine 2.4 km

Figure 30
Photomontage Location L9
Cassilis Road

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Public view location L10 Coolah - Existing view north north east to south east. Photo coordinate Easting:757844 Northing:6475675 (MGAz55)

Public view location L10 Coolah - Proposed view through 120°. Approximate distance to closest visible wind turbine 5.9 km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 31
Photomontage Location L10 Coolah

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L10 Coolah- Proposed view through 47°. Approximate distance to closest visible wind turbine 5.9 km

Figure 32
Photomontage Location L10 Coolah

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Public view location L11 Cooks Road - Existing view north north east to south east. Photo coordinate Easting:762361 Northing:6480829 (MGAz55)

Public view location L11 Cooks Road - Proposed view through 120°. Approximate distance to closest visible wind turbine 4.3 km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 33
Photomontage Location L11 Cooks Road

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L11 Cooks Road- Proposed view through 47°. Approximate distance to closest visible wind turbine 4.3 km

Figure 34
Photomontage Location L11
Cooks Road

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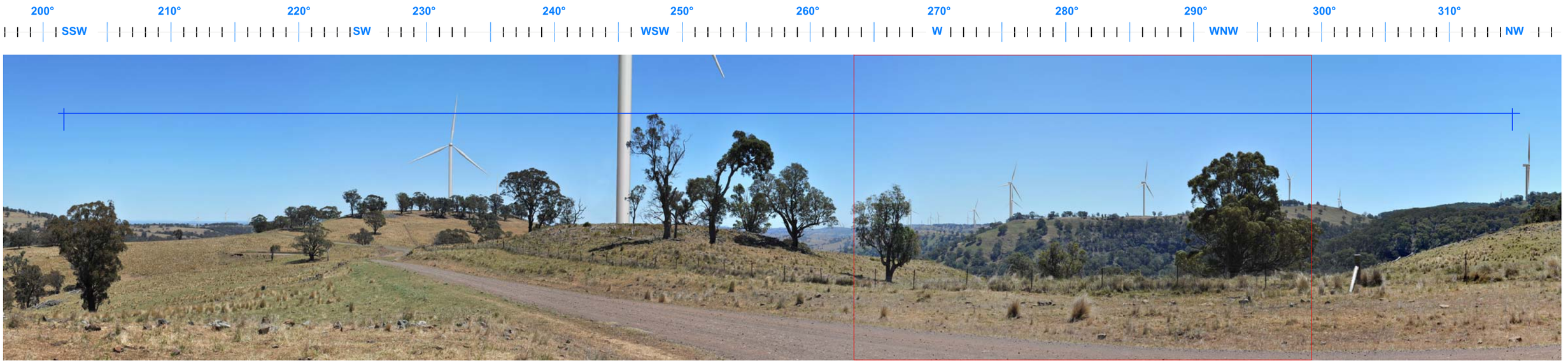
Public view location L13 Warung State Forest Road - Existing view south south east to west north west. Photo coordinate Easting:780415 Northing:6484831 (MGAz55)



Public view location L13 Warung State Forest Road - Proposed view through 120°. Approximate distance to closest visible wind turbine 600 m

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 35
Photomontage Location L13
Warung State Forest Road

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L13 Warung State Forest Road- Proposed view through 47°. Approximate distance to closest visible wind turbine 600 m

Figure 36
Photomontage Location L13
Warung State Forest Road

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Public view location L14 Rockgedgiel-Pandoras Road - Existing view north north east to south east. Photo coordinate Easting:780415 Northing:6484831 (MGAz55)

Public view location L14 Rockgedgiel-Pandoras Road - Proposed view through 120°. Approximate distance to closest visible wind turbine 3.8 km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 37
Photomontage Location L14
Rockedgiel-Pandoras Road

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L14 Rockedgiel-Pandoras Road- Proposed view through 47°. Approximate distance to closest visible wind turbine 3.8 km

Figure 38
Photomontage Location L14
Rockedgiel-Pandoras Road

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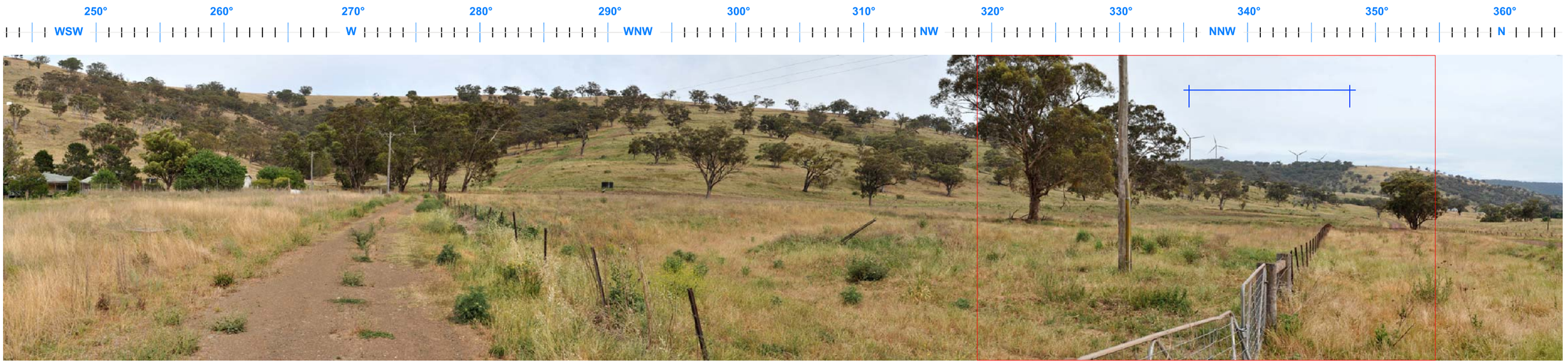
Public view location L23 St Antoine (unoccupied residential dwelling) - Existing view north north east to south east. Photo coordinate Easting:785270 Northing:6465157 (MGAz55)



Public view location L23 St Antoine (unoccupied residential dwelling) - Proposed view through 120°. Approximate distance to closest visible wind turbine 3 km

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 18 for photomontage locations

Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Extent of wind turbines visible in panorama

Figure 39
Photomontage Location L23 St Antoine (Uninvolved and unoccupied residential dwelling)

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Indicative extent of a single frame photograph (in landscape format) taken with the Nikon D700 digital SLR camera with a 50mm lens

Photomontage location L23 St Antoine (unoccupied residential dwelling)- Proposed view through 47°. Approximate distance to closest visible wind turbine 3 km

Figure 40
Photomontage Location L23
St Antoine (Uninvolved and unoccupied residential dwelling)

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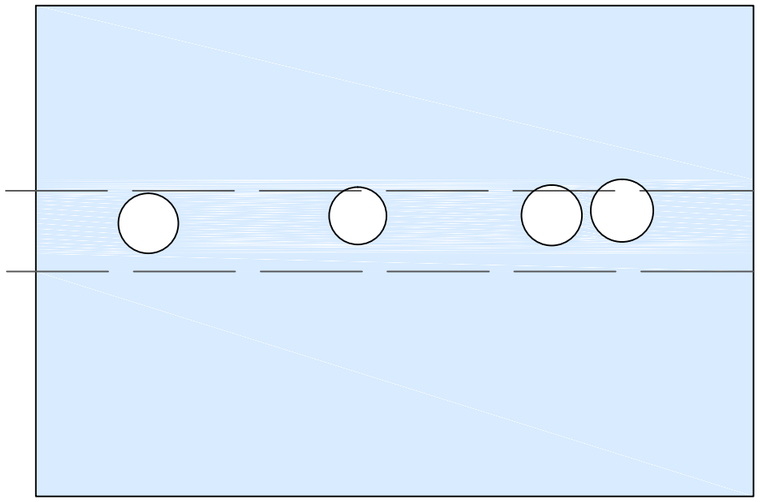
Proposed Liverpool Range wind farm photomontage.

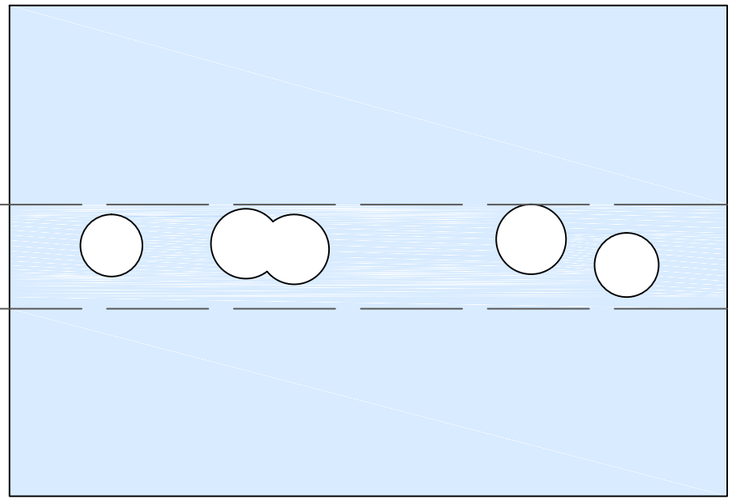
Photomontage location L11 Cooks Road - Existing view north north east to south east.
Photo coordinate Easting:762361 Northing:6480829 (MGAz55) Approximate distance to closest visible wind turbine 4,300 m
Composite panorama photograph taken with a Nikon D700 digital SLR with a 50mm lens (equates to a 35mm SLR camera with a 50mm lens).



LIverpool Range wind turbine photomontage- comparative rotor swept area
Wind turbine 152 m tip height (101 m tower with 56 m rotor length)

Existing view toward the operational Gunning wind farm from Gunning Road.

Existing view north east to east. Photo coordinate Easting:711091 Northing 6157317 (MGAz55). Approximate distance to closest visible wind turbine 4,200 m
Composite panorama photograph taken with a Nikon D700 digital SLR with a 50m lens (equates to a 35mm SLR camera with a 50m lens).



Gunning wind turbine photograph- comparative rotor swept area
Wind turbine 120 m tip height (80 m tower with 40 m rotor length)

Figure 41
Comparison of operational and photomontage wind turbines

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Night time lighting

Section 11

11.1 Introduction

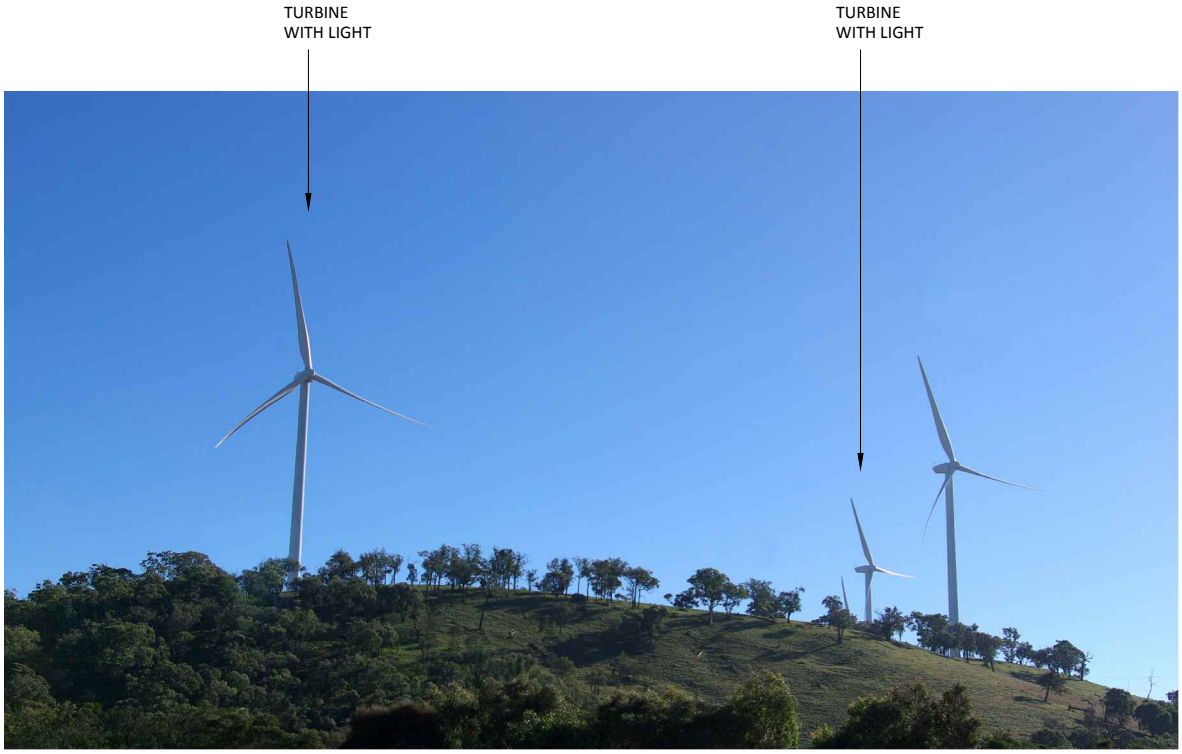
Although not currently proposed, the Liverpool Range wind farm may require obstacle lighting in the future. The future requirement for lighting will be subject to the advice and endorsement of the Civil Aviation Safety Authority (CASA). CASA is currently undertaking a safety study into the risk to aviation 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.

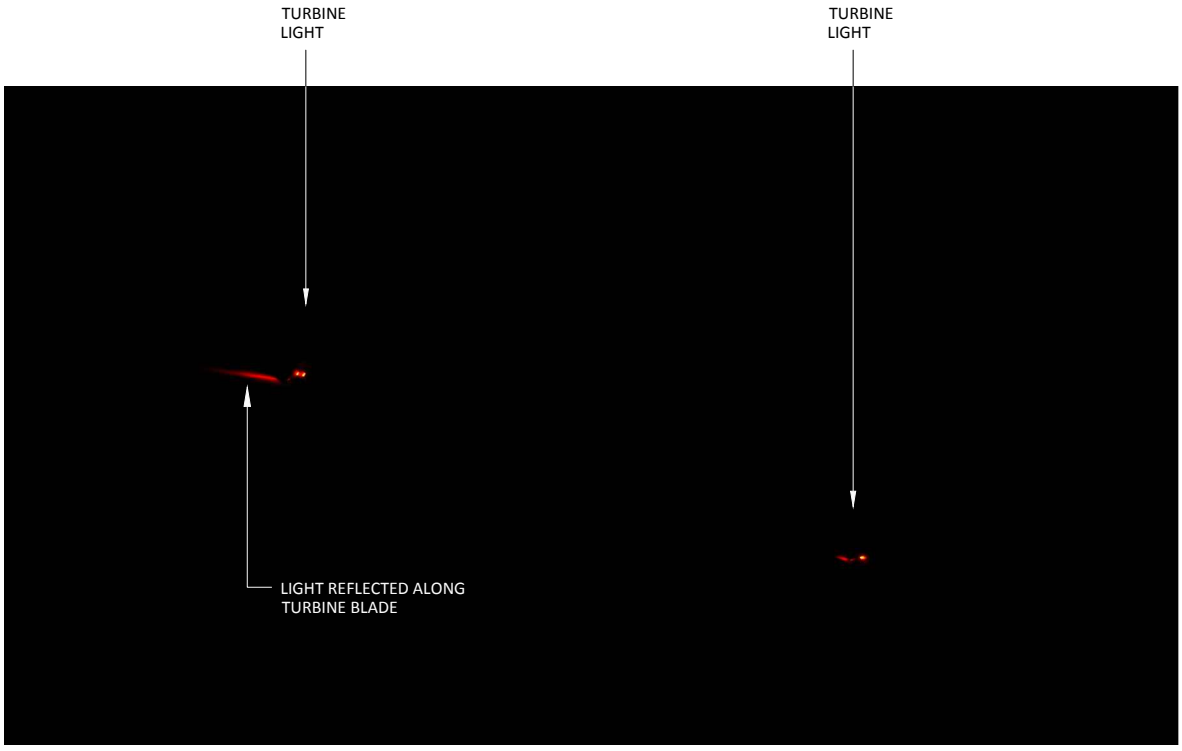
Potential visual impacts associated with obstacle marking and lighting at night time have not been extensively researched or tested in New South Wales, although some site investigations have been carried out at existing wind farms in Victoria. Investigations have generally concluded that although night 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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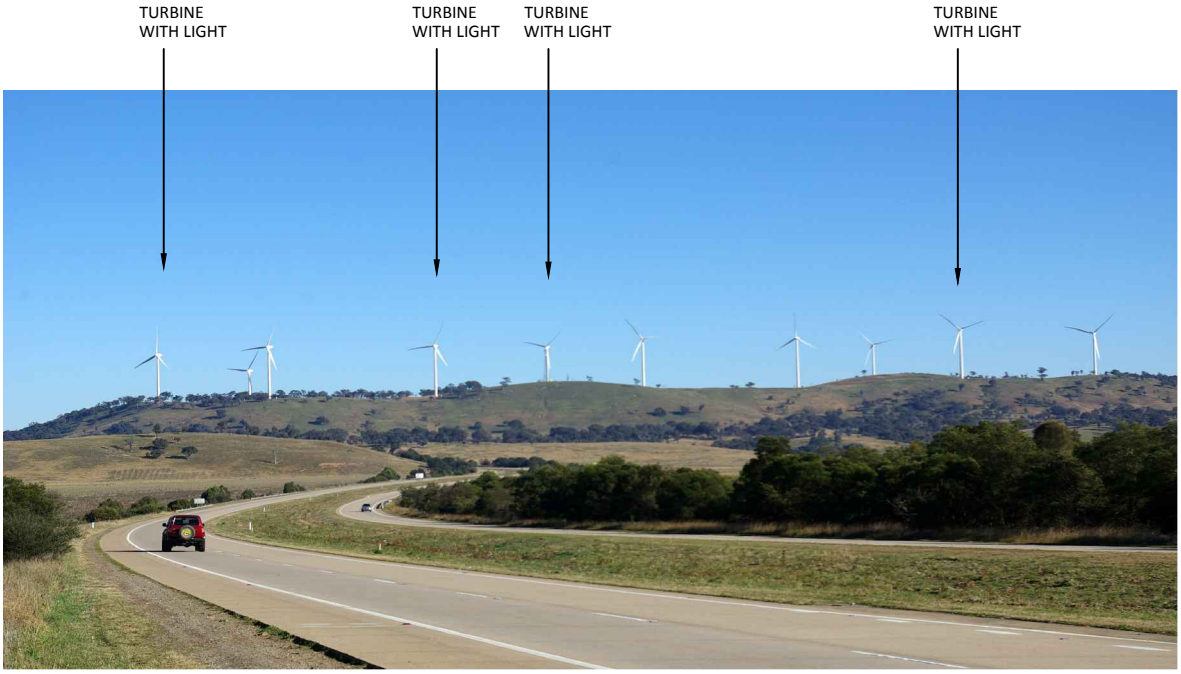
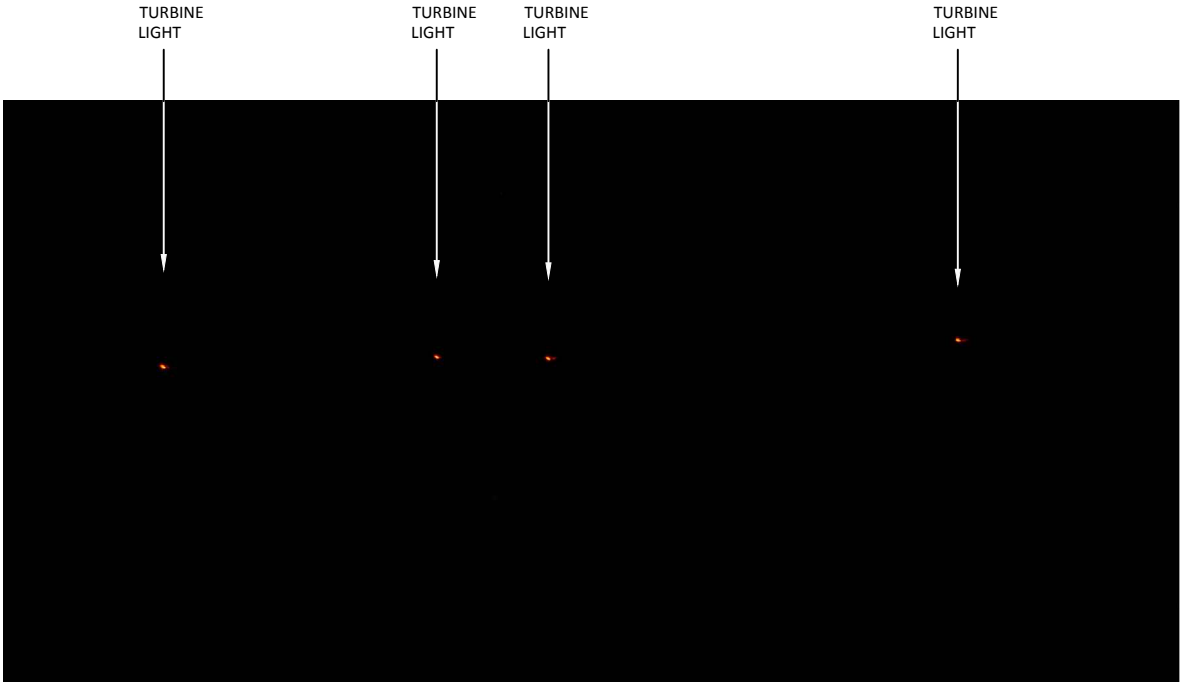


Day time view from Hume highway toward Cullerin wind farm at around 3.5km



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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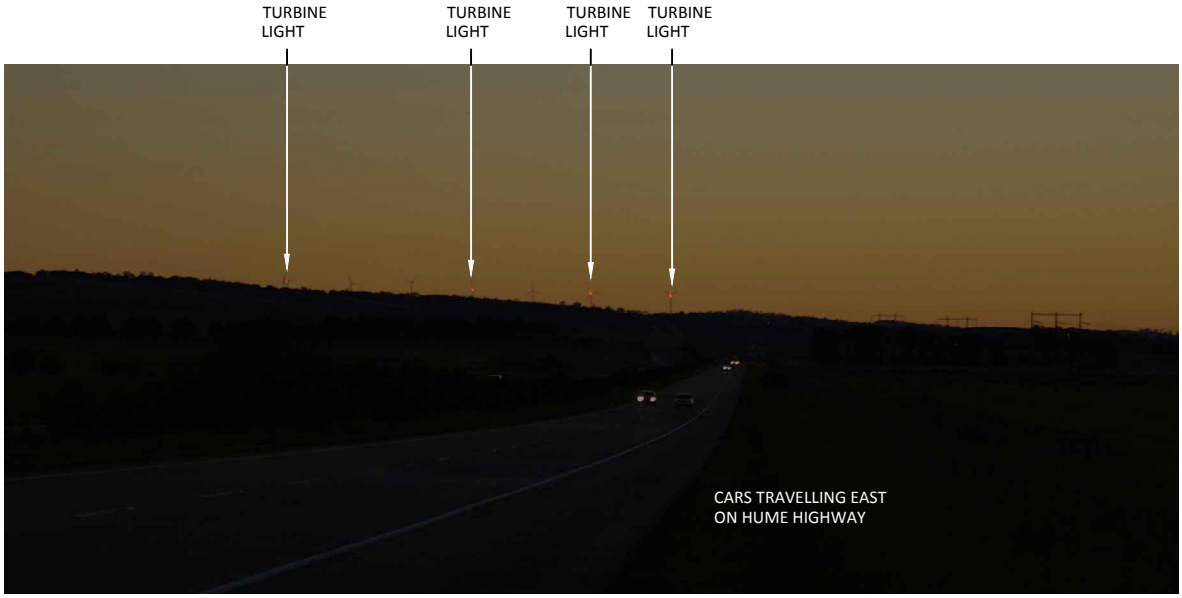
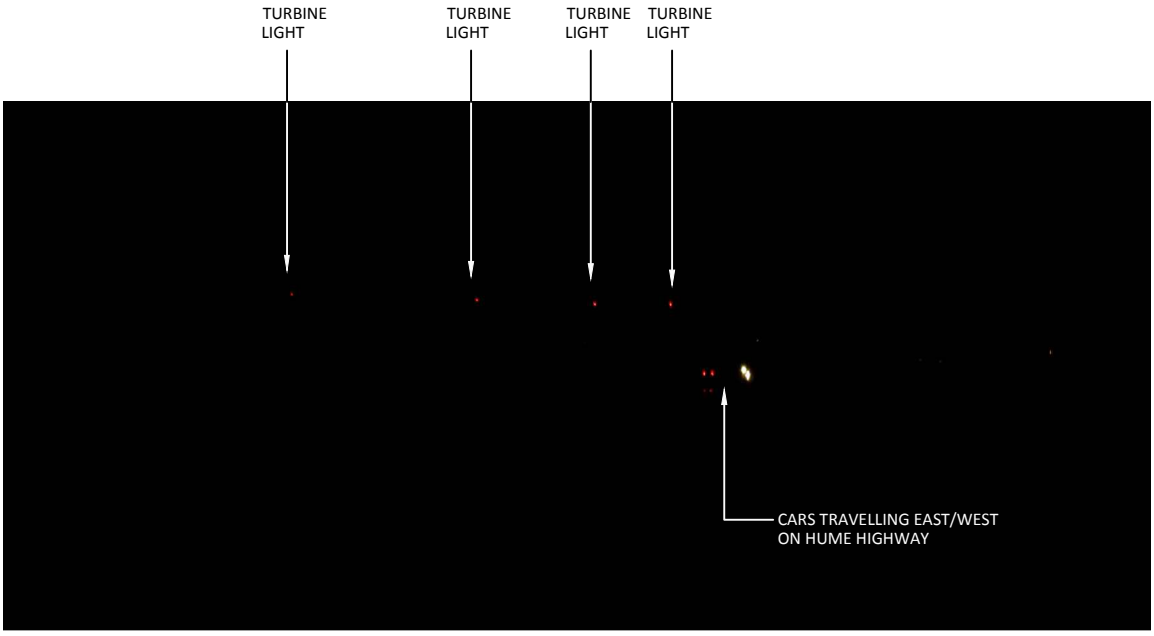


View west at dusk from Hume highway toward Cullerin wind farm at around 17km



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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Golden Highway

(Image source GBD 2013)

Photo Location P16 - View east from the Golden Highway

Golden Highway

(Image source GBD 2013)

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

Coolah Road

Turill State Forest

(Image source GBD 2013)

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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(Image source GBD 2013)

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

(Image source GBD 2013)

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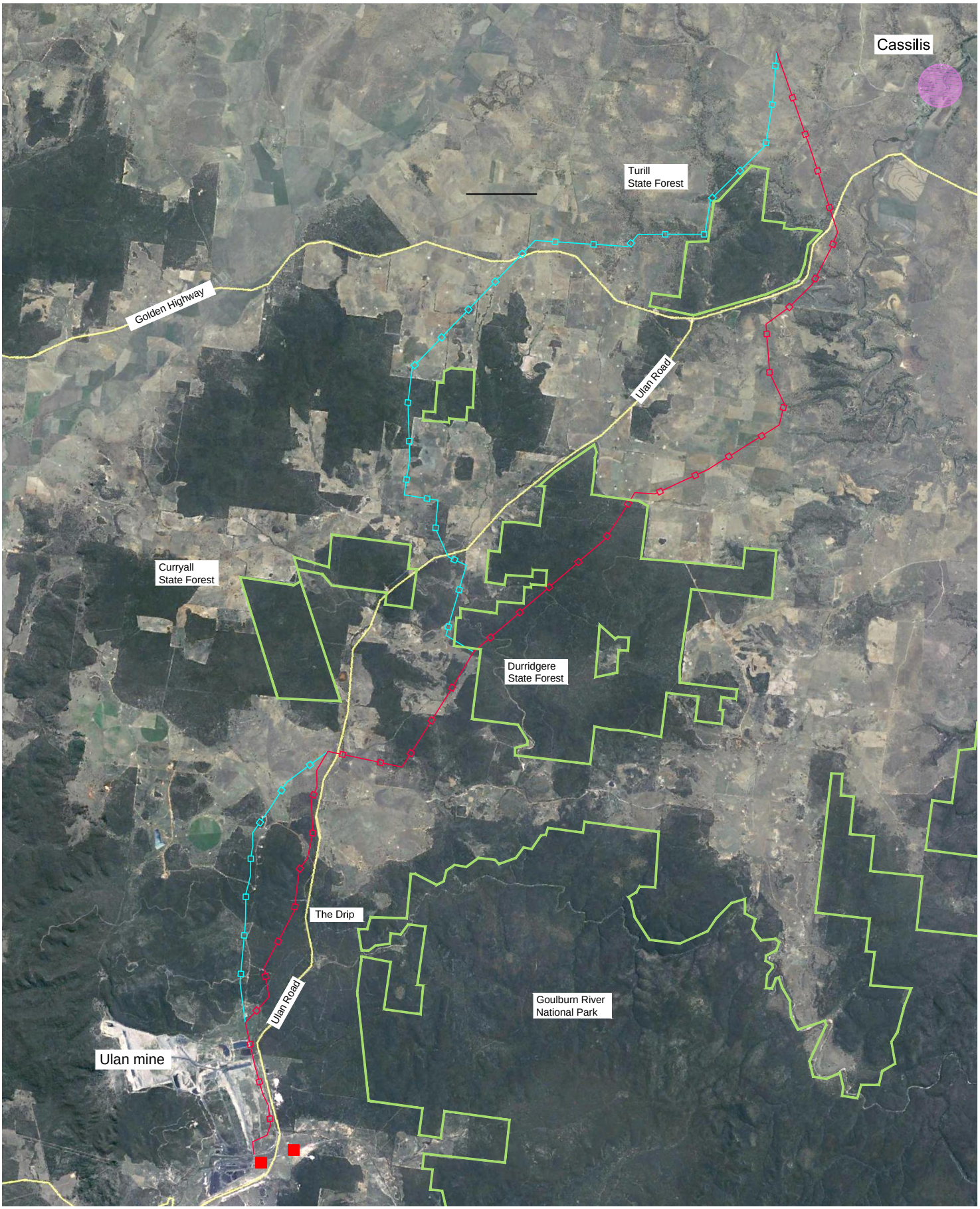

Legend

- 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)

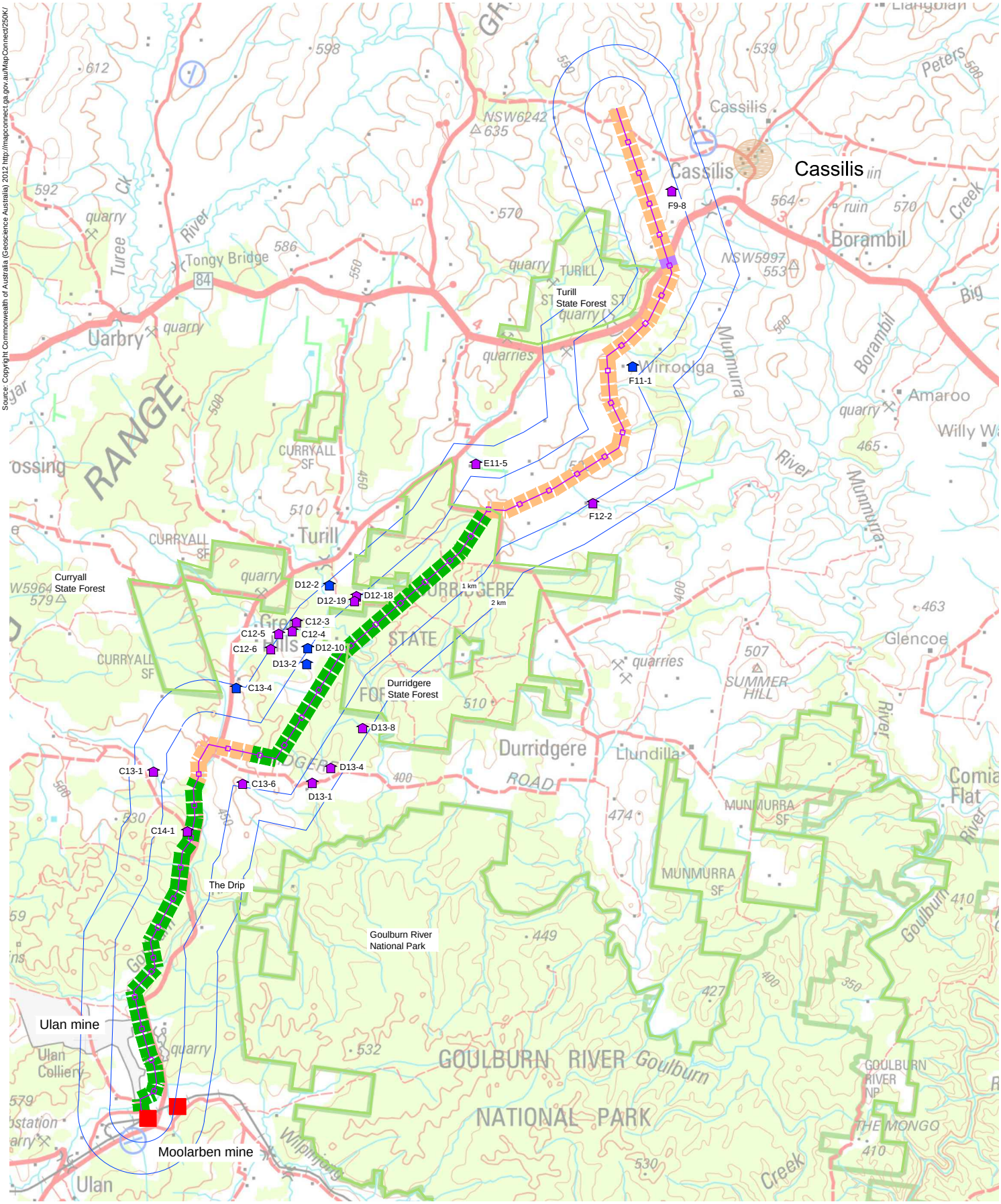
Utilising a methodology very similar to the assessment of the wind turbine visual impact, the potential visibility and resultant visual significance of the substations and powerline infrastructure will primarily result from the combination of two factors:

- 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,



Legend

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

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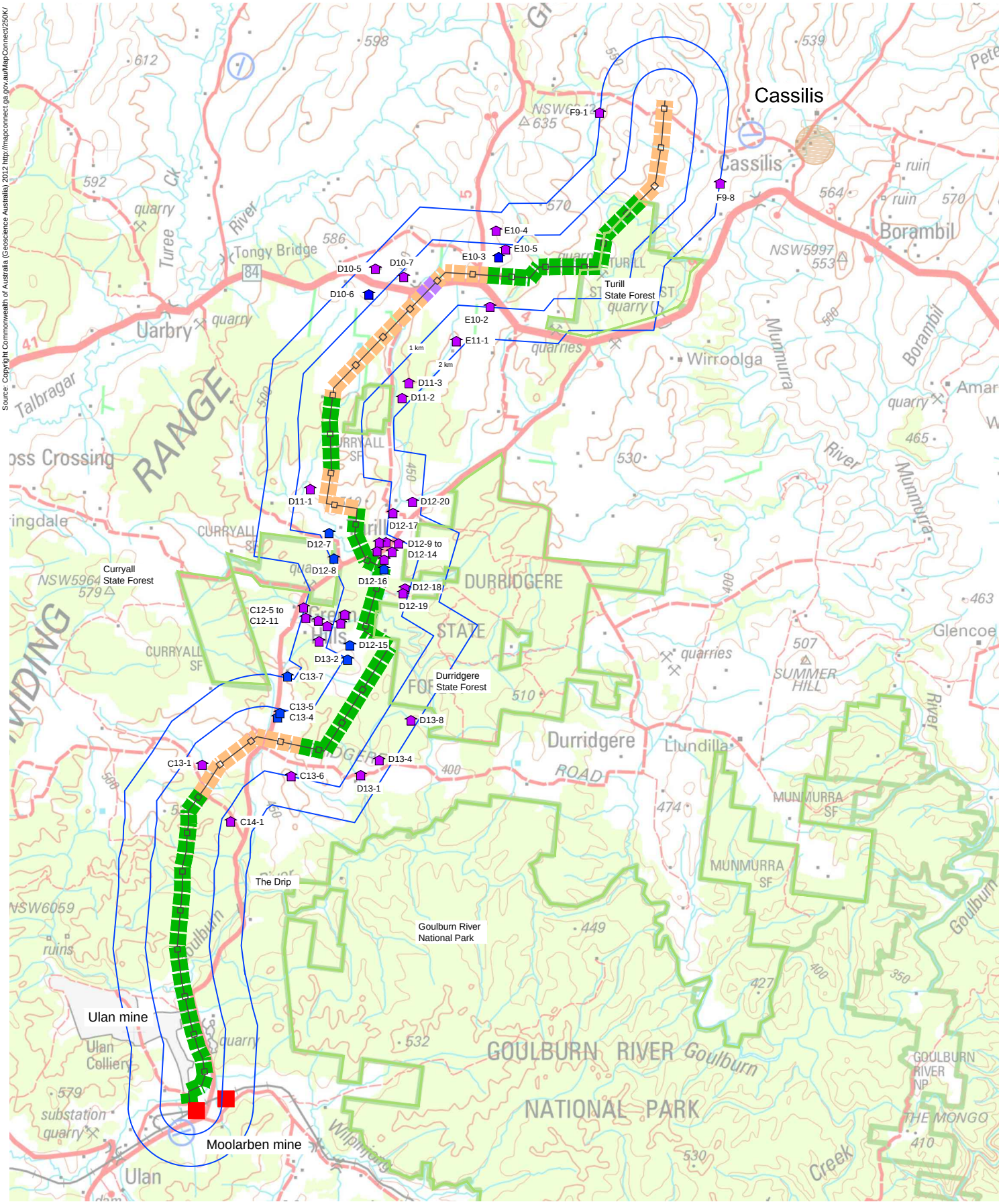

Legend

- 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

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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

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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.	✓	✓	✓	

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.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

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

Appendix A: Meeting assessment requirements

Where a wind farm application is State significant development (SSD), specific assessment requirements are specified in Director General's Requirements (DGRs). This appendix includes information to assist applicants with assessing particular impacts from a wind farm proposal in cases where DGRs require particular impacts to be assessed. The assessment must be detailed in the proponent's EIS.

Landscape and visual amenity

The visual impact of a wind farm depends on the extent of the change to the landscape caused by the development, taking into account:

- the visibility of the development
- the locations and distances from which the development can be viewed
- landscape values and their significance
- the sensitivity of the landscape features to change

The visual impact of the development relates to:

- the number, height, scale, spacing, colour and surface reflectivity of the wind turbines
- the quantity and characteristics of lighting, including aviation obstacle lighting (subject to CASA requirements and advice)
- potential for visual clutter caused by turbine layout and ability to view through a cluster or array (visually well ordered series) of turbines in an orderly manner
- the removal or planting of vegetation
- the location and scale of other buildings and works including transmission lines and associated access roads
- proximity to sensitive areas
- proximity to an existing or proposed wind farm, having regard to cumulative visual effects.

The features of the landscape include:

- the topography of the land
- the amount and type of vegetation
- natural features such as waterways, cliffs, escarpments, hills, gullies and valleys
- visual boundaries between major landscape types
- the type, pattern, built form, scale and character of development, including roads and walking tracks
- flora and fauna habitat
- cultural heritage sites
- the skyline

Assessing landscape and visual amenity impacts

DGRs typically require a comprehensive assessment of the impact of a proposed wind farm on the landscape character, landscape values, visual amenity and any scenic or significant vistas to be undertaken. There should be a particular focus on any neighbours' houses within 2 km of a proposed wind turbine that do not host the wind farm facility. The assessment should include:

- a description of the assessment methodology and a clear justification of it including discrete justification of the methodology for assessing impacts at neighbours' houses within 2 km of a proposed wind turbine
- a description of all relevant components of the project, including turbine heights and layout – where micro-siting or a range of turbines is proposed, the assessment should be based on the 'worst case' layout and turbine height
- a description of the landscape including key features

- a description of the visibility of the development
- photomontages of the project and associated transmission lines taken from:
  - potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights) within 2 km of a proposed wind turbine or other associated infrastructure (note that the number of photomontages may be reduced in less sensitive landscapes such as industrial areas),
  - urban settlements, and
  - significant public view points including roads, lookout points and walkways.
- identification of the zone of visual influence of the wind farm (no less than 10km)
- a description of the significance of the landscape values and character in a local and regional context
- a description of community and stakeholder values of the local and regional visual amenity and quality and perceptions of the project based on surveys and consultation.
- assessment of cumulative impacts on the landscape and any cumulative visual impacts from transmission line infrastructure and any surrounding approved or operational wind farms in the locality

Mitigating landscape and visual amenity impacts

The feasibility, effectiveness and reliability of proposed mitigation measures should be assessed. The extent of any residual impacts left over after mitigation measures have been implemented should also be described. Examples of mitigation measure that proponents can use to reduce the visual impact of a proposed wind farm include:

- where possible, locate turbines:
  - away from areas with high scenic values
  - away from areas with high visibility from local residents
- select turbines that :
  - look the same, have the same height and rotate the same way
  - are off-white or grey colouring
- minimise the removal of vegetation
- plant vegetation to provide a visual screen
- reduce impacts of night and obstacle lighting by
  - limiting lighting on towers to that required for safe operation and aviation safety and
  - use of lighting design which minimises glare
- underground electricity wires where practicable
- use alternative transmission line pole designs to minimise visual impact.

Appendix B – Civil Aviation Safety Authority Advisory Circular AC139-18(0) July 2007 (Withdrawn)

Australian Government
Civil Aviation Safety Authority

Advisory Circular

AC 139-18(0) SEPTEMBER 2004

OBSTACLE MARKING AND LIGHTING OF WIND FARMS

CONTENTS

1. REFERENCES

- CASR Part 139, Subpart 139.E, and in particular
  - ◊ 139.365 Structures 110 metres or more above ground level.
  - ◊ 139.370 Hazardous objects etc.
- MOS-Part 139 Chapter 7 – Obstacle Restrictions and Limitations.
- MOS-Part 139 Section 8.10 – Obstacle Marking.
- MOS-Part 139 Section 9.4 – Obstacle Lighting.

2. PURPOSE

This Advisory Circular (AC) provides general information and advice on the obstacle marking and lighting of Wind Farms (including single wind turbines), where CASA has determined that the wind farm is, or will be, a hazardous object to aviation.

3. STATUS OF THIS AC

This is the first AC to be issued on this subject.

Advisory Circulars are intended to provide recommendations and guidance to illustrate a means but not necessarily the only means of complying with the Regulations, or to explain certain regulatory requirements by providing interpretative and explanatory material.

Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material.

ACs should always be read in conjunction with the referenced regulations

4. GENERAL

4.1 This AC applies specifically to horizontal-axis wind turbines, which are the only type installed, or known to be proposed for installation, in Australia, at the date of issue of this document.

4.2 This AC applies to:

(a) a single wind turbine; or

(b) a group of wind turbines, referred to as a wind farm, which may be spread over a relatively large area.

4.3 The height of a wind turbine is defined to be the maximum height reached by the tip of the turbine blades.

4.4 Australian standards and recommended practices for the marking and lighting of obstacles and objects assessed as being hazardous to aviation, are consistent with international standards and recommended practices as published by the International Civil Aviation Organisation (ICAO) in Annex 14 Volume 1 (Aerodrome Design and Operations). The general requirements are:

(a) marking is used to make objects conspicuous to pilots, by day.

(b) lighting is used to make objects conspicuous to pilots, by night;

(c) lights are located as close as practicable to the top of the objects, and at other locations so as to indicate the general definition and extent of the objects.

4.5 Wind turbines pose a particular practical problem in that their highest point is not a fixed structure, and therefore lights can not be appropriately located. The highest fixed part of the turbine where lights can conveniently be located is the top of the generator housing, sometimes known as the nacelle, and this is typically of the order of 2/3 the maximum height of the turbine.

4.6 ICAO has not yet published standards and recommended practices specifically suited to wind turbines. The advice in this document has been derived by allowing some variations to standards and recommended practices to accommodate the specific practical difficulties associated with wind turbines and wind farms, and taking into consideration the practices of some overseas countries.

5. WIND TURBINES IN THE VICINITY OF AN AERODROME

5.1 CASA strongly discourages the siting of wind turbines in the vicinity of an aerodrome.

5.2 A wind turbine located sufficiently close to an aerodrome so that it penetrates an obstacle limitation surface (OLS) of the aerodrome, is defined by MOS-Part 139 Section 7.1, to be an obstacle.

5.3 If the aerodrome is to be used at night, an obstacle that penetrates an OLS should be lighted, in accordance with MOS-Part 139 Section 9.4. The top lights are required to be arranged so as to at least indicate the points or edges of the object highest above the obstacle limitation surface. For a wind turbine, these lights may be located on a separate supporting structure adjacent to the wind turbine, to overcome the difficulty associated with the highest point of the obstacle being the (moving) blades of the turbine.

Note: Obstacle limitation surfaces are a complex of imaginary surfaces associated with an aerodrome. They vary depending on number and orientation of runways, and the instrument-approach type of the runway(s). Some surfaces can extend to 15 km from an aerodrome. Aerodrome operators can provide details for their particular aerodrome.

6. WIND TURBINES WITH A HEIGHT OF 110 m OR MORE

6.1 CASR 139.365 requires a person proposing to construct a building or structure, the top of which will be 110 m or more above ground level, to inform CASA of that intention and the proposed height and location of the proposed building or structure.

6.2 CASA will conduct an aeronautical study to determine if the wind turbine will be a hazardous object to aviation, in accordance with CASR 139.370.

6.3 If, as a result of the aeronautical study CASA finds that a proposed wind turbine will penetrate an OLS of an aerodrome, the proposal will be dealt with in accordance with 5 above.

6.4 The aeronautical study may find that even though the proposed wind turbine will not penetrate any OLS of an aerodrome, it will be a hazardous object to aviation.

6.5 The hazard that an object poses to aviation can be reduced by indicating its presence by appropriate marking and/or lighting.

Note: The marking and/or lighting does not necessarily reduce operating limitations which may be imposed by an obstacle or hazardous object.

6.6 The advice, in 7 and 8 below, on marking and lighting of wind turbines, should be suitable for wind turbines that do not penetrate an OLS, in most cases. However, because of the variations in configurations and layout of turbines in wind farms, the aeronautical study may indicate that a variation to that advice would be appropriate for a particular wind farm. In such a case, CASA may offer suggestions for variations to the normal advice provided in 7 and 8 below.

7. MARKING OF WIND TURBINES

7.1 Experience with wind turbines installed to date, indicates that they are sufficiently conspicuous by day, due to their shape, size, and colour.

7.2 Wind turbines that are of basically a single colour, and visually conspicuous against the prevailing background, do not require to be painted in obstacle marking colours and/or patterns.

8. LIGHTING OF WIND TURBINES

8.1 In the case of a single wind turbine:

(a) two flashing red medium intensity obstacle lights should be mounted on top of the generator housing;

(b) the light fixtures should be mounted at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction;

(c) both lights should flash simultaneously; and

(d) the characteristics of the obstacle lights should be in accordance with MOS-Part 139 subsection 9.4.7.

8.2 In the case of a wind farm, sufficient individual wind turbines should be lighted to indicate the extent of the group of turbines:

(a) the interval between obstacle lights should not be less than the current extensive object standard of 900 metres, and at a distance that minimises the number of lighted wind turbine generators without diminishing appropriate aviation safety;

(b) in addition, the most prominent (highest for the terrain) turbine(s) should be lighted, if not included amongst the turbines lighted in accordance with (a) above; and

(c) the lighting of individual turbines should be in accordance with 8.1 above.

*Note**:*** *There is an overseas proposal that all lighting provided at a wind farm should flash simultaneously. This proposal is still to be validated and accepted. It is suggested that wind farm operators bear in mind that the simultaneous flashing of all lights at a wind farm could become accepted practice some time in the future.*

8.3 On completion of the project, CASA may choose to conduct a flight check to determine the adequacy of the obstacle lighting. This may result in a change (either more or fewer) to the number of obstacle lights required, to ensure the development remains conspicuous.

8.4 Where obstacle lighting is to be provided, it is recommended a monitoring, reporting and maintenance procedure be put in place to ensure outages are reported through the NOTAM system and repairs are implemented.

Bill McIntyre
Executive Manager
Aviation Safety Standards

Appendix C – Andrew Homewood, curriculum vitae

GREEN BEAN DESIGN *landscape architects*

CURRICULUM VITAE

Andrew Homewood Grad Dip LM, BSc (Dual Hons), Dip Hort - Registered Landscape Architect, AILA

Areas of Expertise

Landscape/urban design
Landscape management
Landscape and visual impact assessment
Independent verification
Landscape photography

Academic

Post Graduate Diploma Landscape Management (Sheffield University 1996)
BSc (Dual Hons) Landscape Architecture and Archaeology (Sheffield University 1994)
National Diploma Amenity Horticulture (Writtle College 1986)

Green Bean Design (GBD) is an experienced landscape architectural consultancy specialising in landscape and visual impact assessment. As an independent consultancy GBD provide professional advice to a range of commercial and government clients involved in large infrastructure project development.

GBD owner and Principal Landscape Architect Andrew Homewood is a Registered Landscape Architect and member of the Australian Institute of Landscape Architects and the Environmental Institute of Australia and New Zealand.

Andrew has over 20 years continuous employment in landscape consultancy and has completed numerous landscape and visual impact assessments for a range of large scale and State significant infrastructure and renewable energy projects, including wind energy and solar power developments. Green Bean Design has been commissioned for over 20 wind energy projects across New South Wales, Victoria, South Australia, Queensland and Tasmania.

CURRICULUM VITAE

Andrew Homewood Grad Dip LM, BSc (Dual Hons), Dip Hort - Registered Landscape Architect, AILA

Selected Project Experience ***Landscape and Visual Impact Assessment***

Wind and Solar Farms

BP Moree Solar Power Station, Status: Approved

LVIA for the Solar Flagship Moree Solar Farm site in northern New South Wales.

Boco Rock Wind Farm EA, (Wind Prospect CWP Pty Ltd) Status: Approved

LVIA for the proposed construction of up to 125 wind turbine generators in the NSW Southern Tablelands Monaro sub region, including coordination for supply of photomontage, ZVI and flicker assessment.

Sapphire Wind Farm EA (Wind Prospect CWP Pty Ltd) Status: Approved

LVIA for the proposed construction of up to 174 wind turbine generators in the NSW New England region, including coordination for supply of photomontage, ZVI and flicker assessment.

Silverton Wind Farm EA Stages 1 & 2 (Epuron Pty Ltd) Status: Approved

LVIA for a 1000MW wind farm at Silverton in the Unincorporated Area of western NSW, for up to 600 wind turbines including a 25km length of 220kV transmission line between the wind farm and Broken Hill.

Conroy's Gap Wind Farm (Epuron Pty Ltd) Status: Approved

LVIA for a DA modification for additional wind turbines to an approved development located in the southern highlands NSW.

Collector Wind Farm EA, (RACL Australia Pty Ltd) Status: Approved

LVIA for the proposed construction of up to 68 wind turbines adjoining the operation Cullerin wind farm project including a detailed cumulative impact assessment.

Mount Emerald Wind Farm (RACL Australia Pty Ltd)

LVIA for the proposed construction of up to 75 wind turbines located in the Atherton Tablelands Far North Queensland.

Bango Wind Farm (Wind Prospect CWP Pty Ltd)

LVIA for the proposed construction of up to 100 wind turbines located in the southern highlands NSW.

CURRICULUM VITAE

Andrew Homewood Grad Dip LM, BSc (Dual Hons), Dip Hort - Registered Landscape Architect, AILA

Liverpool Range Wind Farm Stage 1 (Epuron Pty Ltd)

LVIA for the proposed construction of up to 200 wind turbines located in the Warrumbungle and Upper Hunter Shire Councils approximately 370 km north of Sydney, and a 60 km length of 330 kV line connecting to the Ulan mine site.

Rye Park Wind Farm, (Epuron Pty Ltd)

LVIA for the proposed construction of up to 120 wind turbines adjoining multiple wind farm sites in the New South Wales southern highlands.

Deepwater Wind Farm (Epuron Pty Ltd)

LVIA for the proposed construction of up to 7 wind turbines at Deepwater in north NSW.

Port Kembla Wind Farm (Epuron Pty Ltd)

LVIA for the proposed construction of up to 7 wind turbines within the Port Kembla industrial facility at Wollongong.

Eden Wind Farm, (Epuron Pty Ltd)

LVIA for the proposed construction of up to 7 wind turbines within the SEFE woodchip facility on the south coast of New South Wales.

Paling Yards Wind Farm EA, (Union Fenosa Pty Ltd)

LVIA for the proposed construction of up to 59 wind turbines including night lighting, cumulative impact assessment, detailed field assessment for shadow flicker and preparation of photomontages.

Willatook Wind Farm EES Referral, (Wind Prospect WA Pty Ltd)

Preliminary LVIA for the proposed construction of up to 190 wind turbines within Moyne Shire Council (Victoria) including a detailed cumulative impact assessment, photomontage location selection and community consultation.

White Rock Wind Farm EA, (Epuron Pty Ltd)

LVIA for the proposed construction of up to 100 wind turbines adjoining the proposed Sapphire and approved Glen Innes wind farm projects including a detailed cumulative impact assessment, photomontage

CURRICULUM VITAE

Andrew Homewood Grad Dip LM, BSc (Dual Hons), Dip Hort - Registered Landscape Architect, AILA

location selection and community consultation.

Crookwell 3 Wind Farm EA, (Union Fenosa Wind Australia)

LVIA for the proposed construction of up to 35 wind turbines adjoining the approved Crookwell 2 wind farm development including a detailed cumulative impact and night time lighting assessment.

Granville Harbour Wind Farm, (Westcoast Wind)

LVIA for the proposed construction of up to 33 wind turbines in north west Tasmania.

Professional History

Green Bean Design, Principal Landscape Architect 2006 – to date

URS Australia Pty Ltd, Practice Leader Landscape Architecture 2005 – 2006

URS Australia Pty Ltd, Associate Landscape Architect 2003-2005

URS Australia Pty Ltd, Senior Landscape Architect, 2002 – 2003

URS Australia Pty Ltd, Landscape Planner, 2001-2002

URS, Contract Landscape Architect, 2000-2001

Blacktown City Council, Contract Landscape Planner, 2000-2001

Knox & Partners Pty Ltd, Landscape Architect, 1996-2000

Brown & Associates, Landscape Architect, 1996

Philip Parker & Associates, Graduate Landscape Architect, 1994-1995
Rendel & Branch, Landscape Assistant, 1989-1991

National Trust, Horticulturalist, 1987-1988

English Nature, Species Protection Warden, 1985-1986

Essex Wildlife Trust, Botanist, 1984-1985

Royal Society for the Protection of Birds, Voluntary Warden, 1983-1984