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:

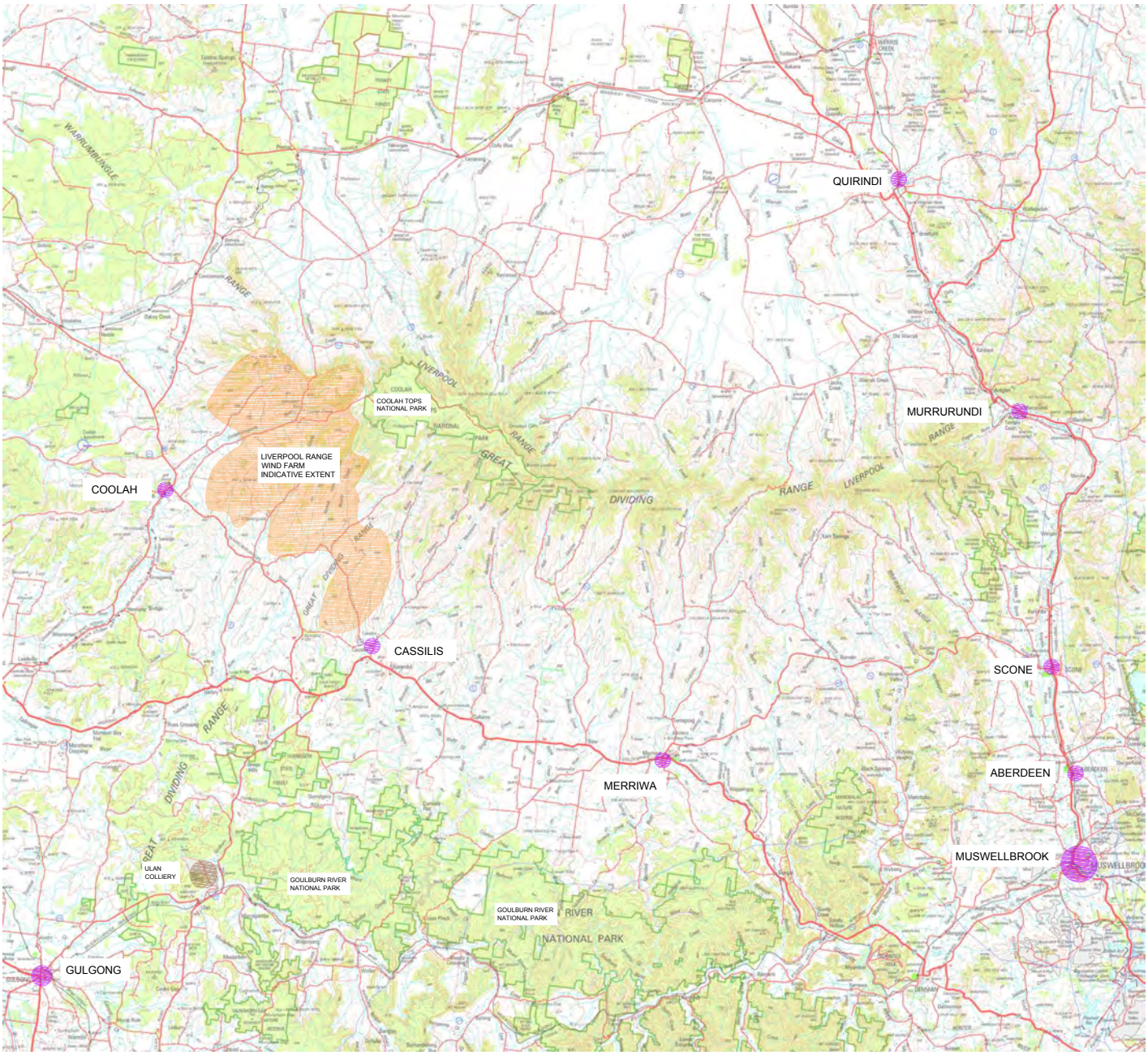
- Upper Hunter Shire;
- Warrumbungle Shire;
- Liverpool Plains Shire; and
- Mid Western Regional Shire.

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

Liverpool Range Wind Farm Pty Ltd

LIVERPOOL RANGE WIND FARM

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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.

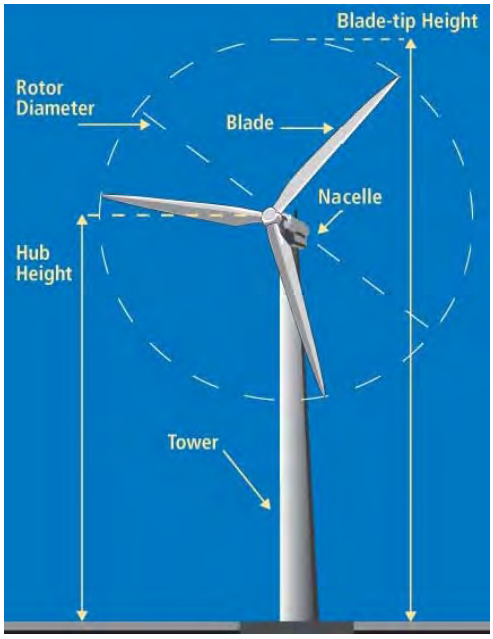
3.2 Wind turbines

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

Figure 2
Site layout

LIVERPOOL RANGE WIND FARM

0km 10km

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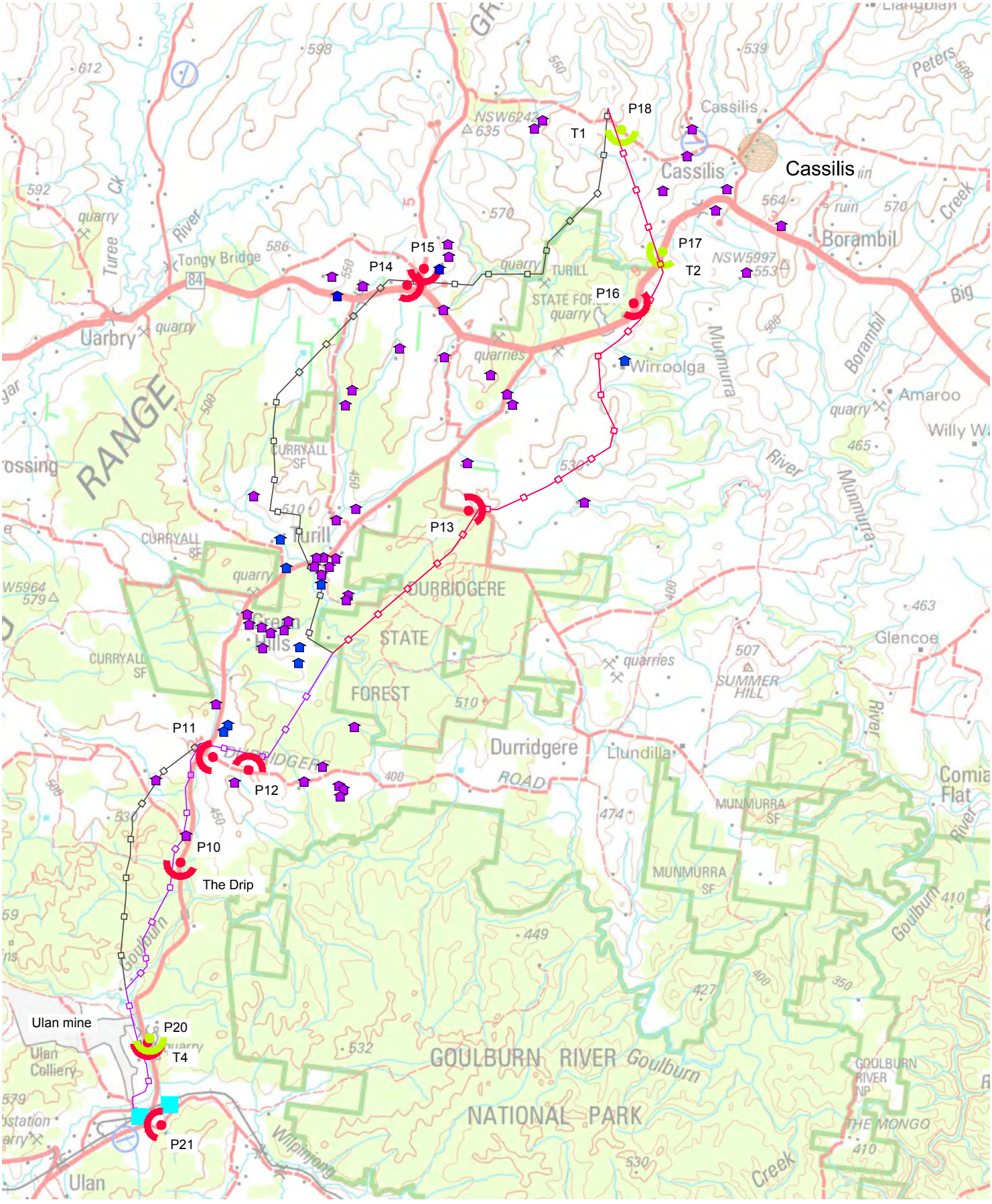

Legend

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

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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

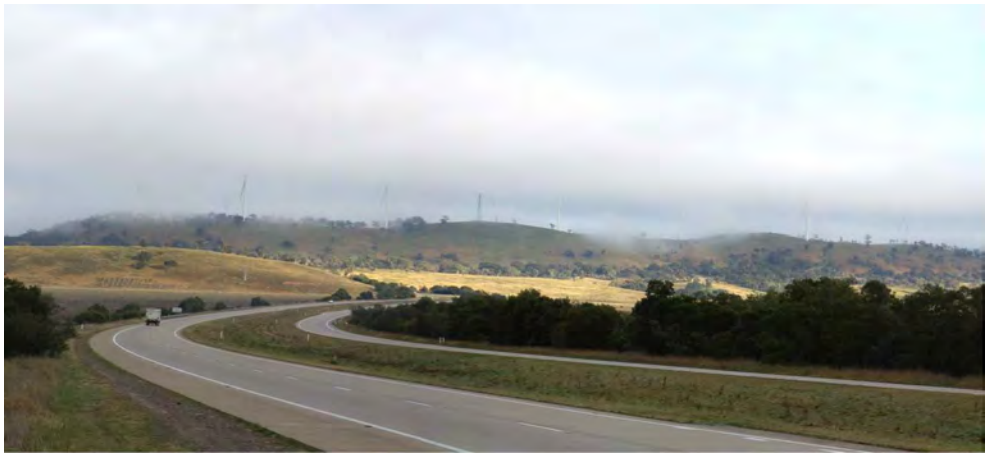
The landform of the wind farm site falls gently from the north to the south across a series of ridgelines sloping from the Liverpool Range mountain range toward the localities of Coolah and

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**.

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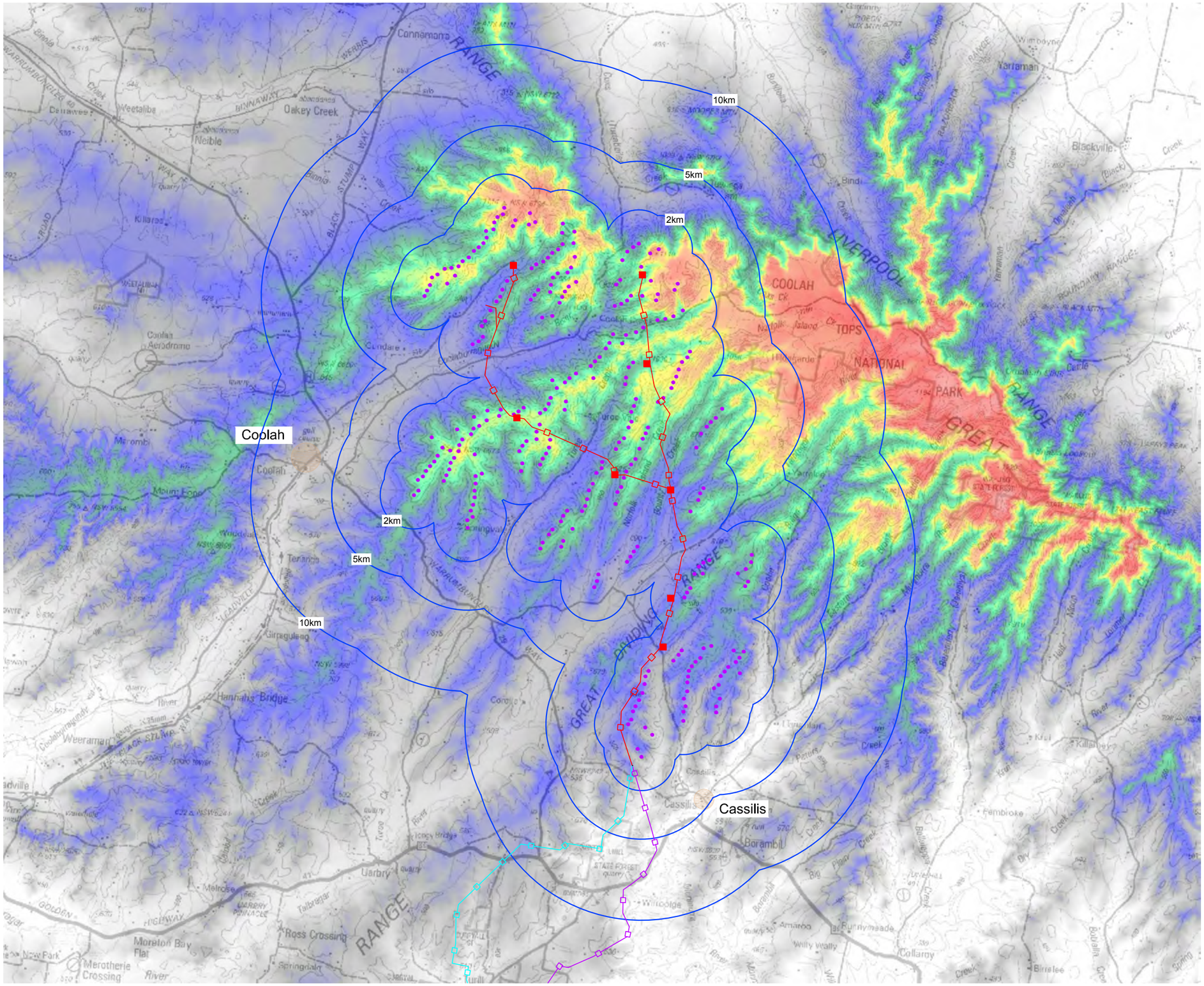

Legend

- 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

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**.

P1
P2
P3
P4
P5
P6
P7
P8
P9
P19
Coolah
Cassilis
10km
5km
2km

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

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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)

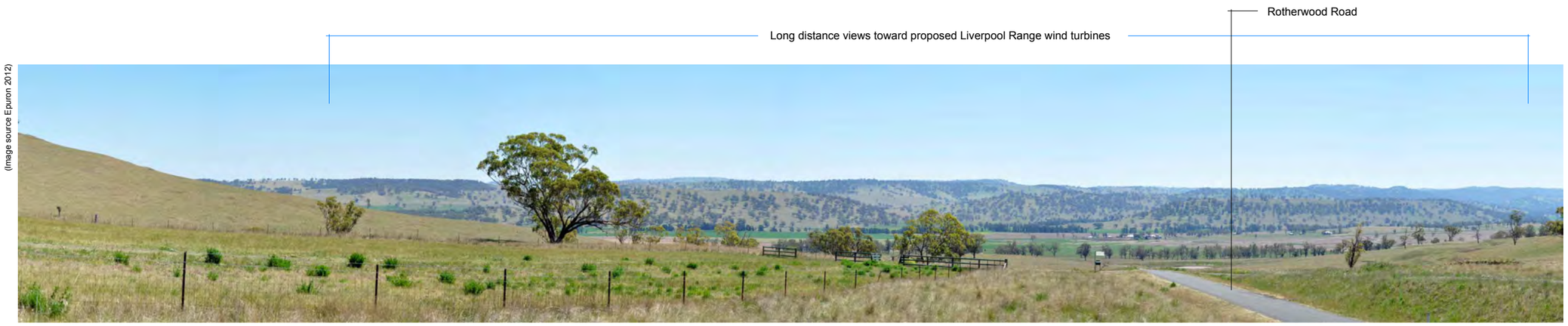

Photo Location P2 - View north west to north from Rotherwood Road (Approximate distance to closest wind turbine 4 km)

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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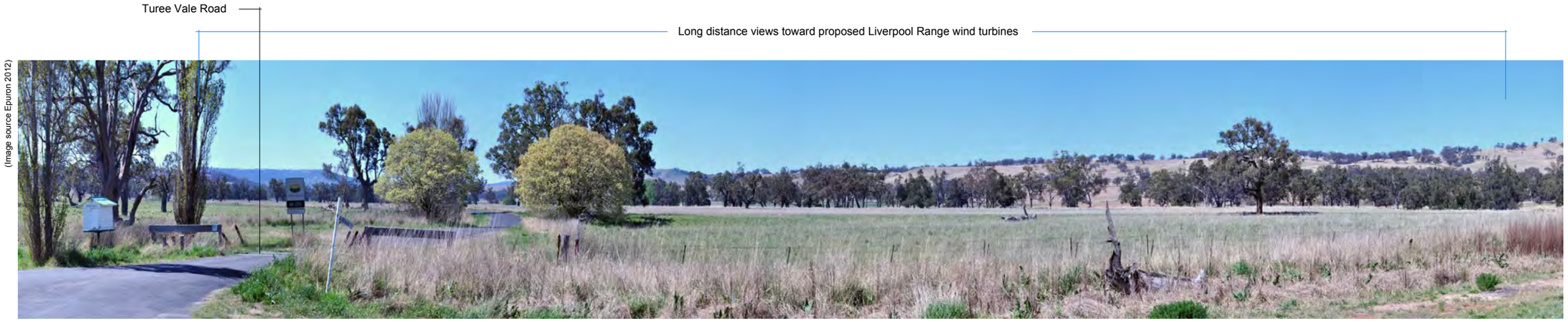

Photo Location P4 - View north from Turee Vale and Cassilis Road intersection (Approximate distance to closest wind turbine 4 km)

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

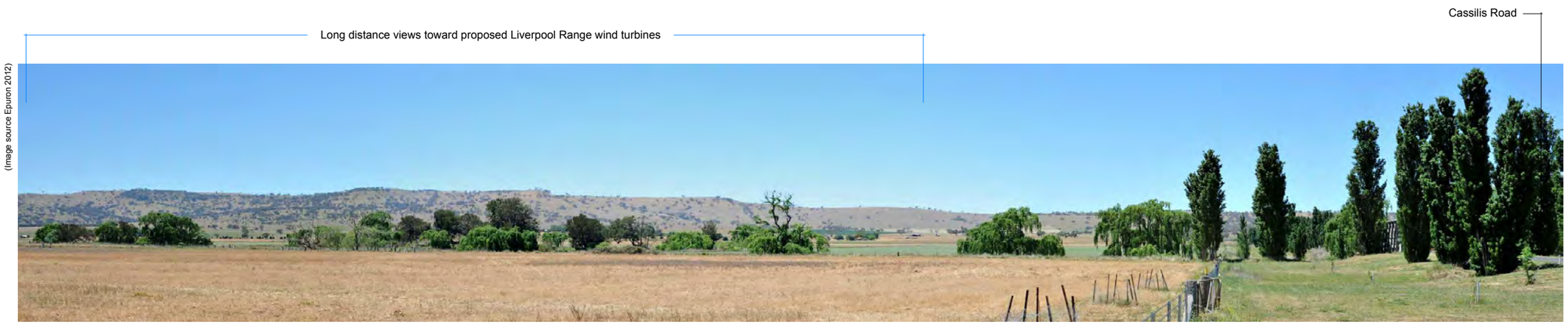

Photo Location P6 - View north east to east from Cassilis Road, Coolah (Approximate distance to closest wind turbine 6 km)

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)

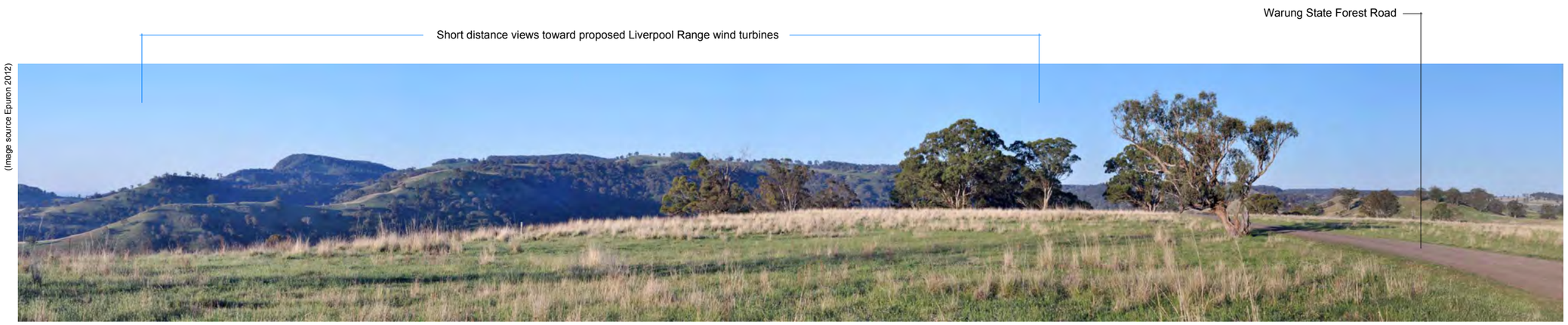

Photo Location P9 - View north from the Warung State Forest Road (Approximate distance to closest wind turbine 2 km)

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

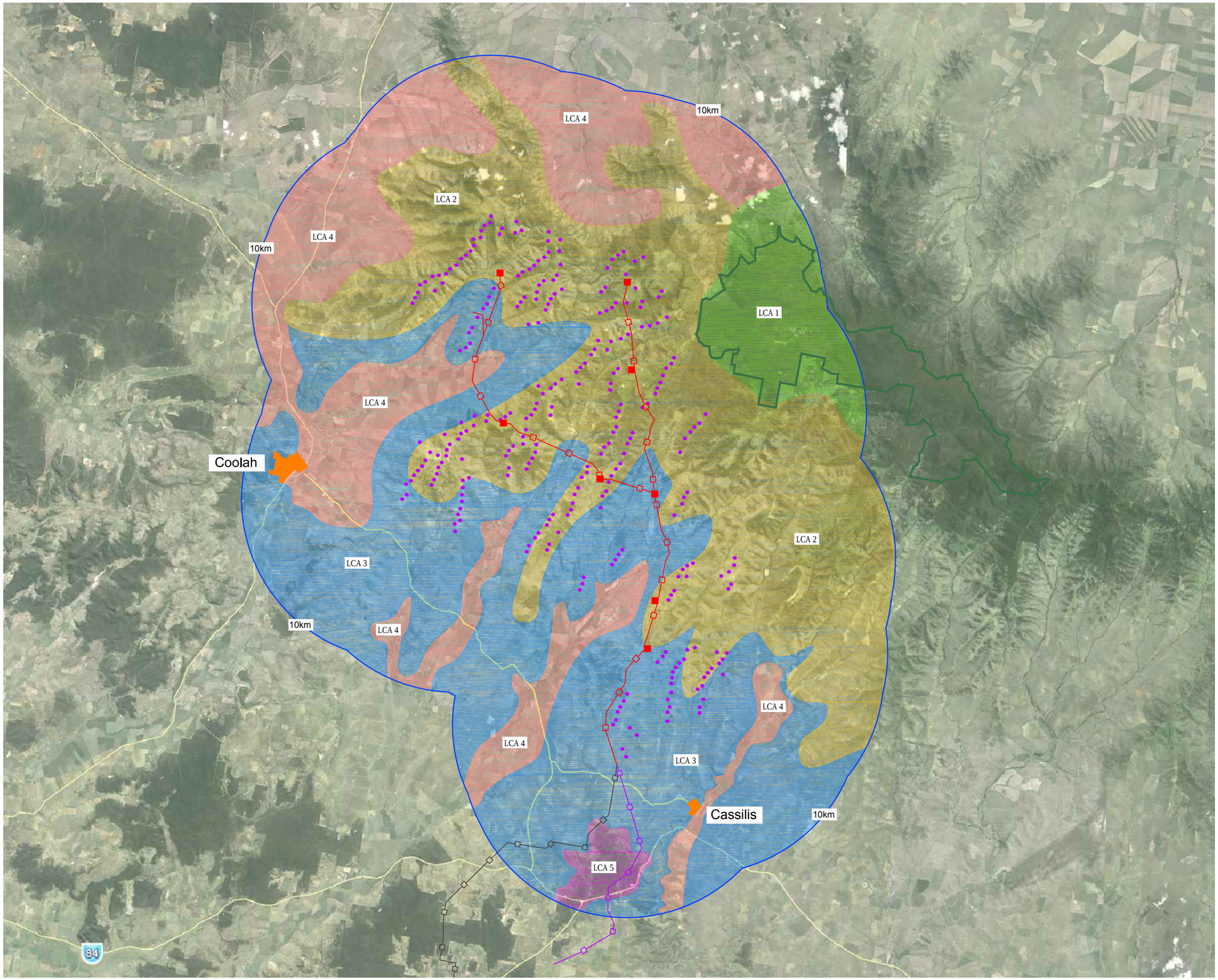
A fundamental part of this LVIA is to understand and describe the nature and sensitivity of different components of the landscape within the Project 10 km viewshed, and to assess the landscape character in a clear and consistent process. For the purpose of this LVIA, landscape character is defined as '*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

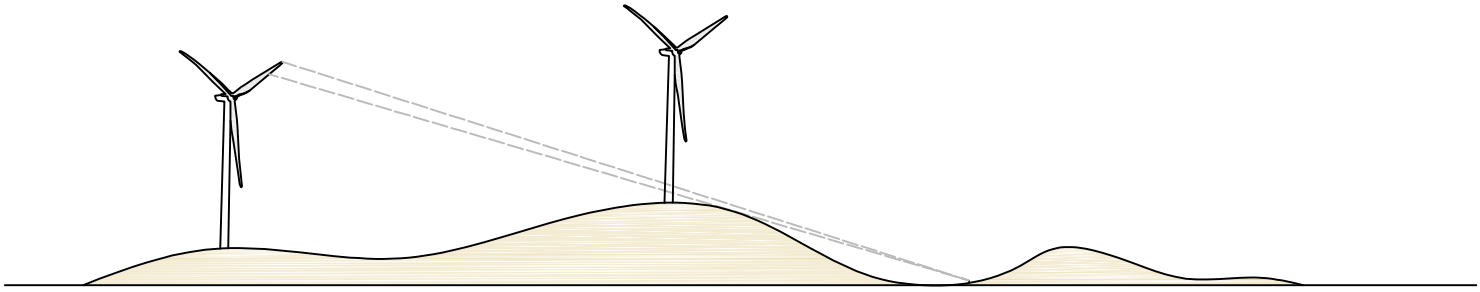
The most extensive and continuous area of visibility toward the Project turbines will generally occur where the tips of the wind turbine rotor blades are visible above surrounding ridgelines or vegetation; however, views toward the tips and upper portions of the wind turbine rotors are likely to become 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.

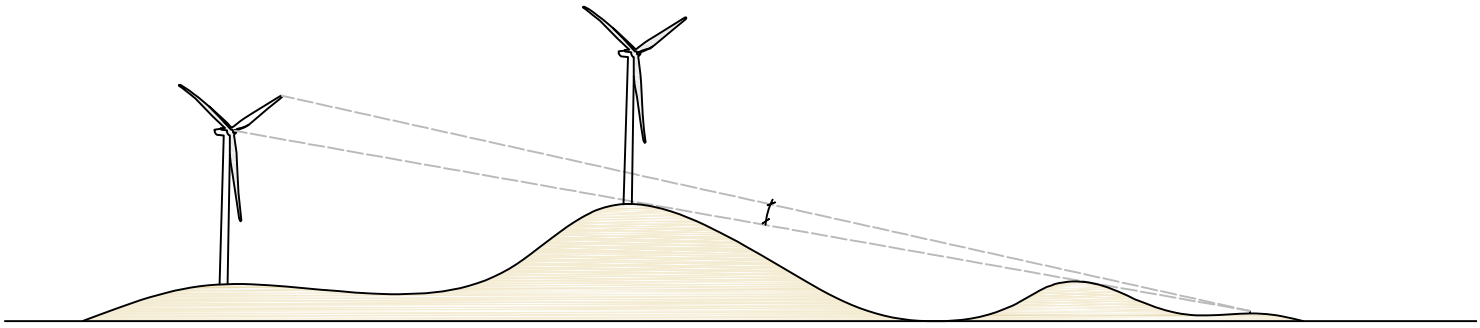
The ZVI diagrams also illustrate a number of discrete pockets within portions of the 5 km to 10 km distance offset from which the wind turbines will not be visible, although this band of the viewshed also represents areas from which a greater number of turbines will also be visible.

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.



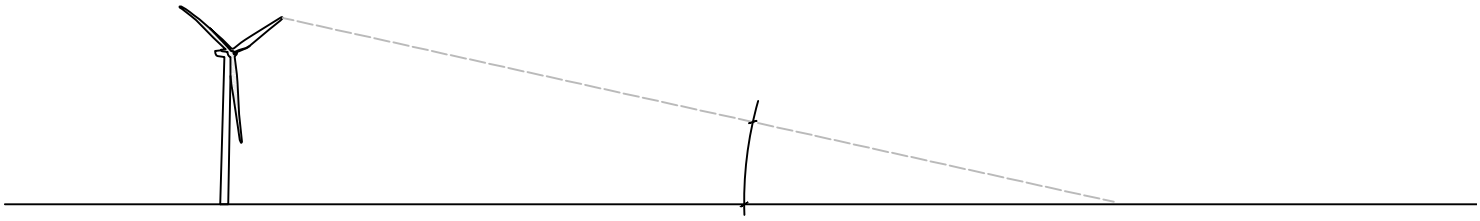
'Tip of blade'

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

EPURON

Liverpool Range Wind Farm Pty Ltd

GREEN BEAN DESIGN
landscape architects

Coolah

Cassilis

Coolah Tops National Park

10km

5km

2km

2km

5km

10km

0km 10km

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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landscape architects

LIVERPOOL RANGE WIND FARM