

11 LANDSCAPE AND VISUAL ASSESSMENT

This chapter describes the landscape and visual impacts of the Project and the proposed mitigation measures that are designed to minimise any adverse impacts on the landscape values in the vicinity of the Project.

11.1 Introduction

A Landscape Character and Visual Impact Assessment (LCVIA) was undertaken by Clouston Associates (2015) to assess the potential visual impacts associated with the Project on public and private receptors in proximity to the PA. A copy of the LCVIA is provided at *Annex I*. The assessment has been prepared to address the requirements specified in the SEARs pertaining to landscape and visual impacts, outlined in *Chapter 1*, and having regard to the following:

- *Draft NSW Planning Guidelines: Wind Farms 2011 (DP&I 2011) (Draft Wind Farm Guidelines);*
- *Wind Farms and Landscape Values National Assessment Framework, June 2007 (Planisphere et al 2007) (NAF);*
- *Auswind Best Practice Guidelines, December 2006; and*
- *Environmental Impact Assessment Practice Note: Guidelines for Landscape Character and Visual Impact Assessment, March 2013 (RMS 2013).*

11.1.1 Methodology

The LCVIA incorporated the following scope of works:

- describing the landscape character, features and values of the PA, their significance and sensitivity to change;
- identifying effects on significant landscape values of the region;
- identifying sensitive receptors (both public and private) that may be subject to the various amenity effects from the Project;
- assessing the likely effects of the Project on identified landscape values;
- assessing the visual effect of the Project at the selected public and private receptor locations, including the preparation of photomontages from these viewpoints;
- assessing the visual effects of potential night time obstacle lighting installed on WTGs;
- undertaking an assessment of likely cumulative landscape effects, taking into consideration nearby wind farm developments, including Gullen Range Wind Farm and Gunning Wind Farm; and
- outlining potential design and siting options that could mitigate effects on visual amenity from adjoining residences.

11.1.2 Study Area

The study area for the purposes of the LCVIA is defined as the area of land within and beyond the PA, which could be potentially visually affected by the Project, with this area typically referred to as the viewshed. Based on a desktop analysis and site visit, a study area of approximately 12 km offset from the WTGs was identified based on topography, receptor locations and viewing distance.

It is important to note that some of the WTGs would be visible from areas of the landscape beyond the nominated study area, however within the general parameters of normal human vision, the visibility of a wind turbine at a maximum height of 185 m would occupy a relatively insignificant proportion of the visual scene from distances in excess of 15 km.

Zone of Visual Influence

Within the viewshed, a zone of visual influence (ZVI) has been established to identify theoretical areas of the landscape from which a defined layout of WTGs could potentially be visible. This is a useful tool for providing an overview as to the extent to which a wind farm may be visible from the surrounding area.

The ZVI for the Project has been produced using a digital terrain map of the study area, indicating the number of WTGs visible from any given point within the landscape. The ZVI prepared by Clouston Associates that identifies the number of WTGs visible at hub height (110m) is provided at *Figure 11-1*.

It is noted that the ZVI does not take into account the screening provided by built structures and vegetation above ground level. WTGs may therefore, not be visible at many of the locations indicated on the ZVI diagrams due to the local presence of vegetation or built form. Additionally, the number of WTGs visible is affected by weather conditions at the time.

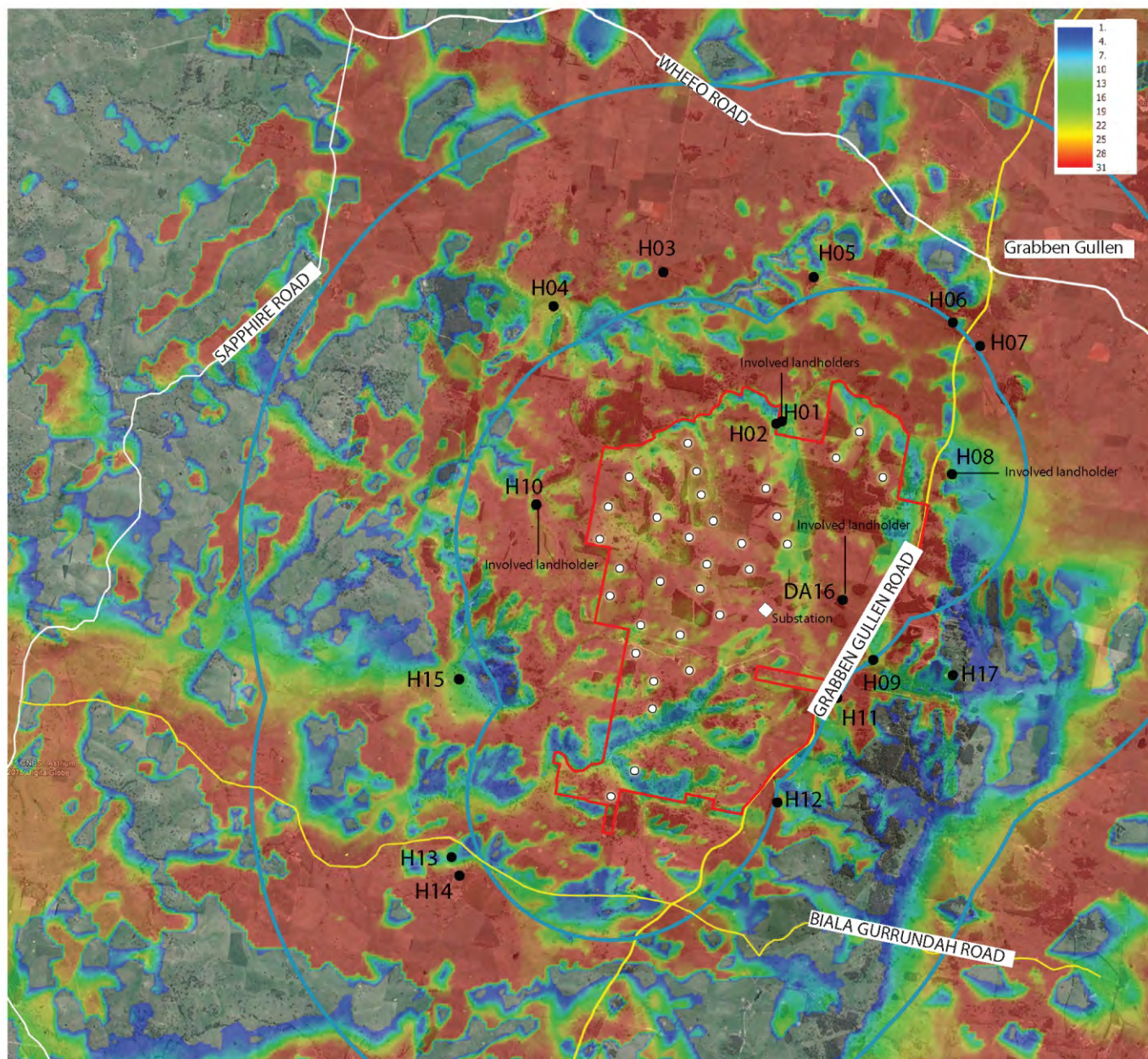
11.2 Existing Environment

11.2.1 Existing Landscape

The landform and topography within the viewshed is generally undulating and indicative of the Southern Tablelands. Broad and rounded crests and ridges grade into concave lower slopes and drainage lines. Within the PA, a broad ridgeline at an approximate elevation of 900 m extends along the eastern boundary with the landform falling away either side of this ridgeline.

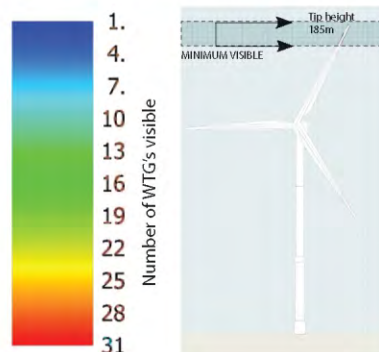
The predominant land use within the study area is agriculture with some areas of rural residential. Other elements within the viewshed include small rural townships, road infrastructure such as highways and local roads, and electrical infrastructure.

The majority of native vegetation within the viewshed has been cleared, comprising of both native and improved pastures for agricultural grazing. Taller vegetation is confined to roadsides, fence lines and boundaries, watercourses and windbreaks. Stands of remnant woodland occur within the wider context of a modified landscape, which continues to be managed through a variety of farming activities.



Legend

- Main Roads
- Minor Roads
- 2 and 5km WTG offset
- Project Area
- Dwelling
- WTG
- Substation



SOURCE: Clouston Associates, Landscape Character & Visual Impact Assessment (150703_BIALA LCVIA ISSUE E), 6 July 2015

Client: Newtricity
 Drawing No: 0178462b_BWF_EIS_C006_R1.cdr
 Date: 15/07/2015 Drawing size: A4
 Drawn by: JC / GR Reviewed by: TH

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 11-1 - Number of WTGs Visible at Blade Tip Height (185 m) and Below
 Biala Wind Farm
 Environmental Impact Assessment
 Environmental Resources Management ANZ
 Auckland, Brisbane, Canberra, Christchurch,
 Melbourne, Newcastle, Perth, Port Macquarie, Sydney



11.2.2

Landscape Character Zones within the Viewshed

Landscape character zones are defined as areas having a distinct, recognisable and consistent pattern of elements, be they natural (soil, vegetation, landform) and/or human built form, making one landscape different from another.

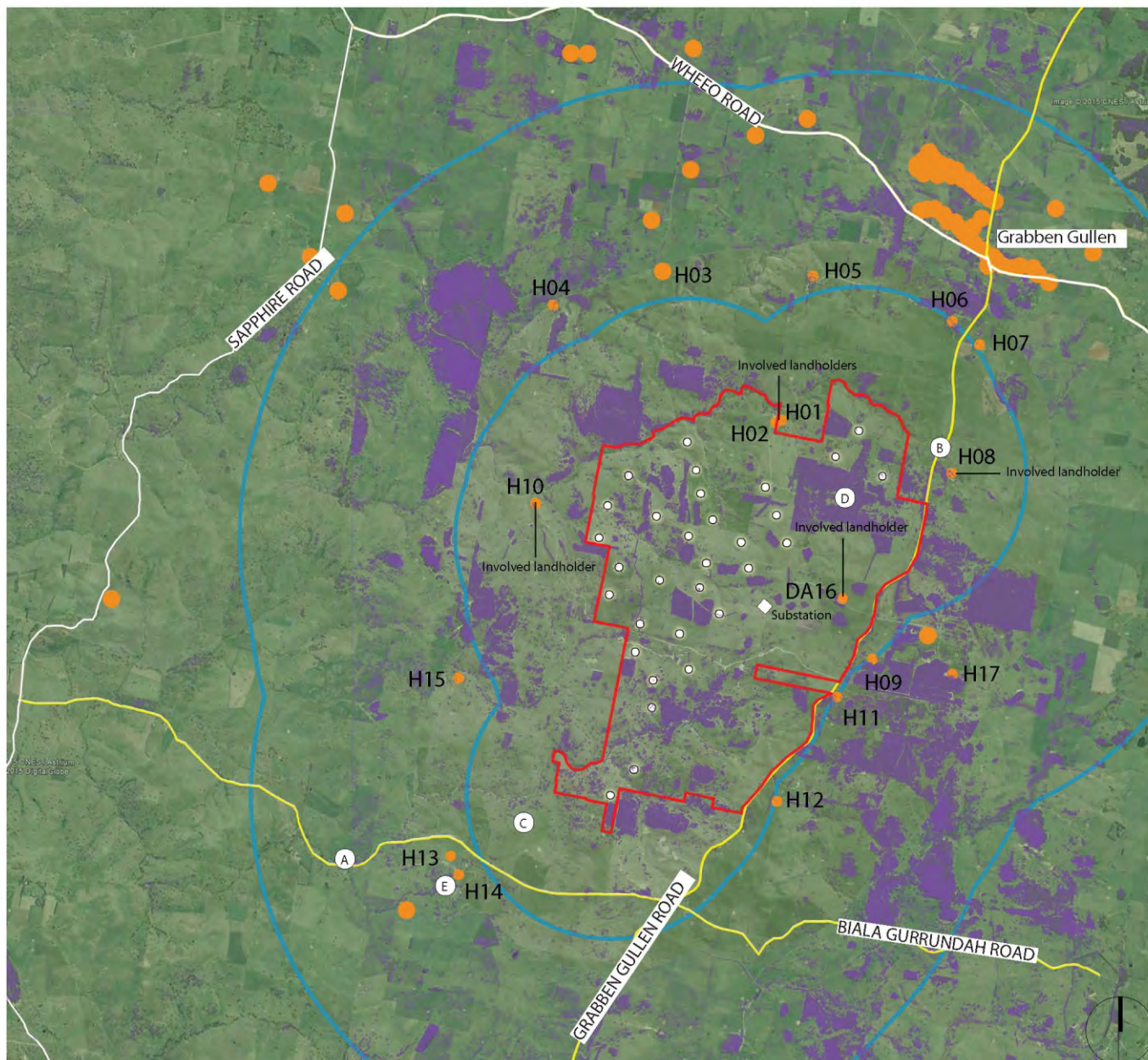
Five distinct landscape character zones were identified within the study area, which are described in *Table 11-1* and shown in *Figure 11-2*.

Table 11-1

Landscape Character Zones

Landscape Character Zone	Description
Zone 1 - Rural Roads	Several lightly trafficked rural roads cross the study area, linking rural properties to the wider sealed road network. The quality of the road surfacing varies but is mostly sealed and lined with banks or swales with no permanent kerb or gutter. The roads traverse areas of low lying grasses and areas enclosed by trees and shrubs. Where the roadside is clear of trees, far reaching views are available across the surrounding landscape.
Zone 2 - Main Roads	Two main roads cross the study area are Grabben Gullen Road and Biala-Gurrundah Road. The roads are sealed and mostly two lane with no median. The roads traverse areas of low lying grasses and areas where the road is enclosed by trees and shrubs. Where open, there are long distance views over the surrounding landscape.
Zone 3 - Undulating Grassland	This landscape character zone is of a large scale and is mostly open with gently rolling landform. The overall landscape pattern created by the grass pasture is smooth, regular and uniform. Trees are present in groups or as isolated individuals. Areas of tree planting also surround the majority of rural dwellings in the form of evergreen windbreaks.
Zone 4 - Wooded Areas	This landscape character zone occurs across a range of landform types from gentle slopes to steep gullies and ridgelines. Vegetation is predominantly native and occurs in dense stands with little understorey. This zone commonly lines road verges and blocks wider views. The darker coloured foliage of wooded areas contrast against the surrounding backdrop of lighter tones of pasture and cultivated areas.
Zone 5 - Rural Development	This landscape character zone is dispersed across the study area and consists of residential dwellings and farm buildings. Many properties are isolated and located within bushland, with others in elevated positions with far reaching views over the surrounding landscape. Vegetation planted as windbreaks often surrounds properties and where present, limits long distant views. Small towns within the study area such as Grabben Gullen have a higher density of dwellings.

The potential visual impact of the Project on each landscape character zone is assessed in *Section 11.3.1*, whilst the potential impact from public and private viewpoints is assessed in *Section 11.3.2*.



Legend

- | | |
|-------------------------------|----------------------|
| Zone 1 - Rural Roads | Main Roads |
| Zone 2 - Main Roads | Minor Roads |
| Zone 3 - Undulating Grassland | 2 and 5km WTG offset |
| Zone 4 - Wooded Areas | Project area |
| Zone 5 - Rural Development | WTG |
| Landscape Zone Photo | Substation |
| Access roads | |



SOURCE: Clouston Associates, Landscape Character & Visual Impact Assessment (150703_BIALA LCVIA ISSUE E), 6 July 2015

Client: Newtricity
 Drawing No: 0178462b_BWF_EIS_C007_R1.cdr
 Date: 15/07/2015 Drawing size: A4
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Figure 11-2 - Landscape Character Zones

Biala Wind Farm
 Environmental Impact Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch,
 Melbourne, Newcastle, Perth, Port Macquarie, Sydney



11.3 Assessment of Impacts

11.3.1 Landscape Character Zones

The landscape character of the study area is typical of the Southern Tablelands with undulating hillsides, large swathes of native vegetation, creek lines, ridges and a low density of rural residential development. The overall impact of the Project on each landscape character zone within the PA was assessed and the results are summarised in *Table 11-2*.

Table 11-2 *Summary of Landscape Character Impacts*

Landscape Character Zone	Assessed Level of Impact
Zone 1 - Rural Roads	Low The roads are lightly trafficked and mainly used by local residents to access remote properties. These roads are often highly scenic, with extensive views over the surrounding landscape although they only serve the local community and are not used as scenic drives. Receptors move through this landscape zone relatively quickly. The closest WTG is over 1.4 km from a rural road corridor. The WTG will be visible from sections of the road where views are not blocked by vegetation but will not be visually dominant.
Zone 2 - Main Roads	Moderate The main roads are moderately trafficked, being used to access properties and traverse through the study area. These roads are often highly scenic, with extensive views over the surrounding landscape and serve the local community and visitors to the area. The Project is located in close proximity to Grabben Gullen Road. The WTGs will be highly visible from sections of this road where views are not blocked by roadside vegetation.
Zone 3 - Undulating Grassland	Moderate There is a general absence of development throughout this landscape zone. Extensive views to ridgelines and distant hills are available from open areas. The structure of the landform is simple, containing few distinct features and therefore any new tall development will potentially stand out prominently within the landscape. The WTGs will be clearly visible within this landscape and will appear prominent when positioned on elevated topography. The open character of the landscape and lack of other features/built form will potentially make the WTGs more noticeable.
Zone 4 - Wooded Areas	Moderate This landscape zone is enclosed in nature with views generally blocked by the surrounding dense vegetation and there is limited development within the zone. Some vegetation removal will be required to accommodate the Project including the WTGs and access roads, although the extent of vegetation removal will be small.
Zone 5 - Rural Development	High Residential development is widely dispersed and mostly of a very low density. The isolation, large plot sizes and lack of surrounding development are important features of this character zone and therefore any new bulky development may alter the character of the area. The WTGs may be clearly visible from some parts of this zone. They are significantly taller than any other features within the landscape. Many dwellings however, have dense vegetation surrounding the property, which will filter and/or block views towards WTGs.

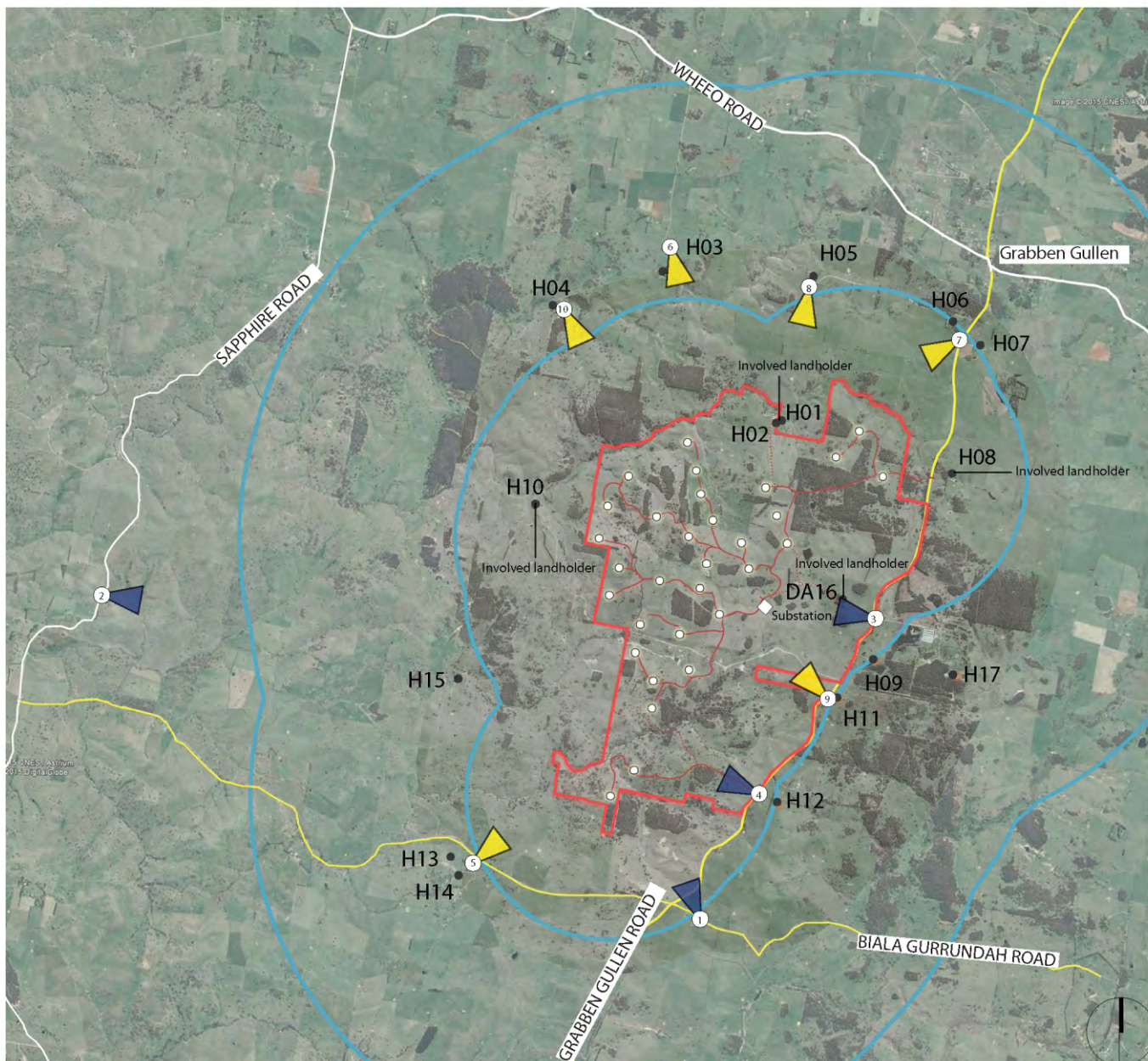
The Project may alter some of the distinguishable landscape characteristics of zones rated as moderate and moderate/high, although all zones have the capability to absorb change to some extent. The prominent height of the WTGs will be the most noticeable element of the Project, standing out in a landscape with very few tall structures.

Despite being naturalistic in appearance, large portions of the NSW Southern Tablelands region have been heavily modified by agricultural for pasture and crop production. Irrespective of the extent and nature of modifications to the landscape, it is not correct to assume that the landscape surrounding the Project 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.

11.3.2

Key Visual Receptors

During the detailed site visit undertaken by Clouston Associates, ten key receptor locations with the potential to be visually impacted by some element of the Project were selected as representative of receptors within the study area. The locations of the selected public and private viewpoints are shown in *Figure 11-3*.



Legend

- Main Roads
- Minor Roads
- 2 and 5km WTG offset
- Project area
- Dwelling
- WTG
- Access roads
- Substation
- Private viewpoint
- Public viewpoint

0 1000 2000 3000 4000 5000m

SOURCE: Clouston Associates, Landscape Character & Visual Impact Assessment (150703_BIALA LCVIA ISSUE E), 6 July 2015

Client:	Newtricity	Figure 11-3 - Location of Public and Private Viewpoints in Proximity to the Project Area Biala Wind Farm Environmental Impact Assessment Environmental Resources Management ANZ Auckland, Brisbane, Canberra, Christchurch, Melbourne, Newcastle, Perth, Port Macquarie, Sydney	
Drawing No:	0178462b_BWF_EIS_C008_R1.cdr		
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Public Receptors

The public domain within the study area with visibility of the Project is mostly limited to minor and major roads. No parks, reserves or major walking trails were identified within the study area.

Table 11-3 provides a summary of the potential visual impact of the Project on the selected public viewpoints. The detailed visual impact assessment for each selected public viewpoint is provided in Section 4 of the LCVIA and photomontages for each viewpoint is provided at Section 8 of the LCVIA, refer *Annex I*.

Table 11-3 *Summary of Impacts from Public Receptors*

Viewpoint No. and Description	Assessed Level of Impact
Viewpoint 1 <i>Biala Gurrundah Road (looking north-west) – Major Road</i>	Moderate A cluster of WTGs will be visible in the middle of the viewframe from this location at a distance of 2.1 km. The WTGs will be noticeable to westbound travellers on the road and will be visually prominent within a wide panoramic view. Whilst receptors will move along the road quickly, the Project is likely to have a moderately negatively impact on visual amenity from this section of the road.
Viewpoint 2 <i>Sapphire Road (looking east) – Minor Road</i>	Low WTGs will be visible stretching across a low ridgeline in the middle distance range from this location. In clear conditions, the WTGs will be apparent against the skyline, although are unlikely to dominate the view. Blade movement will be discernible.
Viewpoint 3 <i>Grabben Gullen Road (looking west) – Major Road</i>	Moderate A cluster of WTGs will be visible in close proximity to Grabben Gullen Road, however this will be partially obscured by topography and vegetation. The WTGs will be visually prominent to road users travelling in both directions. Whilst the receptors will move past the Project quickly, the WTGs are likely to have a moderate impact on visual amenity from this section of the road. Views towards the substation will be blocked by the local topography.
Viewpoint 4 <i>Grabben Gullen Road (looking west) – Major Road</i>	Moderate A long line of WTGs will be visible in the middle of the viewframe from this location at a distance of 1.7 km. The WTGs will be noticeable to west and eastbound travellers on the road and will be visually prominent within a wide panoramic view. Whilst receptors will move along the road quickly, due to the large area covered by the WTGs, they will be visible for a reasonable length of time. The Project is likely to have a moderately negative impact on visual amenity from this section of the road.

The low visual sensitivity of many of the public receptors has reduced the level of visual impact experienced. The minor roads that traverse the study area, such as Sapphire Road and Wheeo Road, are lightly trafficked and mostly used for accessing remote properties. Despite some of the WTGs being in relatively close proximity to these roads, their low sensitivity to change and the short duration of views experienced ensures a low impact on visual amenity.

The highest visual impact on public receptors was assessed as moderate and was recorded at viewpoints along Grabben Gullen Road (to the east of the PA) and Biala Gurrundah Road (to the south of the PA). Grabben Gullen Road passes in close proximity to a cluster of WTGs and has a higher sensitivity due to its increased traffic and importance as a major and scenic thoroughfare. Grabben Gullen Road sits on an elevated ridge line with occasional panoramic views across the surrounding landscape. The visual amenity of the driving experience may be moderately negatively impacted by the scale and proximity of the WTGs along the road corridor.

Settlements within the study area are limited to the township of Grabben Gullen. The town is over 3.5 km from the nearest WTG and views towards the Project are blocked by a combination of vegetation and topography.

It is acknowledged that the Project may have the potential to impact people engaged in farming or recreational activities, where views toward WTGs occur from surrounding agricultural areas. Ultimately the level of visual impact would depend on the degree to which scenic quality was central to that activity, level of screening provided by local landform or vegetation and the perception of the viewer.

Private Receptors

There is a low density of residential receptors dispersed throughout the study area. There are four involved landholders who have agreed to host WTGs and associated infrastructure on their properties. Given these involved landholders do not have concerns regarding impacts to visual amenity, they have not been assessed further as part of the LCVIA.

There are no dwellings associated with non-involved landholders within 2 km of a proposed WTG. A total of 12 dwellings have been identified within 2-3 km of the WTGs proposed as part of the Project. Where access was agreed with the non-involved landholder, spatially accurate photomontages were prepared with photos taken from the property itself, providing a more accurate representation of potential visual impact.

Table 11-4 provides a summary of the potential visual impact of the Project on the selected private viewpoints. The detailed visual impact assessment for each selected private viewpoint is provided in Section 4 of the LCVIA and photomontages for each viewpoint is provided at Section 8 of the LCVIA, refer *Annex I*.

Table 11-4 *Summary of Impacts from Private Receptors*

Viewpoint No. and Description	Assessed Level of Impact
Viewpoint 5 <i>Residential Properties – H13, H14 and H15</i>	Moderate/High A review of the topography and vegetation in this area indicates Dwellings H13, H14 and H15 will have filtered views of the WTGs, depending on the topography and the level of screening vegetation present. The southernmost property (H14) is likely to have the most unobstructed view of the WTGs, which may be clearly visible along a ridge in the middle distance from this location. All properties will have only partial views of the WTGs, with the undulating topography blocking views towards the base of the WTGs.
Viewpoint 6 <i>Residential Property – H03</i>	Moderate/High A large cluster of WTGs will be visible stretching across the ridgeline in the near to middle distance from this location. The WTGs will appear prominent against the skyline and will be an obvious element within the landscape. Blade movement will be clearly visible. The level of visual impact on Dwelling H03 will depend on the orientation and level of screening vegetation present - potentially reducing the level of visual impact experienced. H03 is surrounded by tree planting, which may filter views of the Project from the main dwelling area of this property. The most extensive views of the Project are likely to be from Church Lane and the associated driveway.

Viewpoint No. and Description	Assessed Level of Impact
Viewpoint 7 <i>Residential Properties – H06 and H07</i>	Moderate The level of visual impact on Dwellings H06 and H07 will depend on their orientation and level of screening vegetation present - potentially reducing the level of visual impact experienced. The two properties are surrounded by tree planting and the most extensive views of the Project are likely to be from associated driveways. Where visible, a cluster of WTGs will be apparent to the west, partially obscured by the low ridgeline in the middle distance. The WTGs will appear prominent against the skyline and blade movement will be clearly visible on the closer WTGs. The WTGs will occupy a relatively small portion of the viewframe.
Viewpoint 8 <i>Residential Property – H05</i>	Moderate/Low Screening vegetation planted as garden plantings and long windbreaks surrounding Dwelling H05 are expected to screen or block the majority of views towards the WTGs from the main dwelling area. Views of multiple WTGs are likely to be available from the driveway of the property and these will appear as dominant features within the viewframe.
Viewpoint 9 <i>Residential Properties – H09, H11, H12 and H17</i>	Moderate The level of visual impact on individual properties in these locations will depend on their orientation, local topography and level of screening vegetation present - potentially reducing the level of visual impact experienced. Dwellings H09, H11, H12 and H17 are surrounded by tree planting and the most extensive views of the Project are likely to be from the driveways.
Viewpoint 10 <i>Residential Property – H04</i>	Moderate/Low The review of topography and vegetation indicates that Dwelling H04 is highly unlikely to have visual accessibility to any full WTGs. The tops (hub height or above) of six WTGs may be visible, although these will be heavily filtered or blocked by vegetation. Views of additional WTGs may be visible from some parts of the extensive driveway, although topography and vegetation will again block many views.

Generally, the closer the proximity of the dwelling to the WTGs, the higher the visual impact, with the WTGs becoming increasingly distinct and dominating the viewframe as the viewing distance decreases. The remoteness of the WTGs has assisted in reducing the level of visual impact on residential dwellings in proximity to the PA. Of the two viewpoints that recorded a visual impact rating of moderate/high, one is an elevated location with minimal screening (H03). At 2.4 km from the nearest WTG, blade movement will be clearer and the WTGs visually prominent within the landscape. The other viewpoint (associated with H13, H14 and H15) is at a lower elevation but will have clear partial views of numerous WTGs.

Local vegetation and topography can significantly alter the visual impact experienced by individual properties. Many of the dwellings are surrounded by vegetation in the form of garden planting, nearby woodland or tall shelter belts, which may filter or block views of WTGs from the main dwelling areas. The WTGs however, will often still be visible from other parts of the property (such as the driveway) and therefore a visual impact is still recorded.

Construction Works

Potential visual impacts may occur during the construction phase of the Project. The construction activities are generally temporary in nature and restricted to various discrete areas within the PA. Whilst the cranes and concrete batching plant are likely to be the most visible construction elements, the majority of activities would be unlikely to result in an unacceptable level of visual impact given the relatively short duration of construction.

Obstacle Lighting

The Project may require obstacle lighting at night time or during periods of reduced visibility. Whilst the Aeronautical Impact Assessment (Aviation Projects 2015) provided at *Annex M* concluded that the Project will not require obstacle lighting to maintain an acceptable level of aviation safety, CASA issued correspondence in May 2015 stating “CASA recommends that the wind farm is lit with steady red low intensity lighting at night as per Section 9.4 of the MOS Part 139.” On this basis, night montages have been prepared by Clouston Associates for the selected viewpoints where WTGs will be visible, refer Section 8 of the LCVIA at *Annex I*.

Potential visual impacts associated with obstacle marking and lighting at night time have not been extensively researched or tested in NSW, 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 WTGs may be visible for a number of kilometres from the wind farm site, the actual intensity of the lighting appears no greater than other sources of night time lighting, including vehicle head lights and tail lights.

The potential receptors that could be impacted by night time lighting include residents and motorists using surrounding roads. Night time lighting associated with the Project is unlikely to have a significant visual impact on the majority of public viewpoints. Whilst obstacle lighting would be visible to motorists travelling along the local roads, the duration of visibility would tend to be very short and partially screened by undulating landform.

Night time obstacle lighting associated with the Project would be visible from a number of the private viewpoints within the study area, although topography and screening vegetation would block or partially obscure many of the views. On this basis, night lighting (if installed) is expected to have a moderate/low impact on the selected private viewpoints.

11.3.3

Community Perception towards Wind Farm Developments

Viewer perception is an important factor to consider for wind farm developments, especially when considering community values towards local and regional visual amenity. People perceive size, shape, depth and distance using many cues, so that context is critically important. The magnitude or size of wind farm elements, and the distance between them and the viewer, are basic physical measures that affect visibility, but the real issue is human perception of visual effects and that is not simply a function of size or distance. Given this, the attitude or the opinion of individuals or the community towards wind farms can contribute significantly to their perceived impact on visual amenity that a development may impose.

Whilst published Australian research into the potential landscape and visual impacts of wind farms is limited, community perception studies undertaken in Australia and internationally have continually shown that wind farms are an acceptable element in any but the most sensitive landscapes.

Research undertaken by the CSIRO was documented in the report *Exploring community acceptance of rural wind farms in Australia: a snapshot* (Hall, N. et al 2012 p67) and concluded:

“There is strong community support for the development of wind farms, including support from rural residents who do not seek media attention or political engagement to express their views. This finding contrasts with the level of opposition that may be assumed from the typically ‘conflict-orientated’ portrayal of wind farm proposals in the popular media. This media coverage frequently gives significant attention to legal challenges, political protests and vocal opponents including ‘Landscape Guardian’ and high profile individuals, but fails to balance this with coverage of middle ground views, or with equivalent attention to the potential benefits of wind farms.”

The NSW Department of Environment, Climate Change and Water (DECCW) also commissioned a study by AMR Interactive (September 2010) to consider community attitudes towards wind farms in NSW. The study considered the six Renewable Energy Precincts within NSW, including the ACT/NSW Border Region. The key findings of the study indicated (p83-85):

- 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 in the media). Awareness in the NSW/ACT Border Precinct was much higher, with 95% of those surveyed familiar with wind farms;
- the large majority of residents across the Precincts supported the construction of wind farms in NSW (85%) as well as in their local region (80%); and
- 79% supported wind farms being built within 10 km of their residences and 60% of people surveyed supported the construction of wind turbines within 1 to 2 km from their residences. The survey recorded an above average level of support for the construction of wind farms within the NSW/ACT Border Precinct.

These results are reflected in other studies including the community perception survey commissioned by Epuron Pty Ltd for the proposed Gullen Range Wind Farm (ERM & Reark 2007a). The study targeted people living in a number of small urban and rural communities located in the area immediately surrounding the proposed Gullen Range wind farm as well as other communities surrounding potential future wind farm development sites. The results of this study, suggested that 89% of respondents were in favour of wind farms being developed in the Southern Tablelands, with 71% of respondents in favour of a wind farm within 1 km from their residence. These acceptance levels are confirmed by similar studies for wind farms in Victoria, including the Ararat Wind Farm (ERM & Reark 2008) and Lal Lal Wind Farm (ERM & Reark 2007b).

These studies indicate that acceptability of wind farms increases when the residence is further away. Acceptance levels of between 77-79% were recorded for WTGs at distances greater than 3 km from a dwelling. It is acknowledged that these studies are based on WTG heights of between 110-135 m, approximately 50 m lower than the Project, however in reality this height difference would be barely discernible at these distances.

Whilst these studies have not been relied upon as a basis for the LCVIA undertaken by Clouston Associates (2015) for the Project, the findings of the community perception studies mentioned above provide an independent “reality check” that confirms the findings presented within the LCVIA.

11.4 Mitigation Measures

The following measures will be implemented to manage potential cultural heritage related impacts during construction:

- The potential visual impact of the Project from the selected private viewpoints could be mitigated by planting vegetation close to the view locations. For instance, tree or large shrub planting close to a dwelling can screen potential views to individual or groups of WTGs. The location and design of screen planting used as a mitigation measure is site specific and requires detailed analysis of potential views and consultation with surrounding landowners during the detailed design phase.
- Colour choice can provide an opportunity to reduce visual contrast between the WTG structures and the background against which they are viewed. The use of an appropriate off-white or grey colour for the WTGs where the visual contrast would be reduced when viewed against a background of landscape may be possible. The final colour selection would however, be subject to the availability of WTG models on the market at the time.

- In terms of the proposed access roads, the following measures are recommended:
 - minimise the extent of cut and fill in the construction of the roads, following contours where possible,
 - re-vegetating disturbed soil areas immediately after completion of construction works with local native vegetation or pasture grasses depending on location and agreement with land owners; and
 - use local materials as much as possible in road construction to minimise colour contrast.
- With regards to the substation, the following measures are recommended:
 - locating the substation to take advantage of natural topographical and vegetation screening;
 - ensuring materials are non-reflective and colours assist with blending facility with local context; and
 - planting additional screening vegetation.

Residual Impacts

WTGs are by their nature tall and visually intrusive structures and their design and location is limited by functional requirements and minor changes, such as colour choice and reflectivity are unlikely to alter any of the impact ratings identified in the LCVIA.

Whilst screen planting can be highly effective in blocking or filtering views of the WTGs, the impact is often of a highly local nature and can remove parts of the view that may still be considered desirable. New screen planting around affected dwellings would likely reduce some of the visual impact ratings recorded within the assessment however, may not be acceptable to the landholders.

11.5

Conclusion

A Landscape Character and Visual Impact Assessment was undertaken for the Project and concluded as follows:

- The Project has a relatively limited visual catchment and overall moderate to moderate/low visual impact as a result of:
 - the limited number of sensitive residential dwellings in proximity to the PA;
 - the limited number of public viewers on roads and limited quantity of public open space;
 - topography that limits views of the PA, blocking many views of the WTGs from distances of over 3 km; and
 - dense stands of tree planting, windbreaks and garden plantings (associated with individual properties) that block or filter views towards the Project.
- The low density of residential receptors within the 12 km viewshed for the Project ensures that moderate/high visual impacts are limited to dwellings within 2-3 km of the WTGs. The private viewpoints assessed as having the highest potential visual impact are either located on elevated ground with panoramic views over the surrounding rural landscape or in a position when many WTGs are visually accessible.
- Public viewpoints are mostly limited to the minor local road network and two main thoroughfares that traverse the study area. These view locations are dynamic with motorists travelling along the roads relatively quickly, reducing the duration of the view and hence the severity of the visual impact.
- If required, night time obstacle lighting would have the potential to be visible from the surrounding area however; the visual impact would be low and diminish when viewed from more distant locations.
- Landscape mitigation measures have been identified, and if necessary will be offered to reduce visual impact to residential dwellings surrounding the Project.

12 CULTURAL HERITAGE

This chapter discusses the potential impacts to Aboriginal and historic cultural heritage associated with the Project and outlines the proposed mitigation measures to manage any adverse impacts on cultural heritage.

12.1 Introduction

An Aboriginal and Historic Cultural Heritage Assessment (CHA) was undertaken by ERM (2015d) to assess the potential for the construction and operation of Project to impact on known and unknown Aboriginal and historic heritage values. A copy of the CHA is provided at Annex J. The assessment has been prepared to address the requirements specified in the SEARs pertaining to heritage, outlined in Chapter 1, and having regard to the following relevant legislation and government policies:

- NSW National Parks and Wildlife Act 1974;
- Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW (OEH 2011);
- Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (DECCW 2010);
- Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW 2010);
- Heritage Act 1977; and
- NSW Heritage Manual (DUAP 1996).

12.1.1 Methodology

The CHA incorporated the following scope of works:

- consultation with Aboriginal communities in relation to the Project;
- a description of the Project and whether or not it has the potential to result in impacts to Aboriginal or historic cultural heritage;
- a description of historical impacts to the PA;
- the development of an archaeological methodology for the assessment;
- a review of the landscape and natural resources of the PA in order to establish background parameters;
- a review of archaeological and relevant literature and heritage listings on the NSW Aboriginal Heritage Information Management System (AHIMS) database;
- a synthesis of local and regional archaeology;
- a review of the PA's non-Aboriginal history and the results of relevant heritage database searches;
- the development of a predictive model for Aboriginal site types and location relevant to the PA;
- a field survey with Registered Aboriginal Parties (RAPs) documenting historic and Aboriginal archaeological sites, and cultural and archaeological sensitive landforms;
- an outline of the cultural and archaeological sensitive landforms that may be subjected to impacts;
- results of the field survey;
- the significance of any located historic and Aboriginal objects and places;

- an assessment of the potential direct and indirect impacts of the Project on historic and Aboriginal objects and places;
- a description of the outcomes and justification of the proposed alternatives; and
- the development of a series of recommendations based on the results of the investigation.

12.1.2

Study Area

Background research and consultation with Aboriginal communities was undertaken for the entire PA. Based on the background research and consultation, a predictive model for Aboriginal and historic heritage sites was also developed for this area. The field survey focused on the proposed locations of the WTGs and access roads within the PA that were available at the time. The areas surveyed are defined as 'Survey Units' and shown in *Figures 7.1 and 7.2* of the CHA provided in *Annex J*.

12.2

Existing Environment

12.2.1

Aboriginal Heritage

A search of the AHIMS database for an area of approximately 20 km by 20 km around the PA was undertaken on 25 November 2014. The database search identified that 46 previously recorded Aboriginal heritage sites are known to occur within this search area, however none of these sites occur within the PA (refer to *Figure 12-1*). All previously recorded sites are stone artefact sites with the exception of one culturally modified tree. Of the stone artefact sites, the majority (53%) are open camp sites, with the remaining being isolated finds (47%).

A review of previous archaeological studies indicated that there has been limited previous archaeological research within the PA, however several projects have been undertaken in its proximity and in the wider region. The most relevant studies to the Project are those undertaken for Gunning Wind Farm (JMCHM 2003; Austral Archaeology 2009), Gullen Range Wind Farm (Dibden 2007), Cullerin Range Wind Farm (Dibden 2006) and Collector Wind Farm (Dibden 2012).

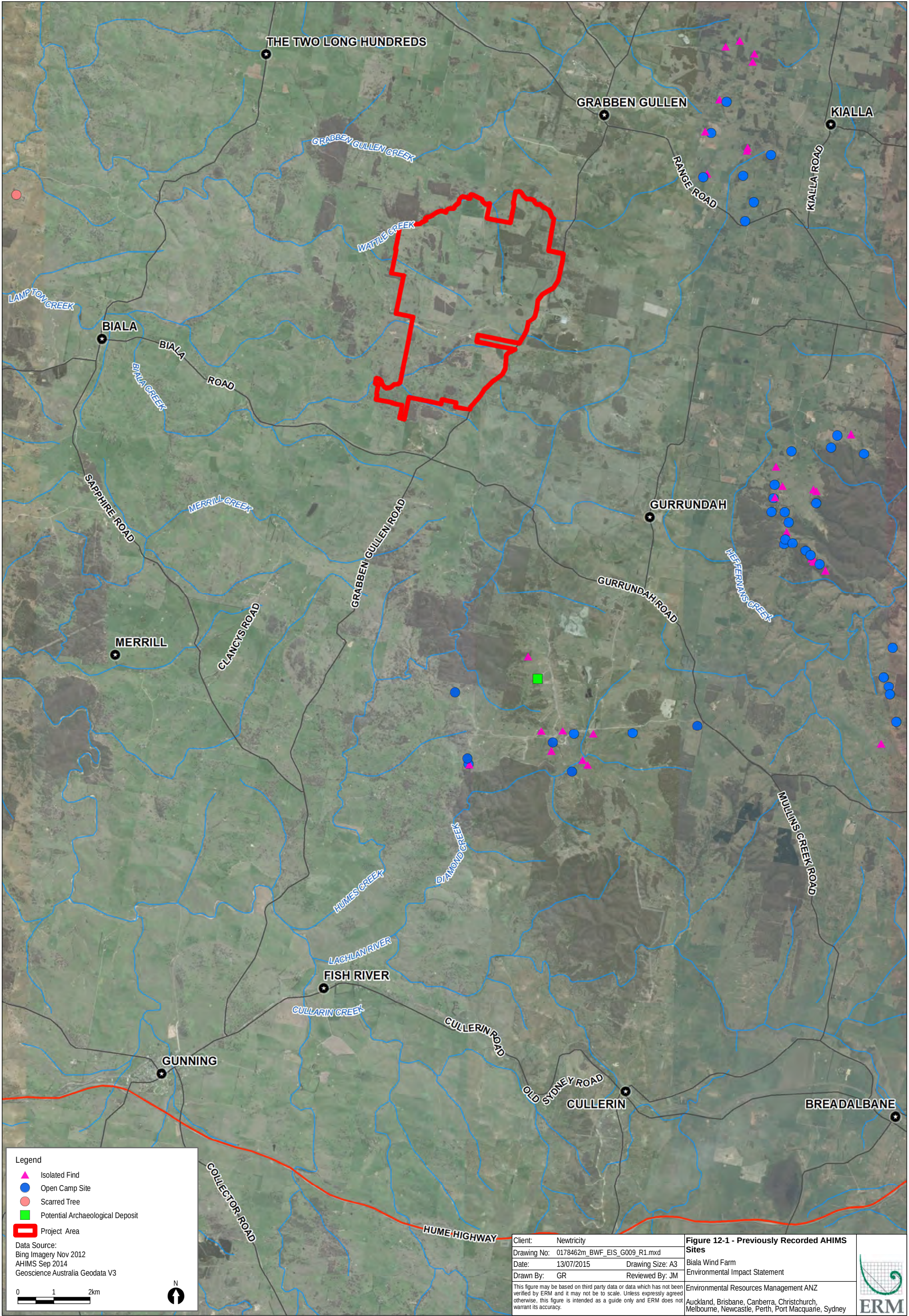
Based on the AHIMS database search results, previous archaeological studies and the existing landscape, a predictive model for unknown Aboriginal heritage sites to occur within the PA was developed. This model identified that the most archaeologically sensitive landforms within the PA are flat and gently sloping terrain, ridge crests and spur line crests within 400 m of a permanent water course. Other landforms would likely contain lower density stone artefact sites, or isolated finds representative of transient movement through the area. It was also determined that Aboriginal heritage sites would likely occur in the form of stone artefact sites (artefact scatters or isolated finds) containing silcrete, chert or quartz artefacts (and to a lesser extent quartzite and volcanic).

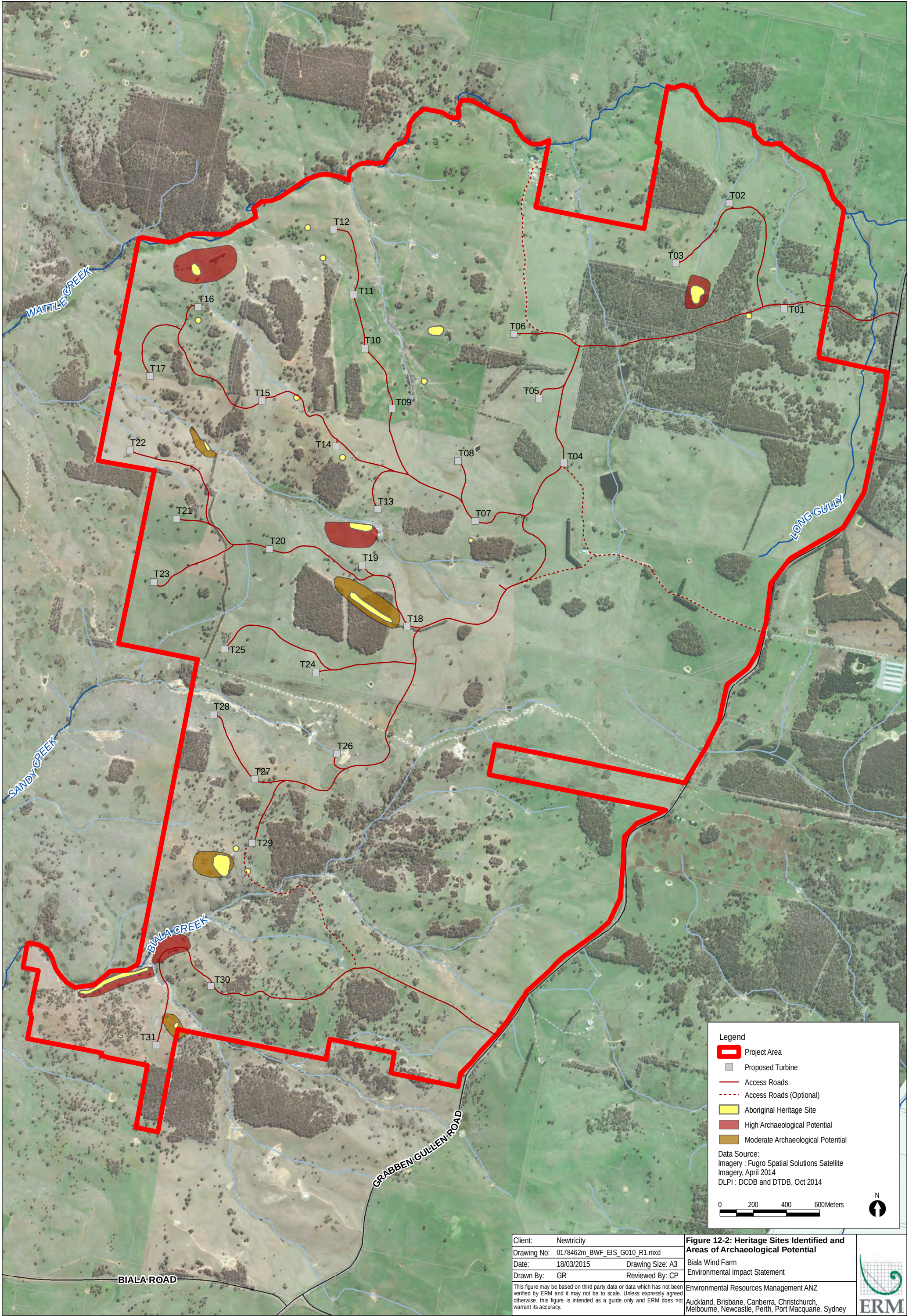
The field survey identified 21 previously unrecorded Aboriginal heritage sites (BWF1-21) (refer *Figure 12-2* to *Figure 12-4*). Some of these sites were found to be associated with a Potential Archaeological Deposit (PAD) (BWF2, BWF3, BWF10, BWF12, BWF13, BWF14, BWF16, BWF19 and BWF21). One area of PAD was also identified without an associated surface expression of artefacts (BWF PAD1). These sites were mostly found within flat to gently sloping terrain within proximity to watercourses and/or with views of the surrounding landscape.

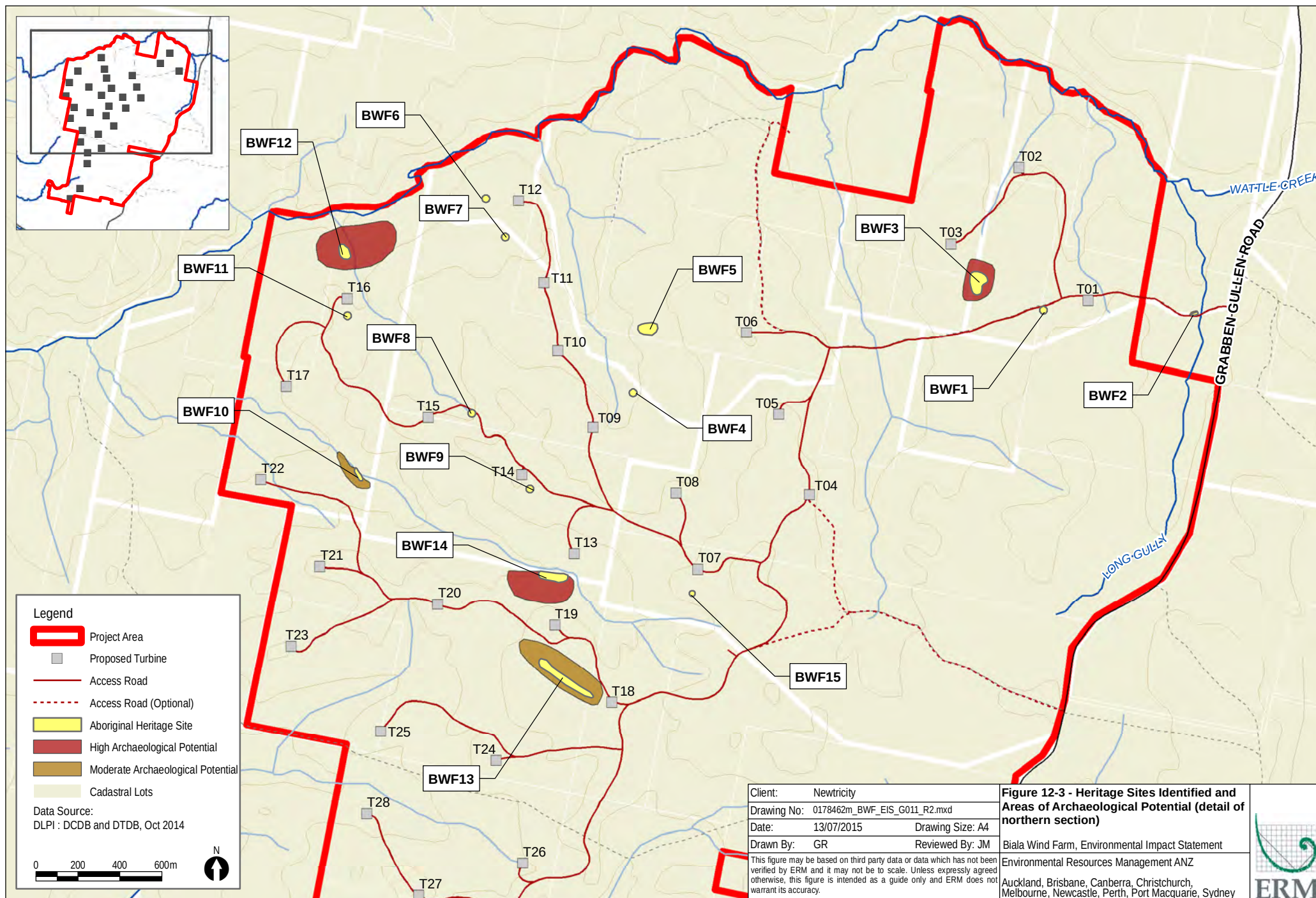
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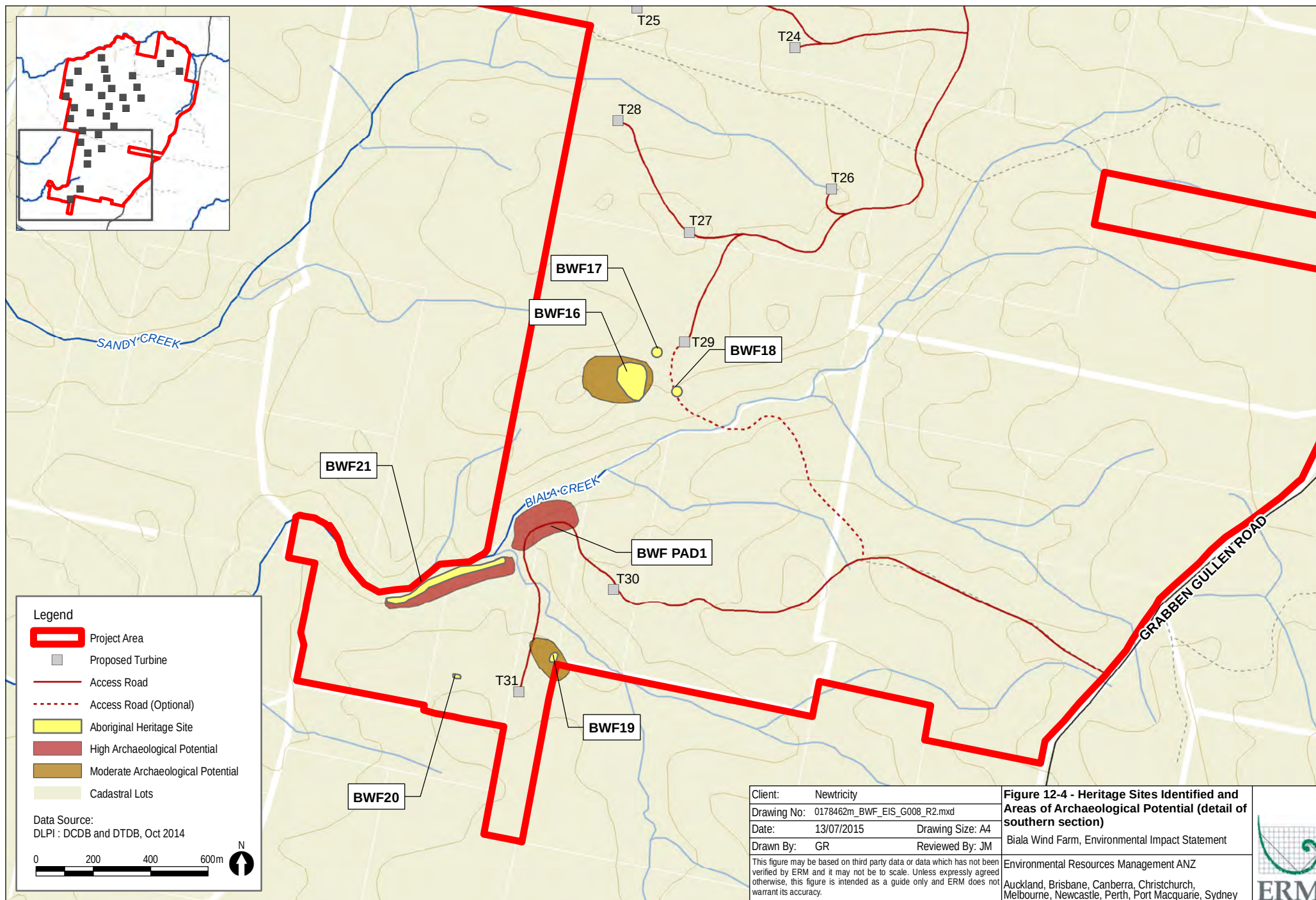
Historic Heritage

Searches of the Commonwealth Heritage List, the NSW State Heritage Register and Inventory, the LEP 2010, the archive of the Register of the National Estate and the National Trust of Australia database was undertaken to identify known historic heritage items. No items of historic heritage were identified within or in near proximity to the PA during the desktop assessment and field survey. The PA was assessed as having a low potential for unidentified items to occur.









12.3 Assessment of Impacts

12.3.1 Potential Construction Impacts

Twenty-one Aboriginal heritage sites and one area of PAD were identified within the PA. No historic heritage sites were identified within the PA. One Aboriginal heritage site (BWF18) and two areas of PAD (BWF19 and BWF PAD1) occur within the currently proposed footprint of the Project (refer *Photograph 12-1* and *Photograph 12-2*). No historic heritage sites occur within the proposed footprint of the Project. The potential impacts arising from the construction of the Project include:

- construction encounters previously identified Aboriginal heritage sites (BWF1-21);
- construction encounters previously identified PAD (BWF PAD1);
- alteration to Project design may impact on ground disturbance of areas likely to contain Aboriginal cultural heritage;
- construction works encounter a previously unregistered Aboriginal heritage site; and
- construction works encounter a previously unidentified historic heritage site.



Photograph 12.1 BWF19 PAD Looking South (ERM 2014)



Photograph 12.2 BWF PAD1 Looking North-East (ERM 2014)

12.3.2

Potential Operational Impacts

The potential impacts arising from the operation of the Project include:

- increased vehicle movement due to ongoing maintenance activities; and
- increased human visitation to the PA due to ongoing maintenance activities or public visitation (such as where there is a viewing station).

These activities may increase the risk of vandalism or unknowing disturbance to heritage sites.

12.4

Mitigation Measures

The following measures will be implemented to manage potential cultural heritage related impacts during construction:

- personnel involved with ground disturbance activities in the PA should undertake an Aboriginal and historic heritage awareness training/induction programme in line with *Section 10.1.2* of the CHA (refer *Annex J*);
- during works, the location of all previously recorded Aboriginal and historic heritage sites and those sites recorded as part of this assessment should be clearly marked on all construction plans for the PA and site foreman informed of their presence and the need to avoid disturbance;
- if suspected Aboriginal heritage objects are found during works the Chance Find Procedures outlined in the CHA should be followed (refer *Annex J*; *Section 10.1.3* for Aboriginal heritage and *Section 10.2.1* for historic heritage);
- the PAD areas within the PA that have been identified as having moderate or high potential to reveal Aboriginal cultural heritage (refer to *Figure 12-3* and *Figure 12-4* - BWF2, BWF3, BWF10, BWF12, BWF13, BWF16, BWF19, BWF21 and BWF PAD1), should undergo a sub-surface testing programme in accordance with the CHA where disturbance to these areas cannot be avoided (refer *Annex J*). This should occur prior to ground disturbance activities commencing;
- an Aboriginal Cultural Heritage Management Plan should be prepared and implemented to manage sub-surface testing activities and the Aboriginal heritage values within the PA;
- where the stone artefact scatter (BWF18) cannot be avoided, an Aboriginal Heritage Impact Permit (AHIP) should be sought from OEHL to salvage this site prior to commencement of works;
- where disturbance of Aboriginal heritage sites cannot be avoided, an AHIP should be applied for with OEHL;
- no archaeological constraints exist for areas that have been surveyed and identified as having no heritage sites or PADs (refer to *Figures 12-3* and *12-4* together with *Figures 7.1* and *7.2* of the CHA provided in *Annex J*);
- no ground disturbing components in the location of Aboriginal heritage sites or areas of PAD should take place until the sub-surface archaeological investigations outlined in this report have been undertaken and reported on;
- where possible, and in consultation with Aboriginal stakeholders, conservation areas should be established for relocation of disturbed artefacts. An interpretive strategy should also be established that describes what the area is and the past use of the landscape by Aboriginal people; and

- where possible, the Proponent should provide an opportunity for registered Aboriginal stakeholders to monitor ground disturbance activities and works undertaken as part of the construction of the Project. This includes work within close proximity to recorded Aboriginal sites and areas of sensitivity and within areas known to be sensitive in the region (i.e. adjacent to Biala Creek, within flat raised landforms etc - refer to *Section 5.6 of Annex J*) (payment for these monitoring works may be made at the discretion of the Proponent).

12.5

Conclusion

An Aboriginal and Historic Cultural Heritage Assessment was undertaken for the Project and concluded as follows:

- At the commencement of this assessment, there were no previously recorded Aboriginal heritage sites within the PA. Twenty-one Aboriginal cultural heritage objects and areas of sensitivity were identified within the PA as part of this assessment.
- At the commencement of this assessment, there were no statutory registered historic heritage places inside or within 10 km of the centre of the PA. No historic heritage places were identified during the course of this assessment.
- The development footprint largely avoids recorded Aboriginal heritage objects and areas of sensitivity; however some recorded sites will need to be salvaged or re-located in line with the recommendations outlined in the *Aboriginal and Historic Cultural Heritage Assessment*. In addition, subsurface testing prior to ground disturbing works will be undertaken at specific locations.
- Impacts to Aboriginal heritage objects outside the development footprint will be avoided through clearly marking their locations on all relevant construction maps, and providing a heritage induction to site personnel.
- Contingency measures have been outlined in the CHA and are recommended for inclusion in the environmental management plan for the Project to manage the unexpected discovery of previously unidentified heritage sites.

13 TRAFFIC AND TRANSPORT

This chapter discusses the potential traffic and transport related impacts associated with the Project and provides the mitigation measures to manage any adverse impacts on traffic and transport. Emphasis is driven towards potential construction related traffic and transport impacts given the low number of vehicles expected to utilise the internal and surrounding road network during operation of the wind farm.

13.1 Introduction

A Transport Impact Assessment was undertaken by GTA Consultants (2015) to assess the potential impacts from the construction and operation of the Project on the surrounding road network. A copy of the assessment is provided in *Annex K*. It has been prepared to address the requirements specified in the SEARs pertaining to traffic and transport, as outlined in *Chapter 1*, and having regard to the following relevant legislation and government policies:

- *Roads Act 1993*;
- *Guide to Traffic Generating Developments* (RTA 2002);
- *Highway Capacity Manual* (TRB 2010);
- *Upper Lachlan Council Development Control Plan 2010*; and
- *Goulburn Mulwaree Council Development Control Plan 2009*.

13.1.1 Methodology

The assessment incorporated the following scope of works:

- a review of the existing surrounding road network conditions including traffic volumes, public transport and potential road hazards;
- a review of the proposed access to and within the PA;
- desktop review of transport impact assessments prepared for other wind farm developments within the locality for approved and considered haulage routes for Restricted Access Vehicles (RAV) from Port Kembla to the Southern Tablelands region;
- estimation of traffic volumes generated during the construction and operation of the Project based on the proposed design and a review of other transport impact assessments within the locality;
- site inspection of the PA and surrounding road network;
- consultation with the Upper Lachlan Shire Council, Goulburn Mulwaree Council and RMS; and
- review of relevant traffic policies including the Upper Lachlan Shire Council and Goulburn Mulwaree Council Development Control Plans.

13.1.2 Study Area

The study area for the purposes of the Transport Impact Assessment includes the internal road network to be constructed within the PA, and the existing road network that connects the PA to Port Kembla, which is anticipated as the location from where the WTG components will be delivered during construction.

13.2 Existing Environment

13.2.1 Existing Road Network

The key roads and potential transport routes within the wider study area are discussed below and illustrated in *Figure 13-1* and *Figure 13-2*.

Hume Highway

The Hume Highway is the major arterial road linking Sydney to Melbourne and has sufficient capacity to accommodate the delivery of WTG components. The route from Port Kembla via Wollongong and Picton Road to the Hume Highway has been adopted for many over dimensioned vehicle routes utilised for other wind farm development in the vicinity, including the nearby Gullen Range Wind Farm.

Crookwell-Goulburn Road

Crookwell-Goulburn Road extends between Crookwell and Goulburn in an east-west direction. It is classified as a state road (No. 54) and traverses 45 km along rolling terrain. It is a two-way road with one lane in each direction with marked centrelines and edge lines. Crookwell-Goulburn Road is part of the RMS RAV route network and is approved for 25/26 m B-Double vehicles. The road currently carries approximately 2,000 vehicles per day (vpd).

Kialla Road

Kialla Road is a local road controlled by Upper Lachlan Shire Council and is configured with a two-way sealed carriageway. It is noted that Kialla Road was previously used to transport WTG components to the nearby Gullen Range Wind Farm (refer *Figure 17-1*), and has therefore been upgraded to cater for the RAVs accessing the Gullen Range Wind Farm site. Kialla Road carries low traffic volumes (less than 500 vpd).

Range Road

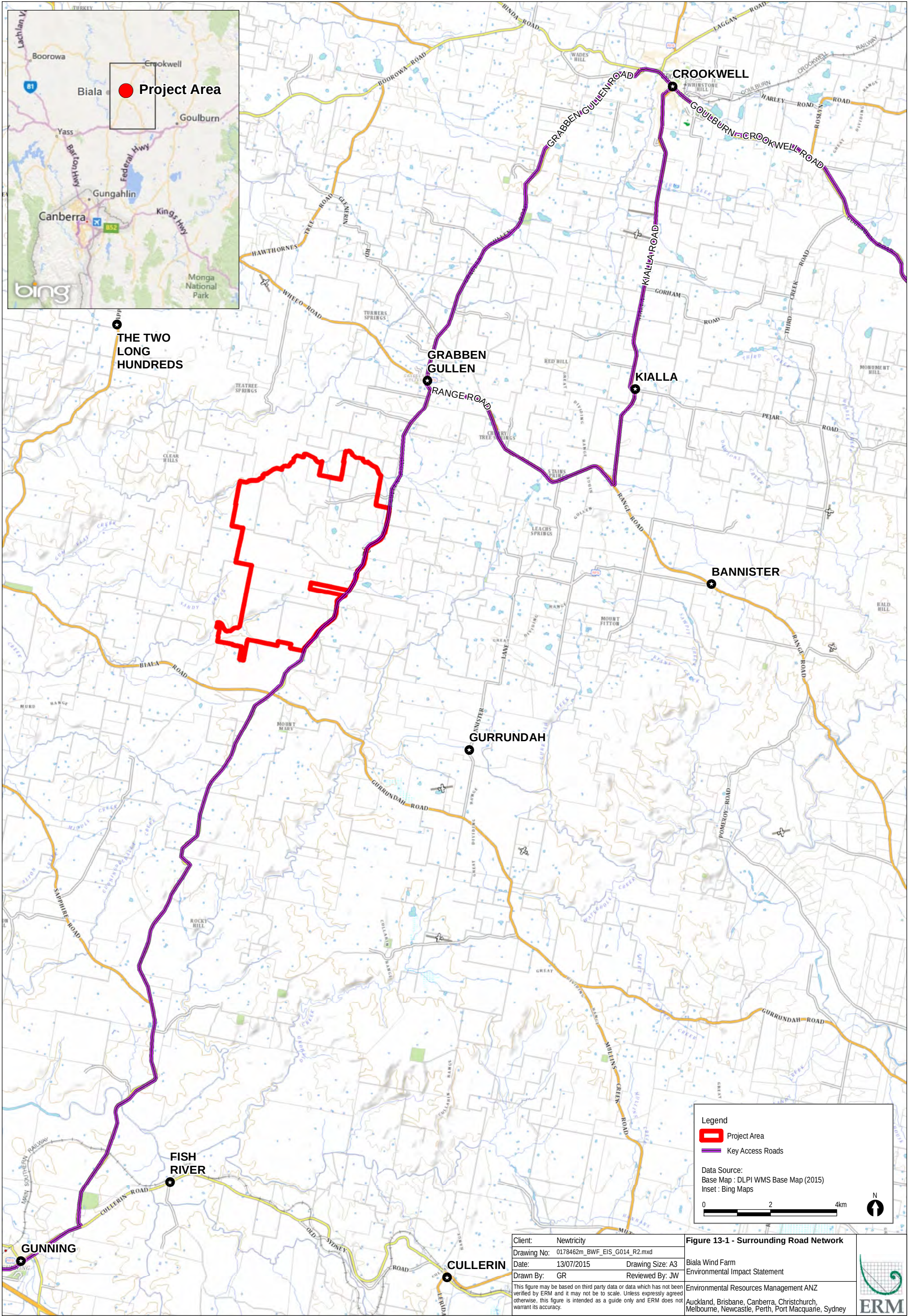
Range Road is a local road controlled by Upper Lachlan Shire Council and is configured with a two-way sealed carriageway. It is noted that part of Range Road (east of Kialla Road) was upgraded to accommodate RAVs used for the construction of the Gullen Range Wind Farm. Range Road carries low traffic volumes (less than 500 vpd). Range Road between Kialla Road and Grabben Gullen Road is currently of unsuitable standard and width to accommodate the movement of RAVs.

Grabben Gullen Road

Grabben Gullen Road adjoins the eastern boundary of the PA and connects the township of Gunning with Crookwell via Grabben Gullen. It is classified as a state road (State No.52) and is controlled by the RMS. It runs in a north-south direction through rolling terrain and is a two-way road with one lane in each direction. Grabben Gullen Road is signposted as a 100 km/h speed limit road. The road carries approximately 400-500 vpd.

Northern Access Road (Unnamed Road)

There is an unnamed road that services the northern part of the PA. At its eastern end between Grabben Gullen Road and the PA, the unnamed road is maintained by Council. Within the PA, the unnamed road is downgraded to a private road. The road is currently configured with a 4 to 5 m wide unsealed carriageway and carries low traffic volumes (estimated to be less than 50vpd).



Existing Road Network Performance

The Transport Impact Assessment reviewed the existing performance of Crookwell-Goulburn Road, Kialla Road, Range Road and Grabben Gullen Road, and determined that they all currently operate at a good level of service (Level of Service B (LOS B) or better) with ample capacity.

13.2.2 Public Transport Routes

One public bus service currently operates between the townships of Crookwell and Goulburn along Crookwell-Goulburn Road. A summary of the service is outlined in *Table 13-1*.

Table 13-1 Public Bus Service Route Information

Number	Monday to Friday (During School Term)	Monday to Friday (School Holidays)
818- Goulburn to Crookwell	9:15am, 1:30pm and 3:15pm	9:15am, 12:00pm and 3:15pm
818- Crookwell to Goulburn	7:32am, 9:51am and 2:06pm	8:26am, 10:56am and 2:13pm

A fortnightly community bus runs twice a day between Crookwell and Gunning via Grabben Gullen Road. There are no exclusive school bus services that operate in or around the area, however the 818 service coincides with school times, and effectively serves as a school bus.

13.3 Assessment of Impacts

13.3.1 Proposed Transport Routes

Determination of the preferred transport haulage routes was based on the following assumptions:

- construction timeframe of approximately 24 months;
- a temporary concrete batching plant will be located on-site, with all rock, aggregate and sand sourced from an external supplier and water sourced internally using existing farm dams;
- WTG towers, blades, and nacelles will be imported to Port Kembla (preferred), Port of Newcastle or Port Botany and transported by road to the PA. Subject to obtaining relevant approvals and permits from RMS, it is expected that RAV access to the PA will largely utilise the route previously used for the Gullen Range Wind Farm development (referred to as 'Route 4a' below);
- to minimise transportation distance, Port Kembla is the preferred location for the delivery of WTG components (towers, blades and nacelles). The preferred RAV construction haulage route has therefore been determined assuming that WTG components are delivered via Port Kembla. In addition, swept path assessment have been undertaken incorporating WTG blade lengths of 60 and 75 m;
- should the Port of Newcastle or Port Botany be utilised as the delivery port, there is sufficient capacity in the road network for RAVs to access the Hume Highway via roads that are regularly used by oversized vehicles. RAVs would use the approved roads and connect to the Hume Highway to follow the same route as that used for Port Kembla; and
- traffic volumes were estimated assuming the Project involved the construction and operation of 31 WTGs.

Two preferred construction haulage routes have been identified by GTA Consultants to accommodate RAVs and general construction vehicles accessing the PA. These two routes are described below:

- **Restricted Access Vehicle Route** (referred to as Route 4A in GTA's Transport Impact Assessment) - in consultation with RMS, Upper Lachlan Shire Council and Goulburn Mulwaree Council, preference has been given for RAVs to access the PA via the same route used for the Gullen Range Wind Farm. This route would involve access via the Hume Highway, the southern interchange through Goulburn, Crookwell-Goulburn Road and then bypassing the Crookwell Township via Grange Road, Cullen Street, Kialla Road and Range Road connecting to Grabben Gullen Road. At this stage, approval as part of the SSD Application is sought for Route 4A only for RAV construction vehicles accessing the PA. Whilst this route has been nominated as the preferred route for RAVs, it may also be utilised for general construction vehicles.
- **General Construction Vehicle Route** (referred to as Route 1 in GTA's Transport Impact Assessment) - this route would involve access from the Goulburn/Marulan region and further afield to the PA utilising the Hume Highway via Gunning and then Grabben Gullen Road.

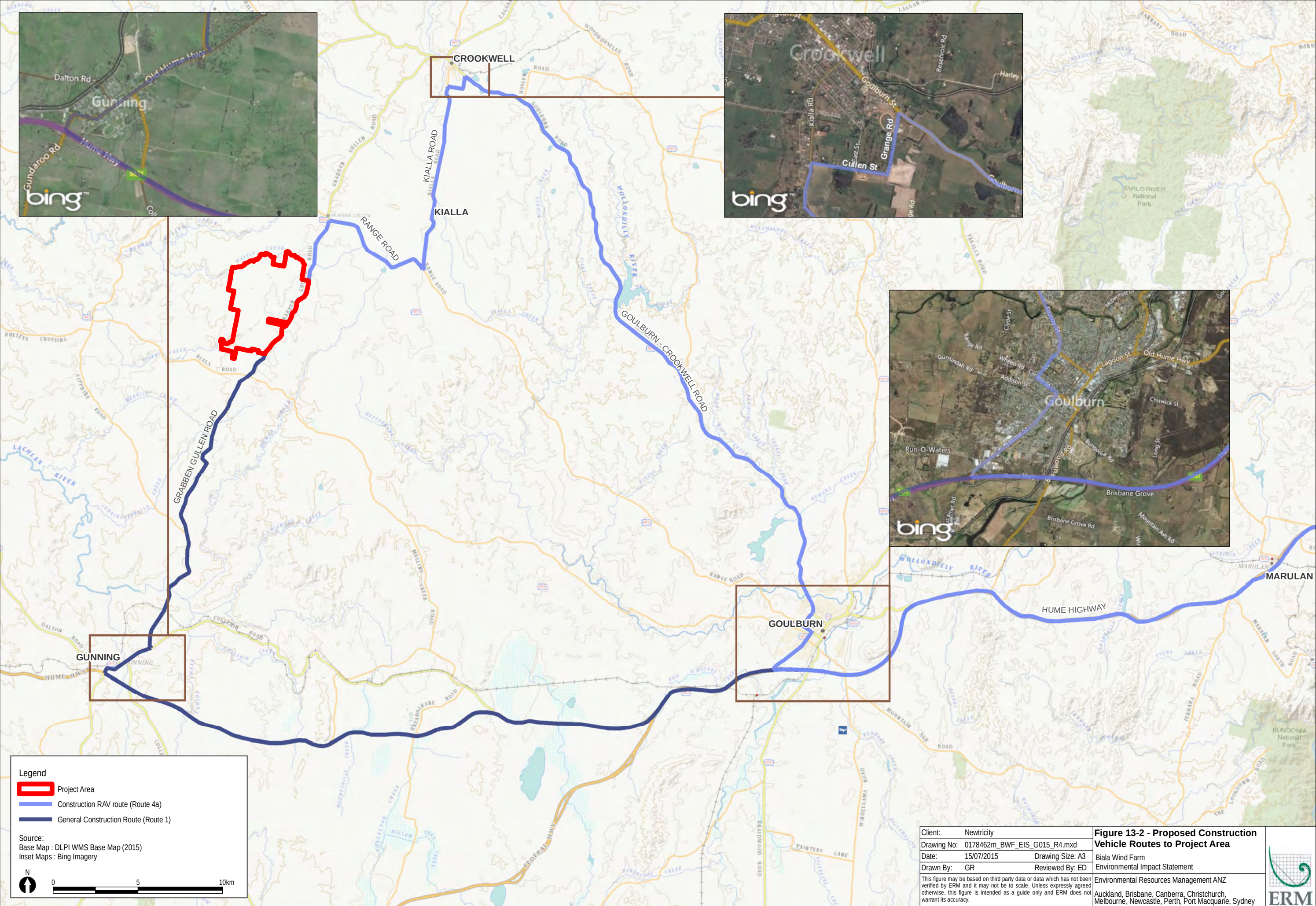
The proposed RAV construction haulage route (Route 4A) through Goulburn to the PA and general construction vehicle route through Gunning (Route 1) are identified in *Figure 13-2*.

13.3.2

Internal Road Network

Access to the WTGs, on-site substation and other Project infrastructure will be provided by a network of access roads within the PA. The access roads will be connected to the existing road network by up to three access points along Grabben Gullen Road (refer *Figure 13-3*). Each of the access points will be designed to provide safe and functional access to the site in consultation with, and subject to approval of, the relevant road authority. Each access will be upgraded to provide a T-junction with Grabben Gullen Road and will be constructed to accommodate the required RAVs.

The internal road network providing access to the WTGs and other Project infrastructure will be up to 8 m wide (with approximately 1 m shoulders on either side), with localised widening where required to support transportation of the WTG components.



Client: Newtricity		Figure 13-2 - Proposed Construction Vehicle Routes to Project Area	
Drawing No: 0178462m_BWF_EIS_G015_R4.mxd	Date: 15/07/2015		
Drawn By: GR	Reviewed By: ED	Biala Wind Farm Environmental Impact Statement	
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.		Environmental Resources Management ANZ Auckland, Brisbane, Canberra, Christchurch, Melbourne, Newcastle, Perth, Port Macquarie, Sydney	





13.3.3

Traffic Generation

Construction Traffic

Construction traffic will be generated through the delivery of equipment, materials and Project infrastructure components, along with construction personnel travelling to the PA on a daily basis. The types and purpose of vehicles anticipated to be used in the construction of the Project are described in *Table 13-2*.

Table 13-2**Vehicle Types**

Vehicle Type	Use
Restricted Access Vehicles (over-dimensional and over-massed vehicles).	Delivery of high-mass items including WTG components (tower sections, blades, hubs and nacelle) and substation transformers.
Heavy vehicles (19 m long semi-trailers, B-Doubles, rigid trucks and cranes).	Delivery of plant, rock and aggregate material for access track and hardstand; sand for cabling installation, concrete constituents, concrete reinforcement, transmission towers and cables, and substation components.
Light vehicles (e.g. vans, utility vehicles and cars).	Construction staff transport and minor deliveries.

The RAVs comprising over-massed and over-dimensional vehicles will be responsible for the delivery of WTG and transformer components and other high mass items and will be subject to permitting requirements at the approval of the RMS to allow travel on the public road network.

Based on a review of other recent wind farm developments, traffic generation associated with the Project is anticipated as follows:

- maximum daily trips per WTG – 3.5vpd (one-way movements only);
- maximum overall trips per WTG – 227vpd (one-way movements only); and
- overall traffic generated will comprise the following vehicle proportions:
 - RAVs: 5%;
 - heavy vehicles: 15%; and
 - light vehicles: 80%.

Utilising the above daily maximum and overall traffic generation rates, the anticipated vehicle movements associated with the construction of the Project are outlined in *Table 13-3*.

Table 13-3**Anticipated Construction Vehicle Movements Per Day**

Vehicle Type	Anticipated Maximum Daily Trips Per Day	Anticipated Overall Trips
RAVs	5	352
Heavy Vehicles	18	1,406
Light Vehicles	87	5,630
TOTAL	110	7,387

Table 13-3 indicates that the Project could be expected to generate up to 110 vehicle trips (110 in and 110 out) per day and approximately 7,400 vehicle trips (7,400 in and 7,400 out) during the construction phase of the Project.

The anticipated traffic volumes during the construction phase is considered conservative given that it is based on the upper traffic generation rates from previous wind farm developments in the surrounding area. As such, actual construction traffic generation from the Project may be less than that estimated. Further, it should be noted that the anticipated daily traffic generation presented above are maximum rates, with average daily traffic generation being significantly less.

Notwithstanding the above, it has been assumed that during peak construction periods, there will be up to 74 construction staff on-site. Given that most staff would be required to travel some distance to the site, it is anticipated that there would be a component of carpooling and as such, it is assumed that vehicle occupancy will be 1.5 staff per vehicle. It is anticipated that construction staff will commence and finish work shifts at the same time and all movements could be expected to occur in a peak hour. Consequently, the peak hour trip generation is anticipated to be approximately 52 trips (50 construction staff and two RAVs or heavy vehicles) during the peak construction periods.

Operational Traffic

Traffic generation during the operation of the Project will primarily be associated with monitoring and maintenance of the wind farm by an anticipated full-time workforce of up to seven staff. In addition, there will be the occasional requirement for heavy vehicles for certain WTG maintenance/repair activities.

13.3.4

Potential Construction Impacts

Impacts on Traffic and Road Network Performance

As outlined above, it has been estimated that the maximum daily traffic generated during construction is 52 vehicles per hour. It was found that there is ample capacity to accommodate this additional traffic on the road network surrounding the PA and even in a worst case scenario where all construction traffic associated with the Project used one route, the peak hour performance of any of the roads assessed in the study area would remain at a good level of service (the same level of service as existing conditions). In reality, some traffic of local origins would potentially utilise a number of routes to access the PA and therefore the traffic generated by the Project would likely be spread across a number of routes. On this basis, it is considered that the road network can readily accommodate the additional traffic associated with construction of the Project.

It is anticipated that during the peak construction period, large and heavy vehicle movements would occur outside the 'typical' peak times, whilst general construction vehicle movements (i.e. construction personnel) could be expected to coincide with the road network peak period. Notwithstanding this, it is noted that the presence of the slow moving RAVs on Crookwell-Goulburn Road may have an adverse impact on the performance of the road. As RAV volumes increase, the ability to pass decreases and delays may result. Further investigations in relation to traffic management would be conducted as part of the Construction Traffic Management Plan (CTMP).

The assessment also suggested that there is sufficient additional spare capacity above the anticipated peak hour volumes associated with the Project that would accommodate the likely cumulative traffic generation of any nearby future developments, whilst still maintaining an appropriate level of service in the surrounding road network.

A review of the sight distances and sight lines at the proposed access points (refer *Figure 13-3*) was undertaken to determine the suitability of the access locations. Based on the findings, it is recommended that the speed limit on Grabben Gullen Road be reduced from 100 km/h to 80 km/h, vegetation be trimmed/cleared at the northern access point to maximise the available sight distance, and appropriate signage warning motorists of construction traffic be erected during the construction period. The access points will be designed in accordance with the requirements of the Australian Standards.

Road Access and Required Upgrades

A swept path analysis of the preferred RAV access route (Route 4A) was undertaken, incorporating WTGs blade lengths of 60 m and 75 m. The analysis indicated that site specific intersection and road upgrades are required to accommodate the RAV movements. In addition, light poles, safety barriers or kerbs would need modification, removal or replacement at some intersections to accommodate RAV movements. It should be noted that road widening works would not necessarily require a sealed road shoulder. The potential for transporting the longer 75 m blades in two sections will be explored and site specific upgrades will be assessed in detail once the dimensions of the RAVs are confirmed.

Table 13-4 provides an overview of the required road upgrades to accommodate the RAVs along the preferred route, with a more detailed analysis provided in the Transport Impact Assessment (GTA 2015). The final route will be dependent on further consultation and approval from the private property owners along the route (relating to any temporary property disturbance), Council, RMS, and subject to approval to remove vegetation.

Each of the vehicle access points and internal access road network will be designed to accommodate the swept path requirements of the largest vehicles.

Table 13-4 Required Upgrades Along RAV Route 4A

Location	Road Upgrade Requirements	
	60 m Blade	75 m Blade
Hume Highway / Hume Street Interchange	Possible removal of guard rail on off-ramp as a result of vehicle overhang.	Possible removal of guard rail on off-ramp as a result of vehicle overhang as well as along bridge as a result of vehicle overhang.
Hume Street / Ducks Lane	Ensure nominated signs are temporarily removed. Roundabout is not mountable.	
Cowper Street / Clinton Street	Ensure nominated signs are temporarily removed.	Removal of electrical and light poles.
Clinton Street / Deccan Street	Consider temporary bus stop relocation. Vehicle clearance to existing electrical pole should be noted.	
Deccan Street / Fitzroy Street	Ensure signs surrounding roundabouts are removed. Temporary no stopping area will be required.	
Goulburn Street/ Grange Road	Existing cut through will be required to be extended to ensure clearance from power poles along Grange Road.	Existing cut through will be required to be extended to ensure clearance from power poles along Grange Road. Removal of electrical poles and fences along the northern edge of Goulburn Street.
Grange Road/ Cullen Street	Embankment and trees along the eastern edge of Grange Road will be required to be removed and levelled to ensure adequate clearance. Removal of fence (private property) and trees along southern side of Cullen Street.	
Cullen Street/ Kialla Road	Reinstate "cut through" on private land similar to the Gullen Range Wind Farm arrangement.	Reinstate "cut through" on private land similar to but larger extent to the Gullen Range Wind Farm arrangement.
Kialla Road / Range Road	Extend existing road widening.	

Location	Road Upgrade Requirements	
	60 m Blade	75 m Blade
Range Road between Kiala Road to Grabben Gullen Road	Range Road would need to be upgraded between the Gullen Range Wind Farm site access and Grabben Gullen Road to a similar standard to that undertaken for Range Road by the Gullen Road Wind Farm. Consultation with Council suggested that as part of the upgrade, road strengthening should be included such that damage to the road during construction is minimised.	
Range Road / Grabben Gullen Road	Widen existing carriageway on Range Road and remove abutting trees.	
Grabben Gullen Road / Northern Access Road (unnamed road)	Intersection will require a complete upgrade with road widening on the unnamed road. Consideration should be had to levelling out the unnamed road to minimise the gradient.	

Impact on Bus Routes

The 818 service operating along Crookwell-Goulburn Road between Crookwell and Goulburn acts as a school bus route and has the potential to be impacted by slow moving RAVs during peak times. A period of inactivity for construction vehicles during the times that this services acts as a school bus service will be negotiated to avoid interaction between RAVs and school bus traffic. Details of this will be confirmed in the CTMP prepared for the Project.

13.3.5

Potential Operational Impacts

Maintenance activities will occur infrequently during operation with only a minor increase in vehicle movements. The majority of vehicle movements associated with ongoing maintenance will be within the PA with minimal impacts on the surrounding road network.

Maintenance such as the replacement of a blade involving RAV vehicle movements will occur rarely. Any RAV vehicle movements to accommodate these activities will be subject to RMS permitting requirements.

Considering the low existing traffic volumes in the vicinity of the PA, the minor additional traffic generated during the operational phase is not expected to compromise the safety or function of the surrounding road network and therefore, outside of meeting RMS approval requirement for any use of RAVs for maintenance activities, no further mitigation measures are proposed.

13.4

Mitigation Measures

The following measures will be implemented to manage potential traffic related impacts during construction:

- a Construction Traffic Management Plan (CTMP) will be prepared prior to the commencement of construction and will include (but is not limited to) the following:
 - confirmation of expected traffic volumes generated by the Project for all work stages and hours of operation;
 - confirmation of, identification and qualification of all heavy vehicle and RAV haulage routes for all work stages;
 - mechanism to review identified haulage route road condition;
 - confirmation of required upgrade works at each of the proposed site access points off Grabben Gullen Road to ensure safe and functional access to the site;

- traffic management measures required to facilitate RAVs, including functional plans detailing road widening/improvement works where required prior to the commencement of works;
- mechanisms/agreements to maintain haulage route roads and road infrastructure during construction works and to reinstate roads to at least pre-construction conditions;
- any requirements for specific work stage construction traffic control plans;
- detail a period of inactivity for construction vehicles during the time of school bus services;
- relevant mechanisms for RAV permits and traffic management requirements; and
- any additional matters identified as required by RMS and Council.
- escorts for RAVs will be provided in accordance with RMS requirements; and
- to ensure that roads utilised by traffic associated with the construction of the Project are maintained to a suitable standard commensurate with their function, a joint inspection of the road surface should be undertaken by representatives of RMS, both Councils and the Proponent prior to the commencement of construction works on the PA. Upon completion of the construction works, a final joint inspection will be undertaken by representatives of RMS, both Councils and the Proponent. The purpose of this inspection will be to identify those works that will ultimately be necessary to return the roads to their pre-development condition or better.

13.5

Conclusion

A *Transport Impact Assessment* has been undertaken to assess the potential traffic impacts associated with the Project and concluded as follows:

- Based on the estimated traffic generation associated with the Project and the existing spare capacity in the road network surrounding the PA, no significant impacts on the capacity of the road network or road users are anticipated.
- Subject to obtaining relevant approvals and permits from RMS and Council, and undertaking the identified road upgrades, RAVs will utilise the Hume Highway from Port Kembla, exiting at Goulburn, then accessing the PA via Crookwell-Goulburn Road, Grange Road, Kialla Road and Range Road and Grabben Gullen Road (bypassing the township of Crookwell) (Route 4A). It is anticipated that this route will be the primary route for RAVs, however could also accommodate general construction vehicles.
- It is anticipated that general construction vehicles will utilise the Hume Highway from the Goulburn/Marulan region and further afield, exiting at Gunning, then accessing the PA via Grabben Gullen Road.
- The final RAV route will be dependent on further consultation and approval from private property owners along the route, Council and RMS, and subject to approval to remove vegetation.
- The majority of vehicle movements associated with the operation and maintenance of the wind farm will be internal to the PA with minimal impacts on the surrounding road network.
- A Construction Traffic Management Plan (CTMP) will be prepared following Project approval. This will include detailed measures to address traffic generation, measures to minimise impacts to existing road users and to maintain and rectify haulage route roads and road infrastructure. The CTMP will address any requirements for specific work stage construction traffic management plans; and contain any additional matters identified and required by RMS and Council.

14 WATER SUPPLY, WATER QUALITY AND HYDROLOGY

This chapter discusses the potential impacts of the Project on water supply, water quality and hydrology and outlines the proposed mitigation measures that are designed to ensure that the Project limits any potential adverse impacts.

14.1 Introduction

A Water Supply, Water Quality and Hydrology Assessment was undertaken by ERM (2015e) to assess potential water and soil related risks and appropriate management and mitigation measures to ensure that construction and operation of the Project would not result in an unacceptable level of environmental impact. A copy of the assessment is provided in *Annex L*. The assessment has been prepared to address the requirements specified in the SEARs pertaining to water supply, water quality and hydrology, outlined in *Chapter 1*, and having regard to the following relevant legislation:

- *Water Management Act 2000* (WM Act); and
- *Environment Planning and Assessment Act 1979* (EP&A Act).

14.1.1 Methodology

The assessment incorporated the following scope of works:

- a description of the existing soil and water conditions across the PA;
- identification of waterway crossings in the PA;
- an outline of likely impacts at the waterway crossing locations and measures to minimise these impacts;
- an outline of the key potential soil and water impacts and an assessment of the associated risks;
- identification of appropriate management and mitigation measures to ensure that construction and operation of the Project would result in an acceptable level of environmental impact, pursuant to the EP&A Act and other relevant legislation;
- development of a conceptual Soil and Water Management Plan;
- analysis of water demands and supply options to determine whether an adequate and secure water supply is available for the life of the Project;
- identification of the statutory (licensing) context of the water supply sources and an assessment of potential environmental impacts associated with the identified sources, including impacts on groundwater; and
- an assessment of the balance of water supply based on expected construction and operation water requirements.

14.1.2 Study Area

The study area for the purposes of the Water Supply, Water Quality and Hydrology Assessment was defined by landforms and waterways associated with the PA.

14.2 Existing Environment

14.2.1 Landforms

The PA ranges in elevation from approximately 940 m AHD in the eastern portion of the middle of the PA to approximately 780 m AHD in the south eastern portion of the PA. Wattle Creek runs along the northern boundary of the PA. The PA is predominately undulating low hills to rolling hills (Hird 1991). The drainage lines between the hills in the southern portion of the PA are much steeper than those in the northern portion, with sheet erosion on some slopes and gully erosion in channels present in some locations.

14.2.2 Geology and Soil Landscapes

Soils information was obtained from the *Goulburn 1:250 000 Soil Landscapes sheet report* prepared by the Soil Conservation Service of NSW (Hird, 1991). The PA contains four soil landscapes – Blakney Creek, Garland, Wyangala and Macalister as shown in *Figure 14-1*.

The Blakney Creek Soil Landscape is formed on Ordovician and early Silurian sediments and typically occurs on lower elevations within undulating low hills. The Garland Soil Landscape is formed from granitic material both in situ and from alluvial-colluvial deposits, often on sideslopes and in valleys. The Wyangala Soil Landscape is formed on Siluro-Devonian granites from in situ and colluvial deposits, in areas of rolling hills. The Macalister Soil Landscape is formed on tertiary olivine basalt, Ordovician and Silurian sediments, Tertiary laterite and Tertiary sand deposits. It typically occupies areas of undulating rolling low hills.

14.2.3 Surface Waters and Watercourses

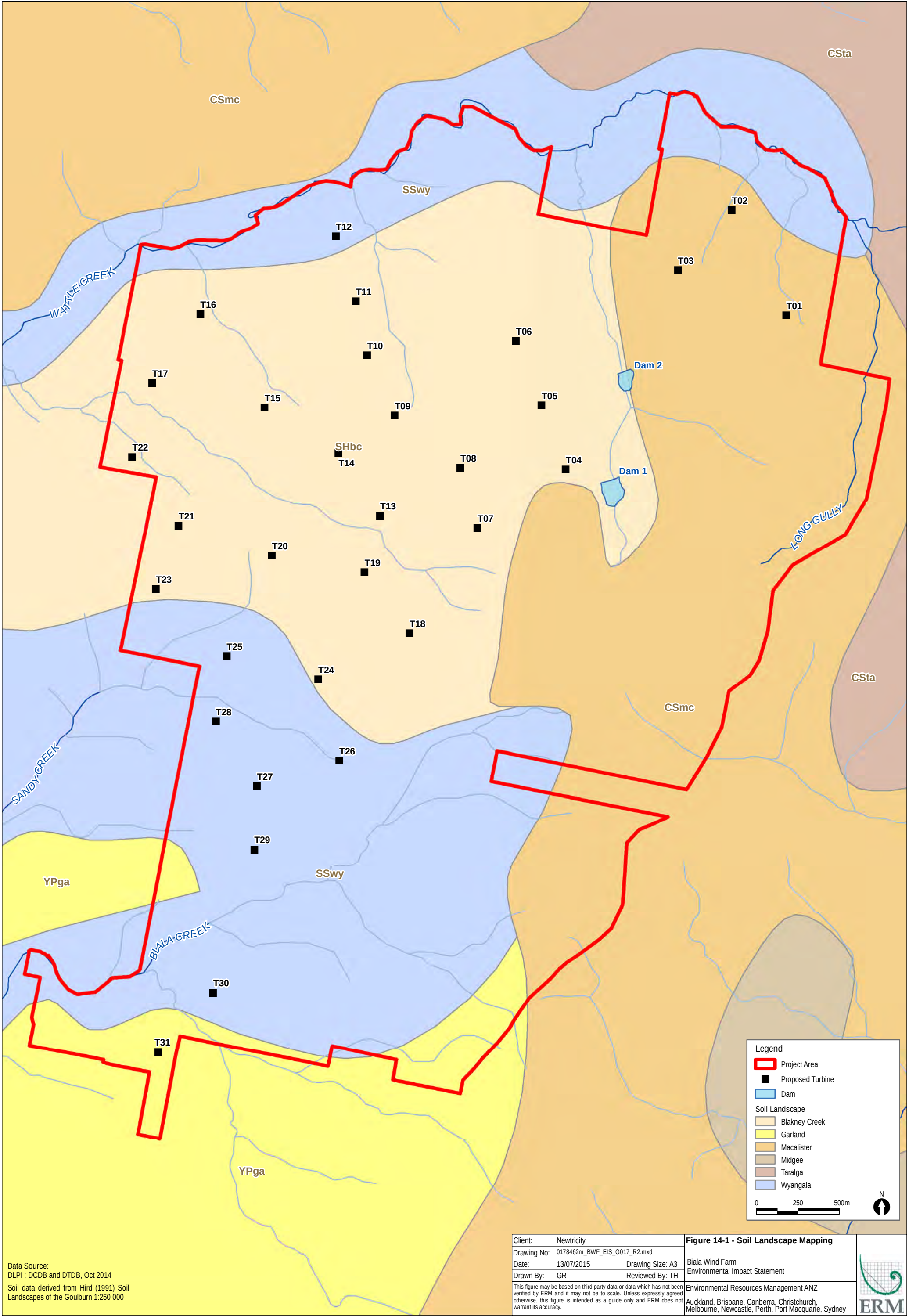
Approximately 20 non-perennial first-order watercourses occur within the PA, predominately flowing east to the Lachlan River. These ephemeral first-order watercourses are broad, open depressions mostly without incised channels or defined bed or banks; they are for the most part stable and well vegetated with pasture grasses. There are very few instances of active erosion along these watercourses.

Far fewer second-order and third-order watercourses occur within the PA. These occur within defined drainage gullies and larger valleys. The higher order watercourses also tend to be stable and well vegetated, with only minor areas of active erosion, particularly in the steeper hills to the south. There are no permanent watercourses in the PA.

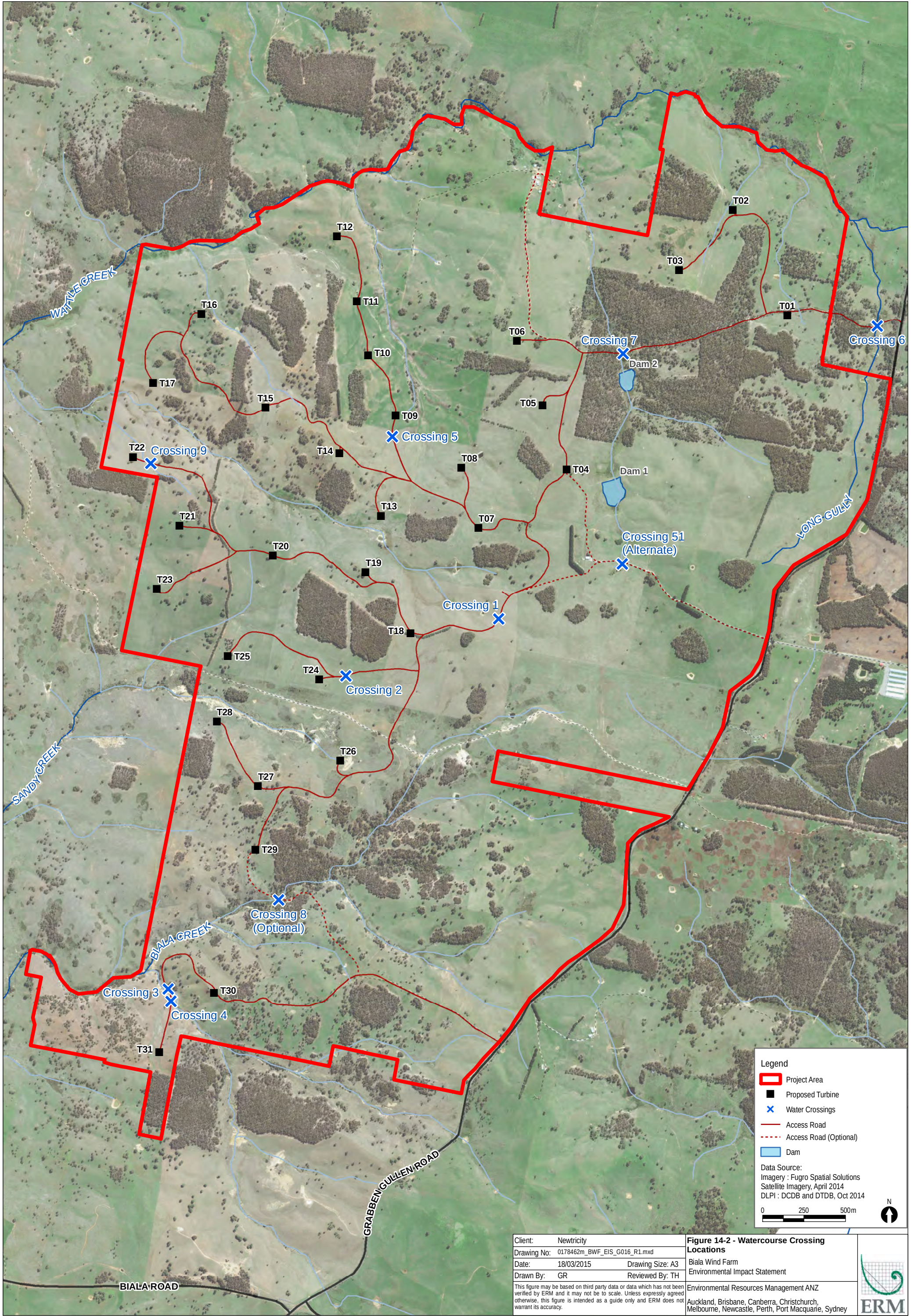
Several dams for stock water supply are located within the PA. Not all of these were visited during the site inspection on 2 February 2015, however those located in close proximity to the proposed concrete batching plant (refer *Figure 14-2*) were observed to determine the potential for using these existing dams to supply construction water to the Project (refer *Photographs 14-1* and *Photograph 14-2*).

There are seven locations where access roads and cabling will cross first-order watercourses. These are typically located very high within the respective catchments. Crossing 7 is located on a second order watercourse and Crossings 3 and 8 are located on third order watercourses. All disturbance areas associated with WTCs construction would be located greater than 20 m from all watercourses and significantly further away from third-order and higher order watercourses. The watercourse crossing locations are shown in *Figure 14-2*.

If needed, constructed watercourse crossings (including major drainage lines) will be designed appropriately in consultation with a qualified engineer and in accordance with the Guidelines for *Watercourse Crossings on Waterfront Land* (NSW Office of Water 2012) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge 2003). This will minimise impacts on the existing banks, water flow, animal passage and on the movement of flows and ensure that they do not impact on water quality.

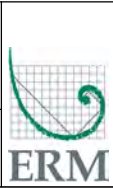


Data Source:
DLPI : DCDB and DTDB, Oct 2014
Soil data derived from Hird (1991) Soil
Landscapes of the Goulburn 1:250 000



Client:	Newtricity
Drawing No:	0178462m_BWF_EIS_G016_R1.mxd
Date:	18/03/2015
Drawn By:	GR
Reviewed By:	TH
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.	

Figure 14-2 - Watercourse Crossing Locations
Biala Wind Farm Environmental Impact Statement
Environmental Resources Management ANZ Auckland, Brisbane, Canberra, Christchurch, Melbourne, Newcastle, Perth, Port Macquarie, Sydney





Photograph 4.1 Largest Dam On-Site (Dam 1) (ERM 2015)



Photograph 4.2 Dam 2 downslope from Dam 1 (ERM 2015)

14.2.4

Groundwater

A search of the NSW groundwater data resource Pinneena GW Version 4.1 (DPI, Office of Water 2014) identified that no groundwater bores were registered within the PA. No geotechnical testing has been undertaken within the PA to date. There are however, six bores to the east of the PA, within 800 m of the PA boundary. Only two of the records have standing water levels (SWLs) available, with both at 23 m Below Ground Surface (BGS), with the bores being drilled to a depth of 72 m and 84 m. The remaining bores were drilled to depths with a range of 27.4 m to 114 m.

The depth of groundwater identified in wells from a similar landscape adjacent to the PA (23 m BGS), the location of the majority of the Project's earthworks in higher reaches of catchments and on ridgelines, and the limited extent of excavation required, indicates that the groundwater aquifer will likely occur at depths significantly greater than would be intercepted by earthworks associated with construction of the Project.

14.3 Assessment of Impacts

14.3.1 Construction Water Demands

During the construction period, water is required to be sourced for the following purposes:

- concrete production;
- construction of roads and hardstands; and
- dust suppression.

Based on an understanding of the construction requirements and the construction schedule as detailed in Chapter 3 and *Annex L*, estimates have been made on the likely quantities of water required. The estimated total water demand over the proposed 24 month construction period is approximately 32.66 ML. The estimated total construction water demand is summarised in *Table 14-1*.

Table 14-1 *Water Demand by Activity*

Roads	Concrete	Dust Suppression	Total
7.5 ML	1.16 ML	24 ML	32.66 ML

14.3.2 Water Supply Options

A number of water supply options have been canvassed, the key options being:

- surface water collection from existing (or new) dams;
- groundwater pumping from new bores;
- water abstraction from a nearby permanent water source (i.e. Lachlan River); and
- tankering water to site.

All options have advantages and disadvantages as well as different licensing and approvals requirements. An overview of the options is provided Chapter 4 of *Annex L*. Licensing and statutory matters have been addressed in Chapter 3 of *Annex L*, and preliminary discussions regarding water licensing have been held with the NSW Office of Water - Richard Meares, Water Regulation Officer, Hunter, Sydney & South Coast Cluster (Parramatta).

The options assessed in Chapter 4 of *Annex L* (Water Balance) demonstrate that water can be feasibly supplied to the Project with the most convenient and cost effective being the use of surface water from existing dams. Groundwater pumping via a new bore and extraction from the Lachlan River would also be viable options, however licensing, economic and logistical requirements would need to be determined. The method to be adopted has not yet been decided. This decision will be made following further discussion with relevant landholders as well as an assessment of economic and other factors associated with each option.

14.3.3

Potential Impacts to Soil and Water

Table 14-2 provides a brief description of the potential impacts to soil and water within and adjacent to the PA resulting from the construction activities. Negligible impacts are expected when the Project is operational. During operation there will be minimal water use requirements and low erosion and sedimentation potential.

Table 14-2

Potential Soil and Water Impacts during Construction

Construction Activities	Potential Impacts to Soil and Water
Unsealed Road Network	• Creation of fugitive dust due to vehicle movements; • erosion of unsealed roadways and resultant sedimentation of runoff from road surfaces; • erosion of roads and roadside drainage in steep terrain or in inappropriately 'finished' locations; and • mud tracking at confluence of internal access roads with the public road network (two access points are proposed at present, with an alternate available should constraints be identified).
Watercourse Crossings	• Erosion of drainage lines and subsequent sedimentation; and • removal of vegetation and subsequent increased erosion potential.
Establishment of Pad Sites (e.g. substation site, WTG foundation sites)	• Erosion of relatively large disturbed areas during establishment and subsequent sedimentation of runoff.
Trenching	• Erosion of trench sites; • erosion from trench spoil stockpiles and subsequent sedimentation should it reach a waterway; and • water collected in the trench following rainfall events may have high sediment content and if not managed appropriately, dewatering could contaminate surface waters.
Dewatering of Site	• Introduction of contaminated water to natural surface waters, including release of water with high sediment loads.
Stockpile Management	• Erosion of stockpiles and loss of soil resource; and • introduction of contaminated water to natural surface waters.
Concrete Batching Plant	• Contamination of waterways from concrete associated water; and • release of water to soil and/or water bodies with increased pH, TSS and potentially other contaminants.
General Construction Activities	• Hydrocarbon spills from machinery (burst hoses, mechanical failures, leaking machinery etc); • contamination of waterways from hazardous substances due to incorrect storage (including drums and containers and spent oil filters etc); • increased refuse in streams due to littering; • contamination of soils and waterways from poor refueling practices; and • discovery of previously contaminated sites.
Water Supply	• Over-extraction of surface water or groundwater resulting in reduced environmental flows, reduced water availability for existing licensed users and impacts on water-dependent ecosystems.

The identified risks can be managed through implementation of appropriate preventative and management measures. These would be outlined in a Construction Environmental Management Plan (CEMP) and Soil and Water Management Plan (SWMP) prepared prior to the commencement of construction.

14.4**Mitigation Measures**

The following measures will be implemented to manage potential soil and water related impacts during construction:

- prepare a detailed SWMP prior to construction commencing. The SWMP should be prepared by a suitably qualified person, such as a soil conservationist;
- prepare Progressive Erosion and Sediment Control Plans as the Project progresses to address management requirements at individual work sites;
- design and construct the Project to minimise land disturbance and therefore reduce the erosion hazard;
- stage construction activities to minimise the duration and extent of land disturbance;
- manage topsoil resources to minimise the risk of erosion and sedimentation, and maximize reuse of topsoil during rehabilitation;
- divert upslope (clean) stormwater around the disturbed sites and capture sediment-laden runoff from within the disturbed site for diversion to sediment control devices;
- rehabilitate the site promptly and progressively as works progress;
- inspect and maintain erosion and sediment control devices for the duration of the Project;
- avoid land disturbance within 20 m of minor streams (first and second order watercourses) and 40 m of third order or higher watercourses;
- ensure appropriate procedures are in place for the transport, storage and handling of fuels, oils and other hazardous substances, including availability of spill clean-up kits;
- minimise disturbance during construction by using existing access tracks and roads until proposed final designs are implemented;
- obtain any necessary water access licenses; and
- ensure appropriate stormwater, collection, treatment and recycling at the concrete batch plant, in accordance with relevant best practice guidelines and any requirements of the NSW EPA.

14.5

Conclusion

A Water Supply, Water Quality and Hydrology Assessment has been undertaken to assess the potential soil and water related impacts of the Project and concluded as follows:

- Overall constraints are relatively minor due to the low erosion hazard over the majority of the area to be impacted by construction. A standard suite of erosion and sediment controls may be adopted in most areas.
- Review of groundwater wells adjacent to the PA identifies that the groundwater aquifer occurs at depths significantly greater than would be intercepted by earthworks associated with Project construction.
- Water supply options are available to meet the demands of the construction phase, with the most convenient and cost effective being the use of surface water from existing dams within the PA.
- Groundwater pumping via a new bore and extraction from the Lachlan River would also be viable options, however licensing, economic and logistical requirements would need to be determined.
- Water access licensing would need to be addressed depending on the preferred option if basic landholder rights of the existing dams require supplementation/replacement. Requirements should be discussed with licensing officers at the NSW Office of Water.
- A detailed Soil and Water Management Plan should be prepared for the Project prior to construction commencing that incorporates the measures identified within the Water Supply, Water Quality and Hydrology Assessment.

15 SOCIO-ECONOMIC

This chapter discusses the potential socio-economic impacts associated with the Project and where applicable, outlines appropriate mitigation measures to manage such impacts.

15.1 Introduction

A socio-economic assessment was undertaken to examine key demographic, economic and infrastructure aspects of the surrounding area to assist in determining potential impacts associated with the Project. In addition, potential impacts were identified based on previous wind farm studies conducted in NSW and internationally, and evaluated against the baseline data for the Upper Lachlan LGA. The assessment has been prepared to address the requirements specified in the SEARs pertaining to potential social and economic impacts on the local community, as outlined in *Chapter 1*, and having regard to the following government policies:

- *Draft NSW Planning Guidelines: Wind Farms, December 2011 (DP&I 2011) (Draft Wind Farm Guidelines); and*
- *Upper Lachlan Development Control Plan 2010 (LEP 2010).*

15.1.1 Study Area

Key demographic and economic data was sourced for the Upper Lachlan LGA and compared to data for the greater NSW region (excluding the greater Sydney metropolitan area) as a representative baseline for Rural NSW.

15.2 Existing Environment

15.2.1 Demographic Profile

The demographic profile of Upper Lachlan LGA was assessed using Australian Bureau of Statistics (ABS) time series data (2011a). Upper Lachlan LGA was assessed due to the location of the Project within this LGA boundary and the likely lack of potential influence on neighbouring LGAs.

The following excerpt was taken from the *Upper Lachlan Shire Social and Community Plan 2013-2018* (Upper Lachlan Shire Council 2013a p9):

“Upper Lachlan Shire covers an area of some 7,200 km², and is characterised by its rural and regional character, affected by its close proximity to the regional centre of Goulburn (45 km), and relative proximity to other major centres such as Canberra (60 km), Bathurst(130 km) and Sydney (240 km).

The Shire has three main centres: Crookwell, Gunning and Taralga and nine smaller centres, Bigga, Binda, Breadalbane, Collector, Dalton, Grabben Gullen, Jerrawa, Laggan, and Tuena. The Shire was proclaimed on the 11th February 2004 following local government boundary changes and includes part of the former Gunning Shire, part of the former Mulwaree Shire and all of the former Crookwell Shire.

At the time of the 2011 Census, Upper Lachlan had a total resident population of 7,193 persons. The median age was 46 and there were 3,589 females and 3,604 males. As a general observation the ratio of females tends to rise in the over 80 age groups, reflecting the tendency for women to live longer.

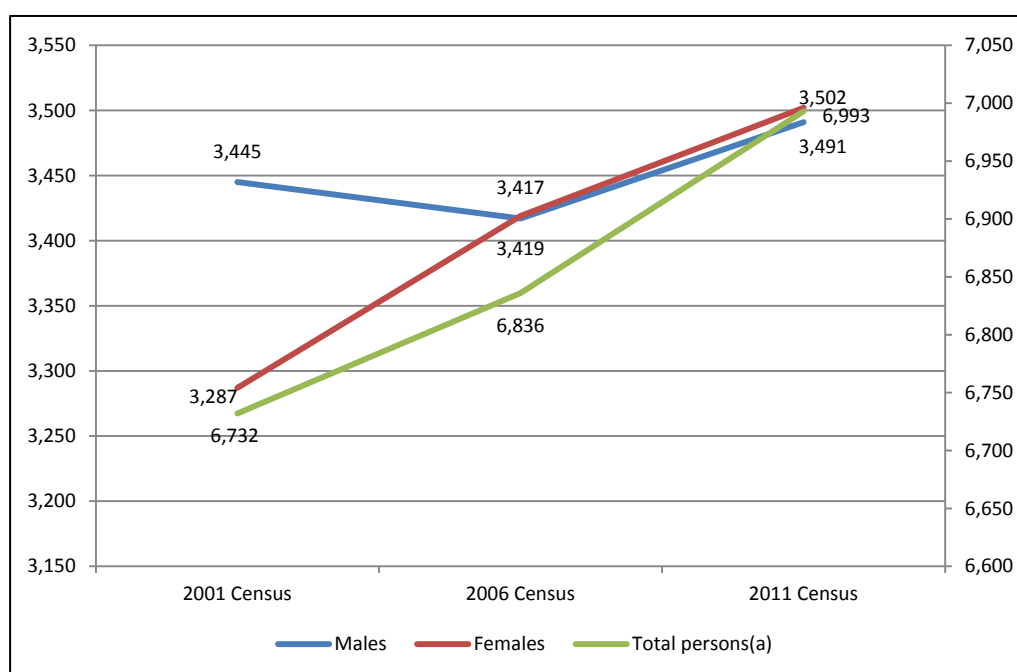
One key observation is the lower numbers in the ‘birthing age of 25-39’ with 928 persons or 12.9% of total population, which is significantly lower (7.8%) than the NSW State average (20.7%). This has a number of implications, including capacity for population renewal and ongoing decline in younger age groups.”

15.2.2

Population

The change in population in the Upper Lachlan LGA from 2001 to 2011 is illustrated in *Figure 15-1*. The blue and red lines show the male and female population respectively. The green line shows the total population and uses the scale on the right of the figure. Between 2001 and 2006 the population grew by 1.5% and between 2006 and 2011 by 2.3%. This represents marginal growth when compared to Rural NSW, which grew by 2.7% and 3.7% respectively over the same timeframes.

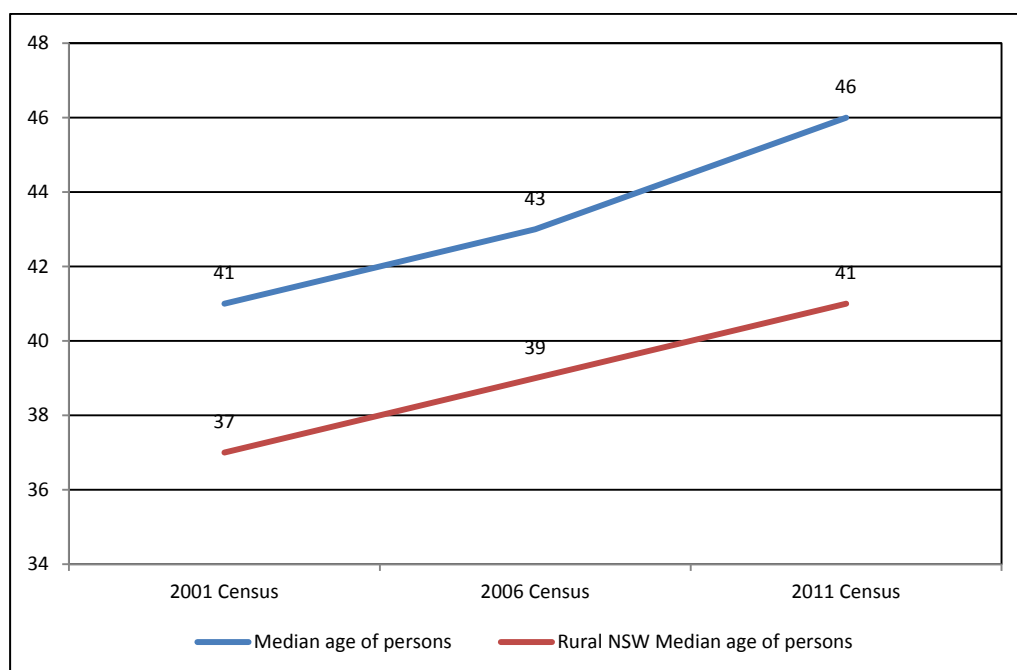
The change in median age of persons from 2001 to 2011 is illustrated in *Figure 15-2*. This data shows the regeneration rate of the population in Upper Lachlan LGA is dropping and the population is aging almost at the same rate across census intervals. The proximity to Sydney and Canberra, low availability of local schooling and employment opportunities, and current Australian population migration trends from rural to urban areas all contribute to the aging population and migration of youth and young adults outside the region. This is a common trend in rural communities as reflected in the Rural NSW data, however the rate for Upper Lachlan LGA is more pronounced.



Notes: Based on Place of Enumeration. (a) Includes overseas visitors.

Figure 15-1

Upper Lachlan LGA Population 2001-2011 (Source: ABS 2011a)



Notes: Based on Place of Enumeration. (a) Includes overseas visitors.

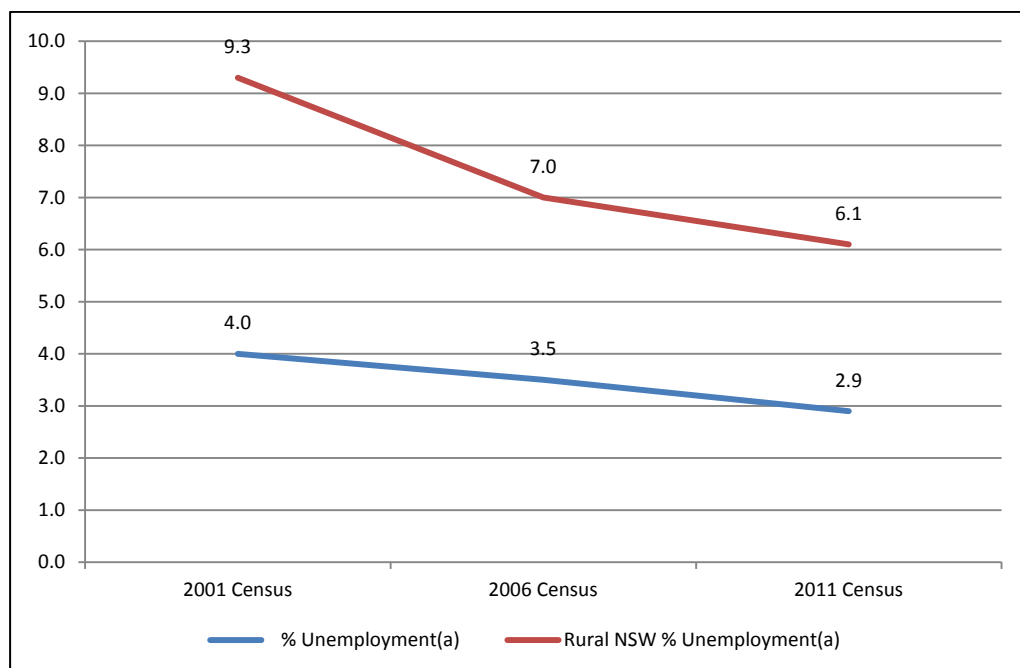
Figure 15-2 Median Age of Persons 2001-2011 (Source: ABS 2011a and ABS 2011b)

In recognition of the ageing population in the region, the *Upper Lachlan Ageing Strategy 2013* was adopted by Council in June 2013, which identified the following key issues for older people within the area:

- outdoor spaces, buildings and infrastructure;
- transport and mobility;
- housing and aged care;
- health and wellbeing; and
- civic and social participation and inclusion (Upper Lachlan Shire Council 2013b).

15.2.3 Employment

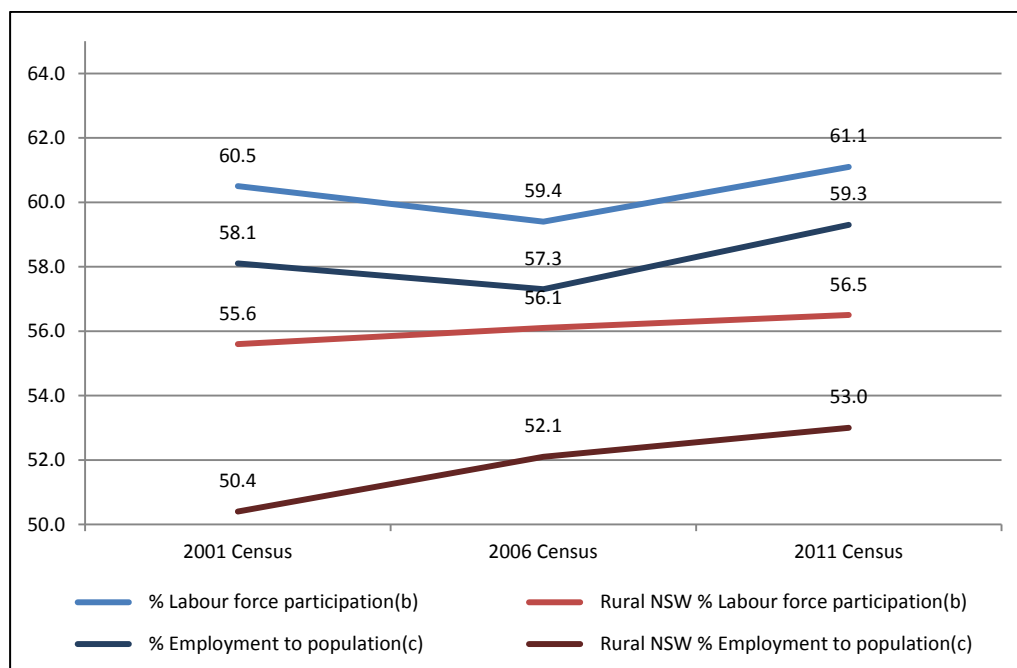
The unemployment rate for Upper Lachlan LGA was in decline between 2001-2011, as illustrated in *Figure 15-3*, and the average rate of 2.9% is significantly below the Rural NSW average of 6.1% in 2011. This is a reflection of a rural economic equilibrium common in well-established communities with well-established industries, as well as the declining youth population who generally experience challenges seeking employment. The rate of unemployment decline parallels the increase in median age and substantiates this hypothesis.



Notes: (a) The number of unemployed persons expressed as a percentage of the total labour force.

Figure 15-3 Unemployment Rate 2001-2011 (Source: ABS 2011a and ABS 2011b)

The percentage of labour force participation and the percentage of employment to population from 2001-2011 are illustrated in *Figure 15-4*. Both values are higher for Upper Lachlan LGA than Rural NSW and correspond with the population data observations and the unemployment rates. The labour force participation increase from 2001-2011 relates to the aging population and captures the increase in people working in the region to sustain themselves, both male and female, though with higher male participation levels than female, which is common in NSW and Australia as a whole.



Notes: (b) The number of persons in the labour force expressed as a percentage of persons aged 15 years and over.
(c) The number of employed persons expressed as a percentage of persons aged 15 years and over.

Figure 15-4 *Percentage Labour Force Participation and Employment to Population 2001-2011 (Source: ABS 2011a and ABS 2011b)*

15.2.4 Income

Figure 15-5 illustrates the comparative analysis of the median incomes for the Upper Lachlan LGA and Rural NSW for the 2001-2011 census periods. The median incomes in the Upper Lachlan LGA are consistent with Rural NSW though slightly below, which reflects limited economic and employment opportunities, however incomes are increasing and 2011 data shows the difference is marginal.

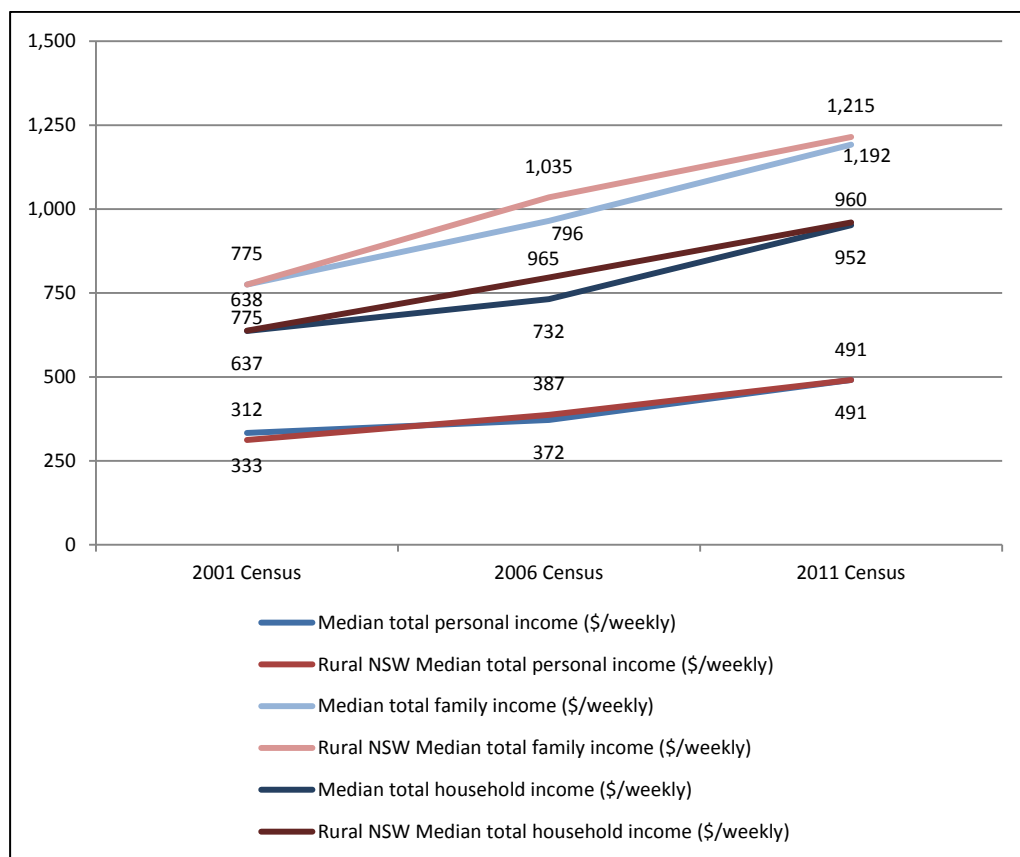


Figure 15-5 Median Incomes 2001-2011 (Source: ABS 2011a and ABS 2011b)

Figure 15-6 illustrates the comparative analysis of the median repayments of loans and mortgages for the Upper Lachlan LGA and Rural NSW for the 2001-2011 census periods. Repayments are consistently lower in the Upper Lachlan LGA than Rural NSW and reflect increased affordability in the region due to the rural aspect.

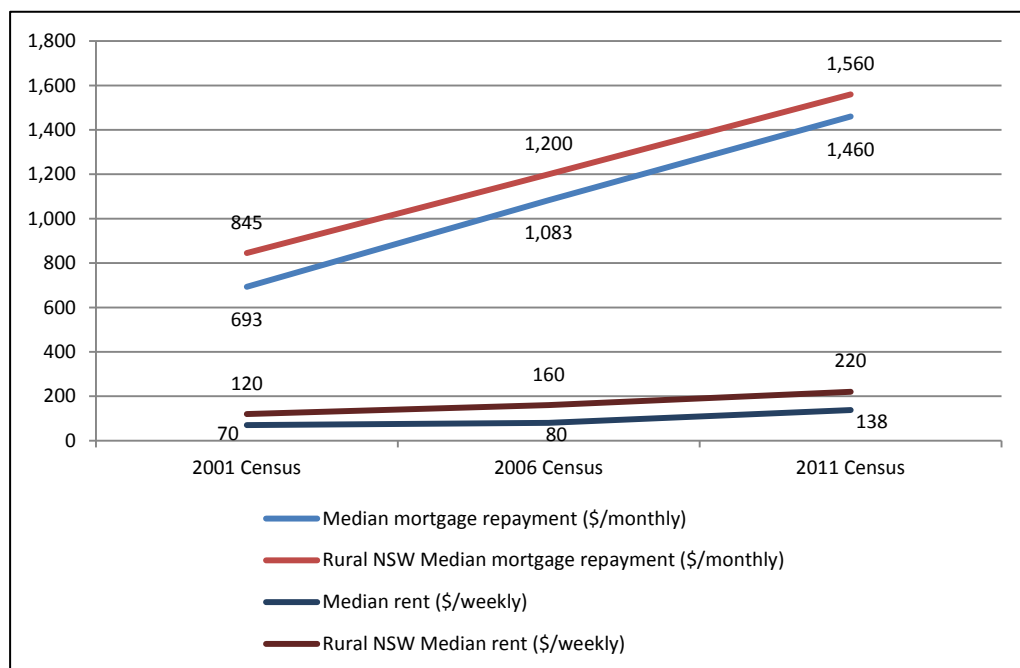


Figure 15-6 Median Repayments 2001-2011 (Source: ABS 2011a and ABS 2011b)

15.2.5

Community Services, Social Infrastructure and Recreation

Community services and social infrastructure are limited in the region due to the population size and proximity to larger centres including Sydney and Canberra. Upper Lachlan LGA is part of the Greater Southern Area Health Service (GSAHS) with the primary health services centre being the Crookwell District Hospital operated by Crookwell Health Service, which is a Level 2 community acute facility (GSAHS 2005).

The following excerpt is taken from the Upper Lachlan Shire Social and Community Plan 2013-2018 (Upper Lachlan Shire Council 2013a p15):

"There are a range of social and community assets in the Upper Lachlan area including both physical and service based assets. The range of services and providers changes over time and Council maintains a service directory for the Upper Lachlan community, which can be found online: <http://upperlachlan.local-e.nsw.gov.au/community/directory.html>.

Upper Lachlan has a range of social infrastructure and services typical of a rural local government area, although the relative close proximity to Canberra and a larger rural city such as Goulburn have impacted upon the range of facilities and services, social infrastructure and services."

15.2.6

Other Wind Farm Developments in the Region

The Project is proposed in a region of significant wind farm development due to the productive wind resources across the landscape. The closest wind farm developments to the Project include Gullen Range, located approximately 5.5 km east of the PA and Gunning Wind Farm, located approximately 7.2 km to the south-east. Other wind farms developments in the broader region are outlined in Table 17-1 and shown in Figure 17-1.

15.3

Assessment of Impacts

Potential social impacts generated by the Project have been identified through community consultation (refer Chapter 7) and through a literature review of other wind farm developments. The potential socio-economic impacts identified for the Project are listed below:

- increased population impacts on social infrastructure and services (workforce);
- increased economic activity;
- decrease in property values;
- decrease in visual amenity;
- decrease in viable agriculture land;
- increased noise and vibration;
- increased traffic;
- increased risk to aviation safety; and
- disruption to local communications.

This section evaluates the impacts identified, their sources and socio-economic context with the mitigation measures to manage the identified impacts outlined in Section 15.4.

15.3.1 Increased Population Impacts on Social Infrastructure and Services (Workforce)

There are anticipated to be impacts associated with the construction workforce required for the Project. This workforce is likely to be sourced from both inside and outside the region, however preference will be given to commercially competitive local tenders. The workforce is predicted to generate up to 74 direct full time equivalent (FTE) construction positions based on similar sized wind farm developments in Australia, and up to seven FTE positions per year during operation. This marginal increase in population (1.3% increase during construction and 0.2% during operation) is expected to impose only a limited increase in demand and usage of social infrastructure and services in the local and regional area.

15.3.2 Increased Economic Activity

The temporary minor increase in population during construction is likely to generate marginal indirect and induced employment from increased demand for local services and infrastructure. There will also be direct project expenditure in the local and regional area for goods and services to local businesses, though this too will be minor given the scale of the Project and proximity to socio-economic receptors. However, the Project will provide increased employment opportunities in the local and regional area, and potentially an increase in the regional skilled workforce if local employment opportunities are realised. This would also result in increased opportunity for higher wages. There is also potential for an increase in demand for workers with experience on the Project for similar developments or other industries in the region after the Project completion. Employment impacts could benefit local or regionally based individuals.

In discussions with Council, the Proponent intends to establish a Community Enhancement Program in lieu of a levy under the Upper Lachlan Section 94A Development Contributions Plan. In accordance with the Upper Lachlan DCP, the Proponent will contribute \$2,500 per WTG per annum, which equates to \$77,500 per annum in direct contributions throughout the operational life of the Project. Consultation with Council regarding the CEP is ongoing and will be finalised for inclusion in the Project approval.

15.3.3 Decrease in Property Values

There is a perception in society that industrial development, and wind farms in particular have a negative impact on property values. This is due to the visual amenity impact, noise impact, perceived electromagnetic and electricity impacts to health, shared land use and traffic impacts, particularly during construction but also for routine maintenance. This impact can occur to local residents on or adjacent to wind farms, and any property or future development that can see the wind farm.

Table 15-1 provides a summary of studies undertaken for Australia and internationally on the effects of wind farms on property values.

Table 15-1

Summary of Studies into Wind Farm Developments Effects on Property Prices

Report	Summary and Key Findings
Australian Studies	
Duponts and Etherington (2009) <i>Preliminary Assessment of the Impact of Wind Farms on Surrounding Land Values in Australia: NSW Department of Lands</i> , Prepared for NSW Valuer General, August 2009.	The study assessed eight wind farms across NSW and Victoria and based on the analysis, no quantifiable effect on property values was identified. Although a small number of rural residential properties (lifestyle properties) reported lower than expected property sales prices, uncertainty remains as to whether this was a reflection of the wind farm or other market factors. Furthermore, no evidence produced from the study suggested that the underlying land use of the property was affected (i.e. agriculture) and no decline in sale prices were evident for rural properties located in nearby townships with views of the wind farm.
Henderson and Horning (2006) <i>Land Value Impact of Wind Farm Development: Crookwell NSW</i> .	The study analysed 78 property sales spanning a 15 year period from 1990 to 2006 within a 6 km viewshed of the Crookwell Wind Farm. No reductions in properties were reported as part of the assessment.
Hives (2008) <i>Wind Farms: The Local Experience</i> , Presentation at the Australian Property Institute (API) Country Conference.	The study assessed the 12 individual property sales surrounding the Waubra Wind Farm near Ballarat, NSW. The study concluded that: - Landowners involved in the Project experienced an increase in land value; - rural property values were unaffected; and - lifestyle properties in the vicinity of the township were most vulnerable, however the reported decline in sale prices may have been driven by other market factors.
International Studies	
Hoehn, B; Wiser, R; Cappers, P; Thayer, M & Sethi, G (2009) <i>The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis</i> , Ernest Orlando Lawrence Berkeley Laboratory, December 2009.	The assessment involved 7,500 sales of family homes within 16 km of 24 wind farms across nine states within the United States of America (USA). No evidence of widespread property value impacts in communities surrounding wind energy facilities was reported.
Canning, G & Simmons, L (2010) <i>Wind Energy Study - Effect on Real Estate Values in the Municipality of Chatham-Kent, Ontario</i> , Report prepared for the Canadian Wind Energy Association, February 2010.	The study in Ontario, Canada reported that where wind farms were clearly visible, there was no empirical evidence to indicate that rural residential properties reported lower sale prices than similar residential properties within the same area that were outside of the viewshed of a wind turbine.
Renewable Energy Project (REPP) (2003) <i>The Effect of Wind Development on Local Property Values</i> , Renewable Energy Policy Project, May 2003 (US Government).	More than 25,000 records of property sales across the USA in the vicinity of wind farms were analysed. The study concluded that there was no statistical evidence that property values within the viewshed of a wind farm, were affected by wind farm developments.

In addition to the literature outlined in *Table 15-1*, reference is made to the Secretary's Environmental Assessment Report for the State Significant Development: Yass Valley Wind Farm (SSD08_0246), which states on page 40:

"The Department acknowledges that, in relation to impacts on land values, the NSW Valuer-General commissioned a report on the impacts of wind farms on land values in Australia. The report states as its principal finding, based on analysis of previous studies and its own investigations, that the majority of wind farms erected in Australia appear to have had no quantifiable effect on land values."

15.3.4

Decrease in Visual Amenity

As discussed in *Chapter 11*, the Project is expected to cause a moderate/low to moderate/high visual impact to non-involved dwellings located within 2-3 km from proposed WTG locations, however the level of impact was noted to decrease with distance from the PA. The Project was assessed by Clouston Associates (2015) as having an overall moderate/low visual impact due to:

- the limited number of sensitive residential dwellings in proximity to the PA;
- the limited number of public viewers on roads and limited quantity of public open space;
- topography that limits views of the PA, blocking many views of the WTG clusters from distances of over 3 km;
- dense stands of tree planting, windbreaks and garden plantings (associated with individual properties) that block or filter views towards the Project.

Public viewpoints towards the Project are mostly restricted to the minor local road network, with the impacts limited in extent due to relatively short exposure time when passing the PA during travel. In addition, the Project is not expected to impact the character of Grabben Gullen village as views towards the PA from the village are largely shielded due to topography and existing vegetation.

15.3.5

Decrease in Viable Agriculture Land

It is well regarded that wind farm developments can coexist with existing farming practises due to the limited disturbance footprint of wind farm infrastructure and the presence of internal roads improving access for farmers across their property. However, wind farm developments have the potential to impact aerial agricultural applications such as spraying of crops and mustering of livestock. As discussed in *Chapter 16*, fixed wing aerial agricultural operations within the PA would most likely be affected, however safe aerial application operations are expected to be possible on properties neighbouring the PA, subject to final WTG locations, and on a case-by-case assessment. Given the higher manoeuvrability of rotary winged aircraft, aerial application operations using these aircraft can be undertaken in closer proximity to WTGs than would otherwise be possible for fixed wing aircraft.

15.3.6 Increase in Noise

The operation of the Project was identified to potentially impact the noise amenity at surrounding residential locations. The Wind Farm Noise Impact Assessment prepared by DNV GL (2015a) determined that operational noise generated by the WTGs and the operation of the substation was compliant with the relevant noise criteria at all surrounding residential dwellings (involved and non-involved properties). As such, the operation of the Project is not expected to impact on the noise amenity at surrounding residential properties.

As discussed in *Chapter 10*, ERM (2015c) prepared a Supplementary Acoustics Assessment to assess the potential construction noise and vibration, including road traffic during construction. The predicted construction noise levels were at or below the relevant noise management levels at the majority of the surrounding residential locations with the most affected dwellings being those of involved landholders. The highest noise levels at the receptor locations were generally associated with the construction of the access roads and WTG site preparation activities.

Predicted construction traffic noise impacts were at or below the RNP criteria at the majority of the receptor locations, however temporary impacts associated with peak vehicle movements during the night-time assessment period could be generated. These peak night-time movements are unplanned at this stage, however would likely be associated with light vehicles or urgent deliveries (refer *Chapter 10*).

15.3.7 Increase in Traffic

As outlined in *Chapter 13*, the local road network has sufficient capacity to accommodate the anticipated level of construction and operational related traffic generated by the Project. It is noted however, that issues have been raised by the community pertaining to potential impacts on road safety, particularly caused from the increased movement of heavy vehicles on surrounding roads during construction. To support the safe access of RAVs to the PA, upgrade works are required at specific locations, which are detailed in *Chapter 13*.

15.3.8 Increase Risk to Aviation Safety

The safe operation of aircraft within the local and broader region is considered important for aerial agricultural operations, aerial firefighting and Royal Flying Doctor (RFD) operations. Impacts to these operations due to the height and placement of WTGs was raised by the local community and consultation undertaken with key stakeholders (refer *Chapter 7*).

The aviation assessment contained in *Chapter 16*, indicated that aerial firefighting operations will potentially be restricted in the vicinity of the PA, however there is valid ground-based means to support firefighting due to the construction of the access road network throughout the PA. The RFD services indicated that they sometimes operate out of Goulburn Airport and Crookwell Aerodrome, however the assessment indicated that aircraft taking off and landing at these locations will not be affected by the Project.

15.3.9 Disruption to Local Communications

Wind farm developments have the potential to disrupt communications services in the immediate vicinity of the Project. Such impacts are often associated with disruption to the television and telecommunications reception, which can adversely impact local residents, emergency services and aviation operations.

An assessment of the potential impacts on communications services in proximity to the Project is outlined in *Chapter 16*. The assessment concluded that television reception at some properties may be affected by the Project, however such impacts can be readily mitigated. Furthermore, the assessment determined that communications services including radio broadcasting, mobile phones, internet and Citizens' Band (CB) radio are unlikely to be affected by the Project.

15.4 Mitigation Measures

To manage potential socio-economic impacts, the following mitigation and management measures will be implemented:

- where feasible and applicable, contractors and suppliers will be sourced from the broader local region during the construction phase;
- where feasible and applicable, service and maintenance staff will be sourced from the broader local region during the operation of the Project;
- prior to the commencement of operation, a community enhancement program will be established providing a voluntary annual contribution for the provision and enhancement of community facilities and Council funded infrastructure projects; and
- the Proponent will consult with local and regional realtors periodically in order to identify trends or changes associated with wind farm impacted properties to determine a correlation between the Project and property values in the region.

In addition to the mitigation measures outlined above, mitigation measures pertaining to the other impacts described in this chapter are outlined in the following chapters:

- landscape and visual - refer *Chapter 11*;
- noise and vibration - refer *Chapter 10*;
- traffic and transport - refer *Chapter 13*;
- aviation safety - refer *Chapter 16*; and
- impacts on communications - refer *Chapter 16*.

15.5

Conclusion

An assessment of the socio-economic issues has been undertaken for the Project and concluded as follows:

- The Project is expected to have a positive impact on the local and regional economy through an increase in the demand for local goods and services particularly during the construction phase.
- The Project is anticipated to assist in the funding of local infrastructure and other projects via the establishment of a community enhancement program in consultation with Council. The structure and administration of these funds will be finalised as part of the conditions of consent.
- A review of available literature did not identify a correlation between declining property values in proximity to wind farm developments. This was reinforced by a statement made by the DP&E in the Secretary's Environmental Assessment Report for the proposed Yass Valley Wind Farm.
- Decrease in visual amenity is a key concern raised by the community and has been addressed in detail in *Chapter 11*.
- Aerial agricultural operations are not expected to be affected on properties neighbouring the PA.
- The operation of the Project is not expected to impact on noise amenity at surrounding residential properties.
- The road network has sufficient capacity to accommodate the construction and operation of the Project, subject to some road upgrades at specific locations as outlined in *Chapter 13*.
- The Project is not expected to impact firefighting operations as there is sufficient capacity within the PA to support ground-based firefighting operations. Further, aircraft utilising local aerodromes including Goulbourn Airport and Crookwell Aerodrome, such as the Royal Flying Doctor services, are not expected to be affected by the Project.
- Potential impacts on communications services can be readily mitigated.

16 HAZARDS AND RISKS

This chapter discusses the potential hazards and risks associated with the Project including aviation safety; electromagnetic interference; shadow flicker; human health impacts; and bushfire. Where adverse potential impacts have been identified, mitigation measures have been proposed to effectively manage such impacts.

16.1 Aviation Safety

16.1.1 Introduction

An Aeronautical Impact Assessment was undertaken by Aviation Projects (2015) to assess the potential impact the Project may impose on the safe operation of aircraft within proximity to the PA. A copy of the assessment is provided at *Annex M*. The assessment has been prepared to address the requirements specified in the SEARs pertaining to aircraft safety, outlined in *Chapter 1*, and having regard to the following:

- *Civil Aviation Safety Regulations 1998*; and
- *Airservices Aviation Assessments for Wind Farm Development – 13 February 2014*.

16.1.2 Methodology

The assessment incorporated the following scope of work:

- site visit and desktop review of the Project layout and materials;
- review of relevant regulatory requirements and information sources;
- preparation of an Aviation Impact Statement in accordance with Airservices Australia guidance;
- preparation of a qualitative risk assessment, considering the requirements for aviation obstacle lighting; and
- consultation by writing and/or telephone interview as practicable with relevant stakeholders, including the Aerial Agriculture Association of Australia (AAAA), Civil Aviation Safety Authority (CASA), Commonwealth Department of Defence (DoD), and representatives of nearby aerodromes and aircraft operators.

The draft Aeronautical Impact Assessment was sent to CASA, Air Services Australia (ASA) and DoD and comments were incorporated into the final assessment. In addition, a summary of the consultation activities undertaken with these organisations is provided in *Chapter 7*.

16.1.3 Study Area

The study area for the Aeronautical Impact Assessment included the PA and extending approximately 30 nm (55.6 km) beyond the PA to encompass aerodromes and aircraft landing areas (ALA), which may be affected by the Project.

16.1.4 Existing Environment

The Aeronautical Impact Assessment identified a total of two aerodromes (Crookwell and Goulburn Airports) and two other ALAs within an approximate 30 nm radius of the PA. In addition, rotary wing aircraft landings were identified at hospitals servicing the surrounding townships, including Crookwell, Roslyn, Goulburn and Cullerin. No aerodromes or ALAs were identified within the PA. A summary of the aerodromes and ALAs is outlined in *Table 16-1*.

Table 16-1

Aerodromes and other Aircraft Landing Areas

Aerodrome	Status	Approximate Distance to Project
Crookwell Airstrip (YCRL)	Unregistered	10.5 km north-east
Goulburn Airport(YGLB)	Registered	41.3 km south-east
Towrang Airstrip	Unregistered	46 km east south-east
Gundaroo Airstrip	Unregistered	48 km south
Ashwell Airstrip	Unregistered	6.5 km south south-east
Aircraft Landing Area (unnamed)	Unregistered	3.8 km south east

The unregistered airfields do not have instrument procedures, and as such do not have any obstacle limitation surface (OLS) or Procedures for Air Navigation Services – Operations surfaces (PANS-OPS). These airfields are sufficiently distant from the PA that take-off and landing operations are not affected. None of these airfields have permanent lighting and would not normally be used in night flying operations.

There may be other private airstrips and landing grounds located within 30 nm of the PA, none of which require OLS and are not included in aeronautical charts or documents for the region. Pilots operating at such private airstrips are responsible for ensuring that they are aware of the conditions on and surrounding these landing sites.

A number of aircraft flight routes fly above or in proximity to the PA, which are outlined in Table 16-2.

Table 16-2

Aircraft Flight Routes in Proximity to the Project Area

Route Number	Waypoint Names on Route	Published Lowest Safe Altitude (feet)
W762	RUG – NICKY – BIK	4900
W184	YAS – MDG	5400
H319	PKS – MAKKA – TARAL	4900
W113	HAPPI - BIK	5500
W423	BTH – CULIN – CB	4600
W817	YAS – KEDDY - BIK	4900
UH205	GTH - CULIN	5300
Y59	NONUP – CULIN - TARAL	N/A (high level route)
W10	EXETA – YAS	4500
W724	GLB – YAS	4500
H247	TOTOB – CULIN	7700

16.1.5

Assessment of Impacts

Aeronautical Impacts

The Project is not expected to result in any significant risk to normal flying operations provided aircraft are operated in compliance with applicable regulatory and operational control requirements and with the application of good airmanship. Specifically, the assessment of aeronautical impacts undertaken by Aviation Projects (2015) concluded:

- there will be no adverse impact by the Project on OLS;
- there will be no adverse impact by the Project on Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) surfaces;
- the Project will not affect any lowest safe altitudes (LSALTs) for air routes in the area, however raising the LSALT for airway W423 by 100 ft to 4,700 ft is recommended;
- WTGs are located outside the clearance zones associated with aviation navigation aids and communication facilities;
- with respect to aircraft taking off or landing from an aerodrome, it was determined that no aerodromes or ALAs are located in such a position that aircraft taking off or landing would be affected by wake turbulence caused by the Project. In addition, the Project is sufficiently distant from airfields to not have an impact on contingency procedures and engine inoperative flight paths; and
- pilots conducting low level visual flight rule (VFR) operations are anticipated to possess an adequate level of understanding of the effects of mechanical turbulence caused by wind farms to maintain an acceptable level of safety.

Radar Surveillance Facilities

A preliminary assessment on the impact of the Project on air traffic control (ATC) radar surveillance was undertaken by IDS Australasia Pty Ltd (IDS) and is included in *Annex M*. The Project was identified to potentially impact radar facilities located at Mt. Majura and Mt. Bobbara and consequently, the impact assessment was focused on these facilities. The assessment concluded that there should be no impact on the secondary surveillance radar (SSR) facilities at Mt. Majura and Mt. Bobbara. However, the primary surveillance radar (PSR) facility at Mt. Majura is in the line of site of the Project and therefore potential impacts were identified. Airservices Australia was consulted in relation to the PSR, however no concerns were raised with regard to the impact of the Project on flying procedures or aeronautical facilities designed by Airservices Australia.

Obstacle Lighting and Marking

The obstacle lighting risk assessment undertaken by Aviation Projects concluded:

- given WTGs are in excess of 150 m AGL, the WTGs must be regarded as obstacles unless CASA assesses otherwise;
- the risk of an aircraft collision with a WTG without obstacle lighting is considered acceptable;
- if obstacle lighting is required at the request of CASA, it is recommended that obstacle lighting would be installed on the following 18 WTGs: T01, T02, T03, T04, T05, T06, T07, T12, T14, T16, T18, T22, T23, T26, T28, T29, T30 and T31; and
- if obstacle lights are to be installed, they can be designed so that there is an acceptable level of visual impact to neighbours.

Whilst the Aeronautical Impact Assessment provided at *Annex M* concluded that the Project will not require obstacle lighting to maintain an acceptable level of aviation safety, CASA has recommended steady red low intensity lighting on 18 of the WTGs at night in accordance with section 9.4 of the MOS Part 139. Consultation with CASA regarding the requirement for obstacle lighting is ongoing and will be resolved prior to approval being granted for the Project.

Aerial Application of Agricultural Fertilisers and Pesticides

The Project is likely to prevent fixed wing agricultural operations within the PA. It is reasonable to conclude that safe aerial application operations would be possible on properties neighbouring the PA with some operational or cost impacts, subject to final WTG locations, and subject to a case by case assessment.

Bushfires

Aerial firefighting operations will potentially be restricted in the vicinity of the Project, however there are valid ground-based means to support firefighting due to the construction of the access road network throughout the PA.

16.1.6

Mitigation Measures

The following mitigation measures will be implemented to manage potential aviation safety related impacts:

- WTG and monitoring mast heights and co-ordinates will be notified to CASA, DoD, ASA and AAAA as well as other aircraft operators in the region for inclusion in databases and navigational charts of the area;
- consideration will be given to marking the wind monitoring towers with bands of contrasting colour according to the requirements set out in MOS 139 Section 8.10 - Obstacle Markings;
- it is recommended the LSALT for airway W423 will be increased by 100 ft to 4,700 ft;
- prior to undertaking aerial application operations, if it is determined there is an unacceptable risk in operating fixed wing aircraft on properties adjoining the PA, helicopters should be utilised as they can operate in closer proximity to obstacles such as WTGs;
- the heights and co-ordinates of WTGs and wind monitoring masts will be provided to emergency services operating in the vicinity of the Project; and
- obstacle lighting is not considered to be required, however if obstacle lighting is ultimately installed it would be designed in a manner to reduce visual impact.

16.2

Electromagnetic Interference

16.2.1

Introduction

This section draws on the assessment of potential electromagnetic interference (EMI) issues associated with the Project, which is detailed in the EMI and EMF Assessment undertaken by DNV GL (2015b) and provided at *Annex N*. The assessment was undertaken to address the SEARs pertaining to EMI, outlined in *Chapter 1*, and having regard to the:

- *Draft National Wind Farm Development Guidelines* (EPHC 2010) (the Draft National Guidelines).

16.2.2

Methodology

The EMI assessment incorporated the following scope of work:

- a review of the radiocommunication licences held by the Australian Communications and Media Authority (ACMA) within 75 km of the PA relating to fixed point-to-point links, fixed point-to-multipoint links and radiocommunications assets belonging to emergency services;
- a review of the trigonometrical stations within 75 km of the PA;
- a review of the aviation and meteorological radar within 250 nm (463 km) of the PA;
- a review of the following communications:
 - broadcast television;
 - citizens band (CB) radio and mobile phones;
 - wireless internet;
 - broadcast radio; and
 - satellite television and internet; and
- liaison with organisations that have or may have communication equipment in the region (i.e. telecommunication companies, media companies, emergency services and government agencies).

16.2.3

Assessment of Impacts

Wind farms have the potential to affect the performance of radiocommunications services through the introduction of EMI. Services most likely to be affected include terrestrial broadcast signals and fixed point-to-point microwave signals. Terrestrial broadcast signals are commonly used to transmit domestic television, while microwave links are used for line-of-sight connections for data, voice and video.

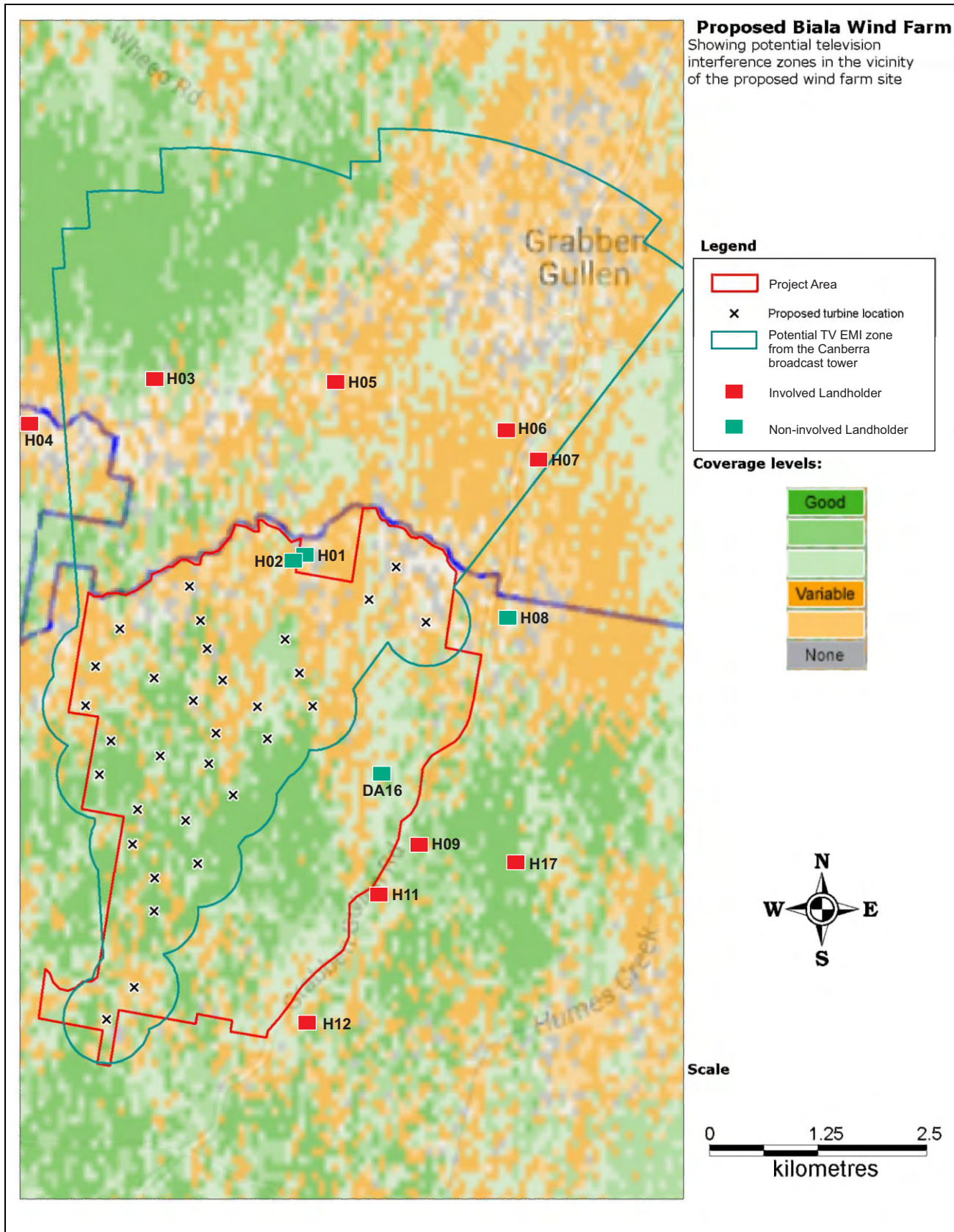
The ACMA database search identified 4321 telecommunication towers within a 75 km radius of the PA. The potential impact of the Project to each of the telecommunications licenses attached to these towers was assessed and the potential impacts are summarised below.

Terrestrial Television Broadcasting

Terrestrial television is broadcast in Australia by a number of networks, both public and commercial. All television broadcasts in NSW are now digital broadcasts, which are typically more robust in the presence of interference than analogue television signals. However, interference is possible particularly in areas of low signal strength.

The nearest broadcast tower is located at least 14 km north of the PA at Wades Hill, however this broadcast tower services the town of Crookwell, and is unlikely to be servicing residents in the vicinity of the PA. Upper Lachlan Shire Council has advised that it is in the process of constructing a new free-to-air television repeater in the town of Crookwell, however due to a lack of information regarding the new repeater, DNV GL was unable to assess the likely impact of the Project on broadcasting services from the repeater.

The main television transmitter used by residents in the vicinity of the PA is the Black Mountain transmitter near Canberra. A total of six dwellings within and in proximity to the PA were identified in the potential interference zone of the Black Mountain transmitter, refer *Figure 16-1*. Two of these potentially affected dwellings are involved landholders. It is expected that any interference to terrestrial television can be mitigated by improving the equipment at a dwelling location or other options as listed in *Section 16.2.4*.



Data Source:
Base Layer -
Author: DNV GL
Report: EMI and EMF Assessment
(170223-AUME-R-03) July 2015
Figure: B-14

Client: Newtricity
Drawing No: 0178462b_BWF_EIS_C004_R1.cdr
Date: 13/07/2015 Drawing size: A4
Drawn by: JC / GR Reviewed by: ED

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 16-1 - Potential Television Interference Zone

Biala Wind Farm
Environmental Impact Statement

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch,
Melbourne, Newcastle, Perth, Port Macquarie, Sydney



Fixed Point-to-Point (Microwave) Links

A review of the ACMA database shows that there are three links passing over the PA. Further analysis indicated that the link passing through the centre of the PA is close enough to ground level, such that four WTGs could potentially interfere with the signal. Consultation with the NSW RFS who operate one of the links was undertaken and an exclusion zone of 1 km wide plus one blade length established around each link. A total of 16 WTGs were found to lie within this exclusion zone. The link operators have indicated that they are willing to re-route the links, provided that specified conditions are met by the Project.

Fixed Point-to-Multipoint licences

A fixed point-to-multipoint licence allows communication between a registered static site and multiple unregistered points, or between static sites.

A review of the ACMA database indicated that there were 44 licenses within 75 km of the PA boundary. As the ACMA database only details the locations of static sites, transmission vectors for point-to-multipoint licenses are not readily identifiable and therefore, prediction of potential impacts is difficult.

There are two point-to-multipoint base stations listed in the ACMA database within 20 km of the PA and operated by the Upper Lachlan Shire Council. DNV GL consulted with Council to identify any potential interference issues that may arise from the Project, however Council was unable to confirm whether the services are likely to be affected. It is DNV GL's opinion that given the location of these stations, they are unlikely to be affected by the Project.

There are a number of point-to-multipoint stations at a distance of greater than 20 km from the PA. The potential risk of interference with links decreases with distance and therefore impacts to operators greater than 20 km from the PA are expected to be low. DNV GL has sought feedback from the operators of the majority of stations within 40 km from the centre of the PA, however no concerns have been raised to date.

Emergency Services

Emergency services with radiocommunications assets in the vicinity of the PA have been identified and have been consulted to assess the potential for adverse impacts to their services.

The closest radiocommunication asset belongs to the NSW RFS and is located approximately 5 km from the centre of the PA. Aside from the issues raised in relation to the fixed point-to-point link, no additional objections have been raised by the RFS.

The other radiocommunication assets belonging to emergency services are located at a distance greater than 18 km from the PA and it is considered unlikely that the Project will cause interference to emergency services' assets. DNV GL has sought feedback from the operators of services within 40 km from the centre of the PA, however no concerns have been raised to date.

Aviation Radar

The Draft National Guidelines (EPHC 2010) recommend that radar operators be notified of the development of wind farms within 250 nm (463 km) of aviation radar operators. Radar installations are typically located at major airports. The Project is located approximately 78 km from Canberra Airport and approximately 180 km from Sydney International Airport. It is understood that there is no radar installed at Goulburn Airport, which is located approximately 40 km south-east of the PA.

As discussed above, the Project is not located within the line of site of the nearby SSR facilities located at Mt. Bobara and Mt. Majura, however does fall within the line of site for the PSR located at Mt. Majura. The potential impacts associated with the aviation radar have been discussed previously discussed in *Section 16.1.5*.

Meteorological Radar

The Draft National Guidelines (EPHC 2010) recommend consultation is undertaken with operators of weather stations within 250 nm (463 km) of a wind farm development. The Bureau of Meteorology (BoM) operates eight weather stations within that range, with the closest station (Canberra) located approximately 117 km south south-east of the Project.

The Project is not expected to cause interference with BoM radar installations given the distance between the PA and radar installations and the nature of intervening terrain. The BoM has indicated that the proposed WTGs do not pose any interference risk to BoM radar system.

Trigonometrical Stations

A trigonometrical station, also known as a trig point or trig beacon is an observation mark used for surveying or distance measuring purposes. Some trig points may host surveying equipment such as GPS antennas and electronic distance measuring (EDM) devices.

The Global Navigation Satellite System (GNSS) network is comprised of permanent stations that provide the geodetic framework for the spatial data infrastructure in Australia. The closest GNSS station is located approximately 85 km south-west of the PA, at Mt. Stromlo near Canberra. Given the distance of the GNSS station from the PA, it is considered unlikely that the Project would interfere with the GNSS network.

A review of the Primary Geodetic Network of Australia indicated that there are 50 trig points within 20 km of the PA. Although it is unlikely that the trig points in close proximity to the Project will be susceptible to EMI, Geoscience Australia and NSW Land and Property Information (LPI) were consulted about the Project. Both parties have indicated that they do not expect any interference on their assets resulting from the Project and operation.

Citizens' Band Radio

Citizens' Band (CB) Radio is a two-way, short distance, communication service. All users of the CB radio operate within the same frequency range on a shared basis.

Given users of CB radio do not require a licence, there is no record of users of the service and their location and the channels are shared among the users and the repeater stations without a right of protection from interference. If interference is experienced it should be possible to improve signal quality by moving a short distance. In any event, the impact of the Project on CB radio is expected to be minimal.

Mobile Phones

In general, mobile phone signals are not susceptible to interference from WTGs. A review of mobile phone towers in the vicinity of the Project indicated that the nearest tower is located at least 13 km from the PA and therefore large scale interference to mobile phone signals is unlikely. Optus, Telstra and Vodafone have been contacted to request feedback on the potential impact of the Project on network coverage in the vicinity of the PA, however no concerns have been raised to date.

Wireless Internet

Wireless internet services are provided to customers in the vicinity of the Project by Yless4U, with one base station located near Goulburn, approximately 33 km from the PA. It is not possible to identify customers who are using the Yless4U Broadband service, however it is considered unlikely that this station will be servicing customers in the vicinity of the PA. Yless4U has been contacted to request feedback on the potential impact of the Project, however no concerns have been raised to date.

A review of the Australian Internet Service Providers (ISP) directory indicated there are four ISPs (NBNSP, Internode, AusBBS and iPrimus) that operate in the vicinity of the PA. According to the National Broadband Network Co. Ltd. the network to support these services is not expected for the next six months. Consequently, residents in the vicinity of the Project may also utilise Telstra Next G wireless broadband, which utilises the same network as the NextG mobile phone service. In summary, it is considered unlikely that the presence of WTGs would interfere with wireless internet services.

Satellite Television and Internet

In some rural or remote areas, television and internet access can only be provided through satellite services. A review of the line-of-sight between all useable television and internet satellites and potentially utilised by dwellings within and in proximity to the PA was undertaken. This review concluded that no WTGs intercept the line-of-sight of the television and internet satellites commonly used in Australia.

Radio Broadcasting

As Amplitude Modulation (AM) radio signals are able to propagate around obstructions such as WTGs, it is expected that the Project will not cause significant interference for any receivers. Frequency Modulation (FM) radio signals however, are susceptible to interference from buildings and other structures, which can result in hissing and distortion being heard by a listener. Any interference is likely to be limited to the immediate vicinity of the central southern portion of the PA and can be mitigated by the installation of a high quality antenna.

16.2.4

Mitigation Measures

To manage potential EMI issues, the following mitigation measures will be implemented:

- following construction, an assessment of the potentially affected dwellings, and at the request of the landholder of any other dwellings, will be undertaken to mitigate television reception impacts considered to be caused from the Project. Mitigation options to be considered will include a combination of the following:
 - realigning the householder's TV antenna more directly towards their existing transmitter;
 - tuning the householder's antenna into alternative sources of the same or suitable signal;
 - installation of more directional and/or higher gain antenna at the affected dwelling;
 - relocating the antenna to a less affected position;
 - installation of cable/satellite television at the affected dwelling; and
 - installation of a television relay station.
- any interference to radio broadcasting can be mitigated through the installation of a high quality antenna and/or amplifier;
- at the expense of the Proponent, the fixed point-to-point link within the PA operated by RFS will be re-routed to avoid any obstruction to the service; and

- the potentially affected point-to-point link operated by Council will be re-routed, with the Proponent to lodge an agreed bond amount at the request of Council and supply all relevant Project information to undertake the works.

16.3 Shadow Flicker

16.3.1 Introduction

This section draws on the assessment outcomes of the Shadow Flicker and Blade Glint Assessment undertaken DNV GL (2015C) and provided at *Annex O*. The assessment was undertaken to address the SEARs pertaining to shadow flicker, outlined in *Chapter 1*, and having regard to the:

- *Draft National Wind Farm Development Guidelines* (EPHC 2010) (Draft National Guidelines); and
- *Draft NSW Planning Guidelines for Wind Farms* (DP&I 2011) (Draft Wind Farm Guidelines).

Shadow flicker may occur under certain combinations of geographical position and time of day, when the sun passes behind the rotating blades of a WTG and casts a moving shadow over neighbouring areas. When viewed from a stationary position, the moving shadows appear as a flicker giving rise to the phenomenon of 'shadow flicker'.

16.3.2 Methodology

The duration of shadow flicker experienced at sensitive locations has been modelled using simple geometric analyses, which takes into account the relative position of the sun throughout the year, the location of WTGs at the site, and the viewer. Calculations were carried out assuming dwellings had either one or two storeys, with window heights of either 2 m or 6 m respectively. The relevant shadow flicker duration at a dwelling was taken as the maximum occurring within 50 m of the centre of a dwelling.

The modelling conducted represents a conservative scenario and over-estimates the actual annual hours of shadow flicker experienced at any location. Therefore, an attempt has been made to quantify the likely reduction in shadow flicker duration due to variation in WTG orientation and cloud cover, and to produce a prediction of the actual shadow flicker duration likely to be experienced at any dwelling. The Draft Wind Farm Guidelines (DP&I 2011) recommend that shadow flicker experienced at a dwelling should not exceed 30 hours per year.

The health related impacts of shadow flicker, and the notion of blade glint have been addressed separately under health impacts in *Section 16.5*.

16.3.3 Assessment of Impacts

The results of the theoretical assessment, as recommended by the Draft National Guidelines (EPHC 2010), indicate that there are four existing dwellings (H01, H02, H08 and H10) and one unbuilt dwelling (DA16) that have the potential to be affected by shadow flicker (refer to *Figure 16-2*). These dwellings, including the unbuilt dwelling, are owned by involved landholders. The four existing dwellings are calculated to experience theoretical shadow flicker within 50 m of the dwelling at durations greater than the recommended limit of 30 hours per year outlined in the Draft National Guidelines and Draft Wind Farm Guidelines (DP&I 2011). Predicted shadow flicker at DA16 was calculated below the recommended limit of 30 hours per year.

When the reduction of shadow flicker due to WTG orientation and cloud cover is taken into consideration, the same four existing dwellings (involved landholders) are expected to experience shadow flicker greater than the recommended limit of ten hours actual duration per year, as outlined in the Draft National Guidelines. Whilst the Draft National Guidelines recommend that only reductions due to cloud cover be included, DNV GL considers the additional reduction due to WTG orientation is appropriate, as the projected area of the WTG

and the associated expected shadow flicker duration, is reduced when the WTG rotor is not perpendicular to the line joining the sun and dwelling. For this reason, the predicted actual results would be further reduced.

The results of the theoretical and predicted actual shadow flicker durations for dwellings affected by shadow flicker are summarised in *Table 16-3*. Newtricity has approached the landholders of the four dwellings where the shadow flicker limits are predicted to be exceeded, and have obtained agreement from the landholders that the predicted shadow flicker durations are acceptable.

All other dwellings within 3 km of the PA were assessed and are not expected to be affected by shadow flicker.

Table 16-3

Theoretical and Predicted Actual Annual Shadow Flicker Durations for Dwellings Affected by Shadow Flicker

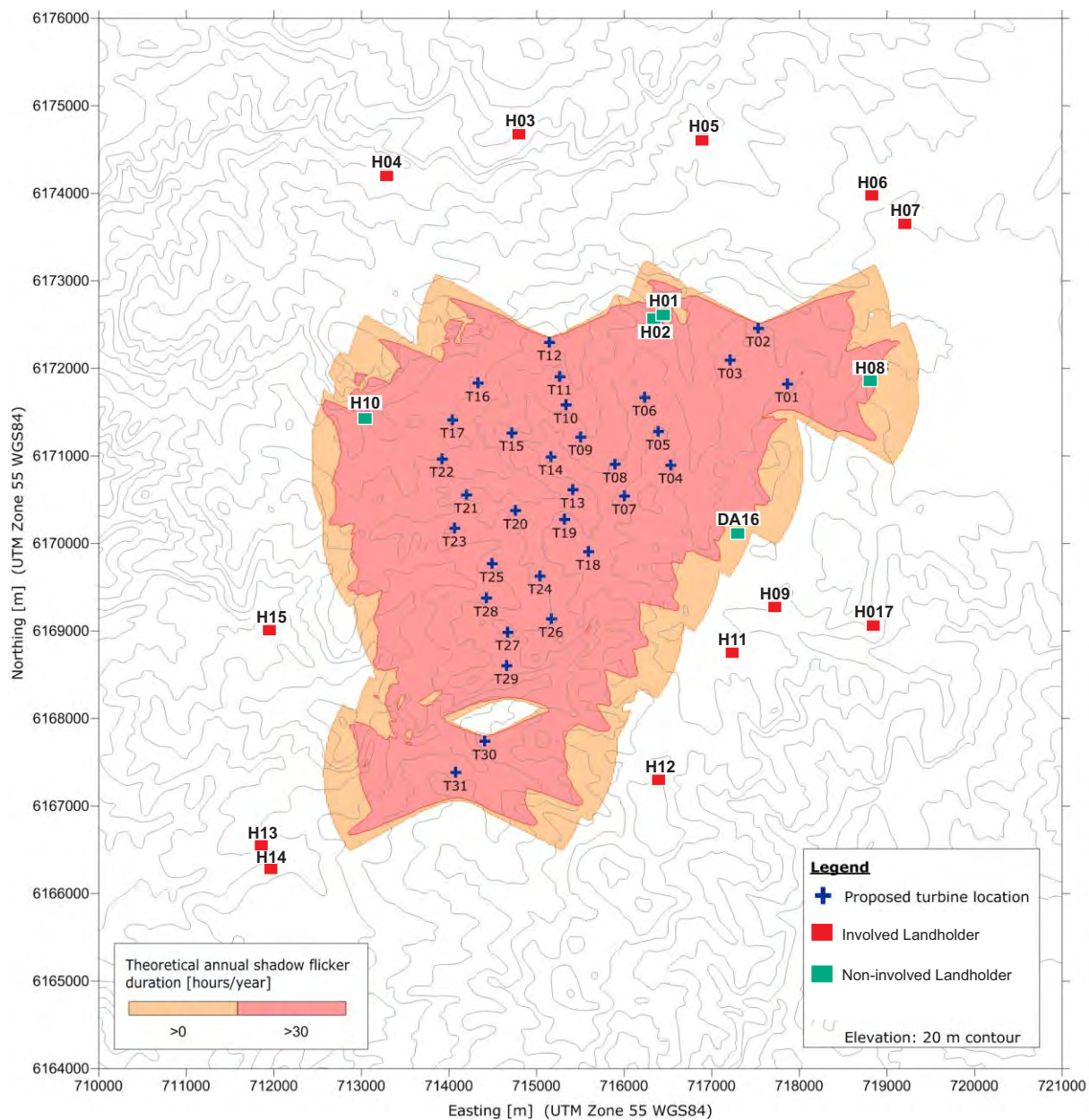
House ID	Contributing WTGs	Theoretical				Predicted Actual	
		At dwelling (hr/yr)		Max within 50 m of dwelling (hr/yr)		Max within 50 m of dwelling (hr/yr)	
		SF at 2m	SF at 6m	SF at 2m	SF at 6m	SF at 2m	SF at 6m
H01	T02, T12	27.8	29.6	32.2	31.8	11.0	10.9
H02	T02, T03, T12	29.0	29.8	51.8	51.7	18.5	18.6
H08	T01, T02	31.4	30.3	35.0	33.6	21.1	11.6
H10	T16, T17, T22,	51.8	52.7	70.4	70.8	25.7	26.0
DA16	T07	9.4	9.0	10.4	10.0	4.0	3.8
Limits		30		30		10	
*Results outlined in bold represent and exceedance above the guideline limit.							

16.3.4

Mitigation Measures

The following mitigation measures will be investigated and implemented in consultation with involved landholders affected by shadow flicker:

- installation of screening structures or the planting of trees to block shadows cast by the WTGs; and
- the use of WTG control strategies which shut down WTGs when shadow flicker is likely to occur or relocation of the WTG.



Data Source:
Base Layer -
Author: DNV GL
Report: Shadow Flicker and Blade Glint Assessment
(170223-AUME-R-02-D) June 2015
Figure: 6

Client: Newtricity
Drawing No: 0178462b_BWF_EIS_C005_R1.cdr
Date: 14/07/2015 Drawing size: A4
Drawn by: JC / GR Reviewed by: ED

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 16-2 - House Locations in Relation to the Theoretical Shadow Flicker Duration within 50 m of a Dwelling at a Height of 2 m

Biala Wind Farm
Environmental Impact Statement
Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch,
Melbourne, Newcastle, Perth, Port Macquarie, Sydney



16.4 Blade Throw

16.4.1 Introduction

This section draws on the assessment outcomes of the Blade Throw Risk report prepared by DNV GL (2015d) and provided at *Annex P*. The assessment was undertaken to address the SEARs as outlined in *Chapter 1*.

Blade throw refers to the rare phenomenon of a structural failure in a WTG blade during operation, resulting in the ejection of projectiles into the surrounding area. Although occurrences of blade throw are considered rare, the consequence of a blade throw event may be serious.

16.4.2 Assessment of Impacts

The assessment found that the risk of death, personal injury or damage to property from a blade throw event is extremely small and well within the risk levels typically deemed acceptable to society, given that:

- modern WTGs are typically certified to international standards to ensure structural integrity and safe operation over the lifetime of the WTG;
- modern WTGs integrate sophisticated lightning protection systems and are designed to shut down during high wind speed conditions and in response to a range of faults; and
- high quality operation and maintenance programs are typically implemented for wind farm developments to ensure that faults are prevented or detected and rectified promptly.

The assessment noted that the separation distance between the nearest dwelling and a proposed WTG was 900 m, which is considered sufficient to mitigate the risk of damage to life or property to an acceptable level.

16.4.3 Mitigation Measures

The following mitigation measures will be implemented to manage the risk of blade throw:

- the WTG model selected for the Project will be certified to the relevant international standards and have an adequate lightning protection system and shutdown system; and
- an ongoing operation and maintenance program will be implemented throughout the lifetime of the Project.

16.5 Health

16.5.1 Introduction

The concept of wind farm developments and the potential impact they have on human health has been extensively studied in recent times. In particular, the National Health and Medical Research Council (NHMRC) released the NHMRC Statement: Evidence on Wind Farms and Human Health on 11 February 2015. This Statement updates previous work undertaken by NHMRC and is based on the findings of an independent assessment of the scientific evidence on wind farms and human health outlined in the *NHMRC Information Paper: Evidence on Wind Farms and Human Health* (NHMRC 2015b). The Statement concludes as follows (NHMRC 2015a):

'There is no direct evidence that exposure to wind farm noise affects physical or mental health. While exposure to environmental noise is associated with health effects, these effects occur at much higher levels of noise than are likely to be perceived by people living in close proximity to wind farms in Australia. The

parallel evidence assessed suggests that there are unlikely to be any significant effects on physical or mental health at distances greater than 1,500 m from wind farms.

There is consistent but poor quality direct evidence that wind farm noise is associated with annoyance. While the parallel evidence suggests that prolonged noise-related annoyance may result in stress, which may be a risk factor for cardiovascular disease, annoyance was not consistently defined in the studies and a range of other factors are possible explanations for the association observed.

There is less consistent, poor quality direct evidence of an association between sleep disturbance and wind farm noise. However, sleep disturbance was not objectively measured in the studies and a range of other factors are possible explanations for the association observed. While chronic sleep disturbance is known to affect health, the parallel evidence suggests that wind farm noise is unlikely to disturb sleep at distances of more than 1,500 m from wind farms.

There is no direct evidence that considered the possible effects on health of infrasound or low frequency noise from wind farms. Exposure to infrasound and low-frequency noise in a laboratory setting has few, if any, effects on body functions. However, this exposure did not replicate all of the characteristics of wind farm noise as it has generally been at much higher levels and of short duration.

Although individuals may perceive aspects of wind farm noise at greater distances, it is unlikely that it will be disturbing at distances of more than 1,500 m. Noise from wind farms, including its content of low-frequency noise and infrasound, is similar to noise from many other natural and human-made sources.'

The Draft Wind Farm Guidelines and SEARs issued for the Project, require consideration of the potential impact of the Project on the health of nearby residents, particularly those located within 2 km of a proposed WTG. As noted previously in the EIS, there are no dwellings associated within non-involved landholders within 2 km of a proposed WTG and therefore, having regard to the NHMRC Statement released in February 2015, the Project is unlikely to cause adverse health effects to surrounding residents.

Nonetheless, the following assessment involved a review of available literature pertaining to health impacts associated with wind farm developments and consideration of impacts drawing on conclusions from the:

- noise and vibration assessment (refer Chapter 10);
- shadow flicker and blade glint assessments (refer Section 16.3); and
- EMF assessment (refer Section 16.5.2).

16.5.2 Assessment of Impacts

Concerns regarding the potential effects that wind farm developments have on human health are generally associated with:

- audible noise;
- inaudible and low frequency noise;
- shadow flicker and blade glint; and
- electromagnetic emissions.

These aspects are discussed in more detail in the following sections.

Audible Noise

Concerns have been raised that audible noise generated by wind farm developments causes annoyance and sleep disruptions to residents located within proximity to WTGs.

Environmental noise policies, including those applied to wind farm developments, establish noise criteria at levels to address potential impacts on health. More precisely, the noise criteria defined under such policies including the *Wind Farm Environmental Noise Guideline* (SA EPA 2003) specify compliance levels to prevent direct physiological impacts caused from noise, and minimise as far as practicable, potential impacts such as sleep disruption and annoyance.

As outlined in *Chapter 10*, predicted noise levels at all dwellings (involved and non-involved landholders) in the vicinity of the Project are expected to be below the relevant compliance limits at each dwelling location. At a minimum, the noise compliance limits at all non-involved landholder dwellings was set at 35 dBA, while the noise compliance limits for the involved landholder dwellings was set at a minimum of 45 dBA in accordance with the SA EPA Wind Farm Environmental Noise Guideline.

It is acknowledged that concerns have been raised by people indicating that wind farm noise can cause them annoyance. A study undertaken by Pederson & Persson (2007) however, found that annoyance generated by wind farm noise was strongly correlated to a person's negative perception towards wind farm developments, particularly their visual impacts. Pederson & Persson (2007) stated that:

"visual exposure enhances the negative associations with turbines when coupled with audible exposure."

In light of the above, the Project is not expected to generate audible noise levels that would impact on a person's sleep or cause annoyance to involved or non-involved landholders in the vicinity of the Project.

Low Frequency Noise, Infrasound and Ground Vibration

Whilst audible noise generated from wind farms and other developments is readily calculated and assessed, attention has also been driven towards low frequency noise, vibration and infrasound emissions from WTGs and the associated potential impacts on human health.

Infrasound is generally defined as sound that is lower than 20 Hertz (Hz), which is considered to be the threshold of human hearing, whilst low frequency noise is generally regarded as sounds above 20 Hz and extending upwards into the range of 100-200 Hz. These types of sounds are an everyday occurrence in our surroundings, occurring from a wide range of sources such as wind, ocean movement and man-made sources including domestic appliances, transportation and agricultural equipment.

Claims have been made that low frequency noise and vibration generated from WTGs have caused illness and other physiological effects among a few people living in proximity to wind farms (*Standards of New Zealand 6808:2010 Acoustics-Wind Farm Noise*). There is currently little evidence to support such claims. In a report prepared by Bowdler et al (2009) and published in the Institute of Acoustics Bulletin, they stated:

"At separation distances from wind turbines which are typical of residential locations the levels of infrasound from wind turbines are well below the human perception level. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles. Sounds at frequencies from about 20Hz to 200Hz are conventionally referred to as low frequency sounds. A report for the DTI in 2006 by Hayes McKenzie concluded that neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived."

Sonus (2010) demonstrated that infrasound and low frequency sound produced by regularly encountered natural and man-made sources, such as wind or distant traffic, is comparable to that of modern WTGs. To this end, the SA EPA (2013) concluded that measured infrasound levels, both near to and at considerable distances away from, wind farm developments were no higher than those measured at typical urban and rural environments, and were well below the perception thresholds.

In relation to ground vibration emitted from the operation of WTGs, a study undertaken by Keele University (no date) concluded that:

"Whilst it is technically correct that 'vibrations can be picked up as far away as 10 km', to give the impression that they can be felt at this distance is highly misleading. The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect."

The NSW Health Service appears to agree with the available literature on potential health impacts linked with wind farm developments. In their submission to DP&I (now DP&E) during the public exhibition of the *Draft NSW Planning Guidelines: Wind Farms (DP&I 201)*, they stated that:

"NSW Health advises that there is currently no health evidence to support a generic 2 km separation distance from a proposed wind turbine. Mandatory enhanced assessment of potential impacts for neighbours within a 2 km radius of proposed wind turbines needs to be justified on non-Health grounds."

Based, on the above literature, low frequency noise, infrasound or vibration generated from the Project is not expected to cause adverse health effects to nearby residents.

Shadow Flicker and Blade Glint

The visual health effects generated by wind farm developments are associated with shadow flicker and blade glint. Shadow flicker has the potential to cause annoyance to people occupying affected dwellings, potentially leading to increased stress levels. Further, in some cases, the flickering effect, if bright enough, has the potential to pass through closed eyelids therefore affecting daytime sleep patterns. The NHMRC noted that in very rare cases, the impact is considered to have the potential to induce photosensitive epilepsy seizures (NHMRC 2010).

As discussed in *Section 16.3*, four involved landholder dwellings (H01, H02, H08 and H10) are expected to be affected by shadow flicker at levels exceeding the recommended limit of 30 hours per year, as outlined in the *Draft National Guidelines (EPHC 2010)* and *Draft Wind Farm Guidelines (DP&I 2011)*. Newtricity has approached the landholders of these four dwellings where the shadow flicker limits are predicted to be exceeded, and have obtained agreement from the landholders that the predicted shadow flicker durations are acceptable.

Blade glint can occur when sun is reflected from WTG blades. The occurrence of blade glint depends on a combination of factors including the orientation of the nacelle, angle of the blade, angle of the sun and the reflectiveness of the surface of the blade. Blade glint is generally not a problem for modern wind farms, provided non-reflective coatings are used for the surface of the blades.

Electromagnetic Emissions

Electromagnetic fields (EMF) and electromagnetic radiation (EMR) are two sources of electromagnetic emissions from wind farm electrical equipment, which includes WTGs, electrical cabling and the on-site substation. Exposure to EMF and EMR at high levels is considered to cause potential adverse health effects.

Potential impacts from EMF and EMR associated with the Project were assessed by DNV GL in the EMI and EMF Assessment (2015b) (refer *Annex N*). The assessment was undertaken to address the SEARs as outlined in *Chapter 1*.

Electromagnetic Fields

EMF are produced by both natural and artificial sources, however artificial sources are the dominant sources of EMF and are usually associated with the generation, distribution and use of electricity at the frequency of 50 Hz. The NHMRC (1989) has issued interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields, which are aimed at preventing immediate health effects from exposure to these fields. DNV GL (2015b) concluded that EMF emitted from WTGs will be well below the NHMRC interim guidelines for exposure to EMF.

As outlined in the SEARs, demonstration of the application of Prudent Avoidance is required in reducing electromagnetic exposures where feasible and applicable. The 33 kV electrical reticulation network for the Project is predominantly comprised of underground electrical cabling and is likely to involve three core cables arranged close together in a trefoil manner to aid in reducing EMF. A small section of overhead electrical cabling (approximately 900 m) connecting WTG T29 and T30 is required due to ground constraints. DNV GL (2015e) has advised that the likely route of the overhead cabling (connecting T29 and T30) is in a remote area that is infrequently inhabited by people, therefore minimising the risk of EMF exposure.

In summary, the EMF emitted from the 33 kV electrical reticulation network within the PA will not pose a particular risk and is considered to demonstrate the application of the principles of Prudent Avoidance.

EMF from other components associated with a wind farm development, including the substation, are expected to be typical of similar installations used elsewhere, and therefore are not considered to pose a particular risk to human health.

Electromagnetic Radiation

Common sources of unwanted electromagnetic radiation that may be found in WTGs include switch mode power supplies, microprocessors and variable speed drives, which are devices also commonly found in homes and workplaces.

WTGs are constructed to meet stringent standards in terms of electrical compatibility. Electrical equipment sold in Australia and New Zealand must meet certain requirements with respect to Electromagnetic Capability (EMC) including the *IEC 61400-6-4*, a standard developed by the International Electro Technical Commission (IEC).

DNV GL has performed electromagnetic emissions testing on WTGs in Denmark, with the only emissions detected being inside the WTG tower and no emissions detected outside the WTG. DNV GL (2015b) highlighted the following:

- devices that are likely to cause electromagnetic emissions are located inside the metallic panels of the WTG, which act as a shield to the external environment;
- there is a strong incentive on WTG manufacturers to control electromagnetic emissions at the source, as WTGs themselves contain sensitive electronic components that may themselves be affected by electromagnetic radiation; and
- despite a large number of wind farm developments being installed, DNV GL is not aware of any issues in the public domain where health problems have arisen due to electromagnetic emission from WTGs.

Given that WTGs are designed to meet the stringent standards as described above, it is considered unlikely that electromagnetic emissions from WTGs will pose any adverse impacts on human health in proximity to the Project.

16.5.3 Mitigation Measures

The assessment of potential health issues did not identify any effects from the Project that have the potential to cause adverse health impacts. Notwithstanding this, the following measures will be implemented:

- WTG blades will be coated with a non-reflective finish to avoid the occurrence of blade glint;
- the mitigation measures pertaining to potential noise impacts as outlined in *Chapter 10* will be implemented; and
- the WTG model ultimately selected for the Project will meet the relevant Australian design and safety standards.

16.6 Bushfire Risk

16.6.1 Introduction

This section draws on the assessment of potential bushfire hazards and risks associated with the Project, which is detailed in the Bushfire Hazard and Risk Assessment undertaken by ERM (2015f) and provided at *Annex Q*. The assessment was undertaken to address the SEARs pertaining to bushfire, outlined in *Chapter 1*, and having regard to the following relevant legislation and government policies:

- *Rural Fires Act 1997*;
- *Draft NSW Planning Guidelines for Wind Farms* (DP&I, 2011); and
- *Planning for Bushfire Protection (PBP) 2006* (RFS 2006).

The objectives of the assessment are to ensure:

- no human life is lost or person injured as a result of bushfire arising from the construction, operation and maintenance of the Project; and
- infrastructure and property is not significantly damaged from bushfire arising from the construction, operation and maintenance of the Project.

16.6.2 Methodology

The following scope was undertaken in the assessment process:

- identify the assets within and surrounding the PA requiring protection;
- identify the bushfire risk factors such as bushfire history and known bushfire behaviour in the PA and within the surrounding lands;
- map the bushfire hazard at a site specific scale following the relevant guidelines;
- assess (likelihood and consequence) and evaluate bushfire risk to and from the Project following the AS/NZS ISO 31000:2009 risk management process; and
- produce risk mitigation and management treatments and satisfy PBP (NSW RFS 2006) requirements.

16.6.3 Existing Environment

The Southern Tablelands Zone Bushfire Management Committee (BFMC) area covers the PA and has on average 265 bushfires per year, of which five are considered large scale fires. Major fires (defined as a bushfire that requires the attendance of multiple brigades, or causes damage to property or injury to one or more persons) occur sporadically with about three in a five year

period. Generally, major fires occur in a cycle of five to seven years (Southern Tablelands Zone BFMC 2009).

An analysis of the fire weather experienced in the locale and the surrounding region provides insight into bushfire behaviour potential. As outlined within PBP (NSW RFS 2006), the 1:50 year fire weather scenario for most of the State was determined as Fire Danger Index (FDI) =80 however, a number of areas including the Greater Sydney, Greater Hunter, Illawarra, Far South Coast and Southern Ranges Fire Areas have higher FDIs, which are set at 100. A FDI of 100 has been used to inform bushfire behaviour on the PA. Prevailing weather conditions associated with the bushfire season in the Southern Tablelands Zone BFMC area are north/north-westerly winds, although in late afternoons southerly and easterly winds may occur for short periods. Lightning strikes during storms occur frequently in the bushfire season.

The ridgelines on which the WTGs are located vary in gradient from less than 5 degrees (°) in some areas to over 10° in others. The majority of the slopes leading up to the WTGs are in a range of less than 5° up to 15° gradient. As the WTGs are specifically located along ridgelines, all directly adjacent lands are on a downslope gradient away from the WTGs.

The Project is set amongst a historically cleared landscape where rolling hills dominate and the majority of native vegetation has been partially or fully cleared for grazing and cropping activities. However, patches of woodland and open forest remain. The Bushfire Hazard and Risk Assessment (ERM 2015f) identified assets that occur within and surrounding the PA and describes the locality of the identified assets in terms of the bushfire hazard present. A summary is presented in *Section 16.6.4*.

16.6.4 Assessment of Impacts

Bushfire hazard classes were identified across the landscape by applying relative weightings to the varying fuel groups (refer *Annex Q*) and combining them with available slope classes (i.e. <5°, 5-10°, 10-15°, 15-20°, >20°) within a Geographic Information System (GIS) model. The vegetation fuel load and slope data sets were loaded into a Weighted Overlay Model to combine the data and highlight areas of overall higher hazard. The low availability of fuels across the landscape combined with the dominance of cleared grazing land and numerous roads (which act as fire breaks) would reduce the likelihood of a severe or widespread fire and the PA is mapped as predominantly low bushfire hazard (refer to *Figure 16-3*). It is important to note that there are residential dwellings on rural properties scattered throughout the landscape that may be at risk from fire.

The risk of fire from a wind farm is low. WTGs have a variety of on-board control systems specifically designed to mitigate the risk of fire. The Project will be controlled by a remote supervisory control and data acquisition (SCADA) from a control room located within the permanent site operations and maintenance facility. The SCADA system will allow remote operation of all WTGs with the ability to shut-down individual or all WTGs if required. WTGs also automatically shut down if they are close to functioning outside their design conditions such as wind speeds typically greater than 25 m/s. The risk of fire starting as a result of a lightning strike is actually reduced by the presence of WTGs through the built-in lightning protection system, which safely dissipates the electricity from the blades or the nacelle into the ground.

Wind farm developments generally require upgrades to existing road infrastructure and construction of access roads to WTGs, increasing the accessibility of farmland to emergency vehicles should a bushfire break out in the vicinity of the wind farm. A Fire Management and Emergency Response Plan will be prepared, in consultation with the local RFS, including an assessment of the existing road network and adequacy of the existing fire breaks.

In terms of potential impacts upon the Project, there will be no WTGs or supporting infrastructure located within areas mapped as high or extreme bushfire hazard, and all WTGs are located within areas mapped as low bushfire hazard. Each WTG will be mounted on a concrete foundation (approximately 25 m by 25 m) and located on a cleared hardstand area. The hardstand will remain in-situ after construction and provide a minimum 10.5 m wide fuel free zone surrounding each tower (based on a tower base of 4 m diameter). An additional hardstand will be required adjacent to the base of each WTG to enable the assembly and erection of the WTG providing a possible 90.5 m of defendable space at each WTG.

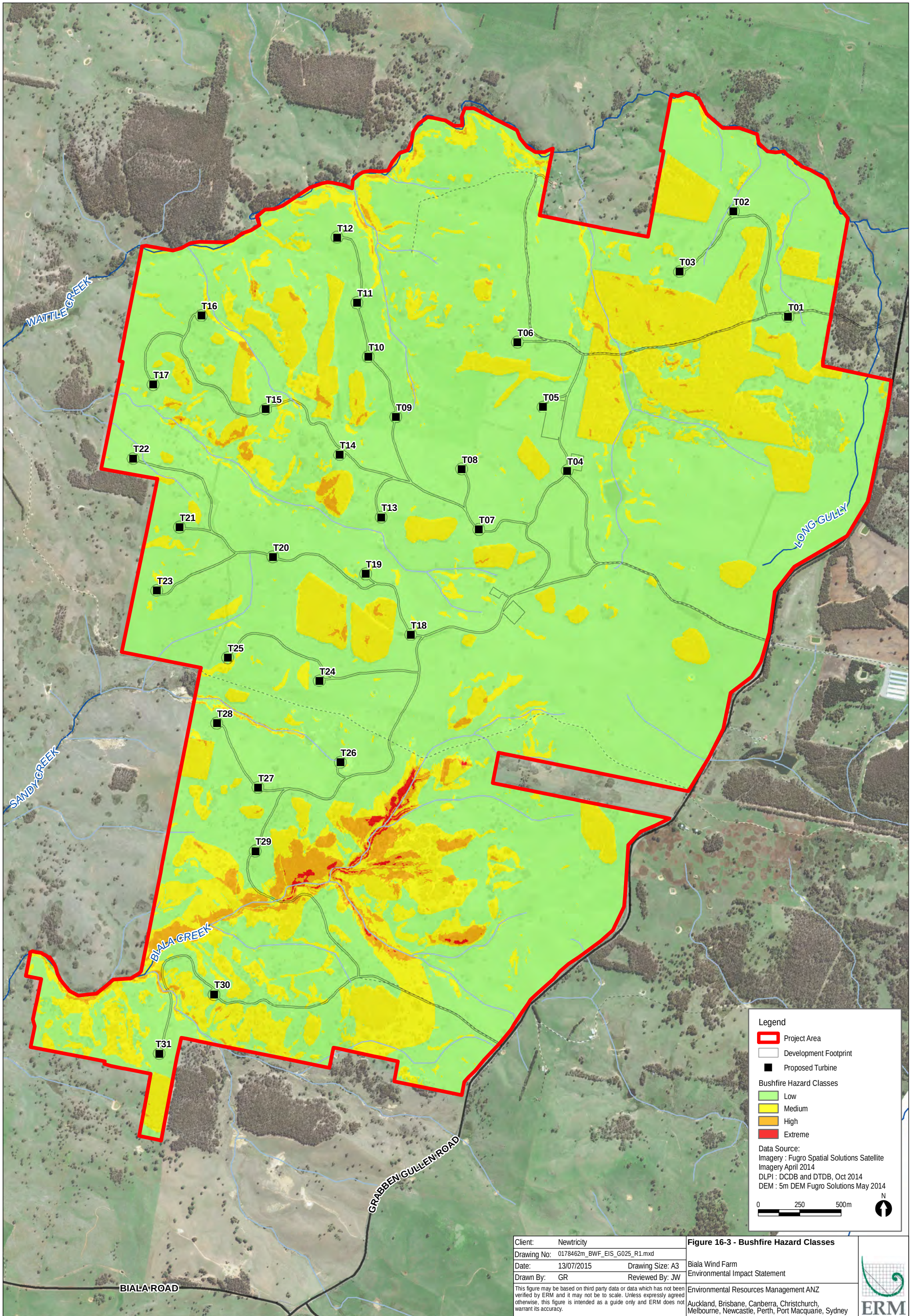
While installation of WTGs may remove the option of aerial suppression of fires over the wind farm itself, the alternative management practices as recommended will take advantage of some of the Project infrastructure and aim to improve the overall fire control capabilities. In the unlikely event that a fire did spread from the PA to surrounding properties, the WTGs would not limit aerial fire-fighting capabilities on other properties in the surrounding area.

The RFS and Australasian Fire and Emergency Services Council (AFAC) have worked together to develop a national position on WTGs (AFAC 2014). This position paper also concludes that WTGs are not expected to increase risks due to wind turbulence or the moving blades. Local wind speeds and direction are already highly variable across landscapes affected by turbulence from ridgelines and tall trees.

Assuming a fire 'escapes' the PA, there is a low to medium risk of fire (adversely) affecting surrounding life, property and environment. The highest risk rating scored was medium, being:

- the possible chance of fatalities or major injuries to life within or surrounding the PA; and
- the possible chance of widespread damage to infrastructure within or surrounding the Project.

It is these identified bushfire risks that require specific management and mitigation (treatment) measures as outlined in *Section 16.6.5*.



16.6.5

Mitigation Measures

The following measures will be implemented to manage potential bushfire related impacts during construction, maintenance and operation of the Project:

- a Bushfire Management and Emergency Response Plan will be prepared in consultation with the RFS and other relevant stakeholders, prior to the commencement of any construction;
- fire weather to be monitored daily on the RFS website. Fire weather to be displayed on-site and activities modified accordingly;
- locate electricity services to limit the possibility of ignition of surrounding bushland or the fabric of buildings and undertake regular inspections of lines to ensure they are not fouled by branches, as per the performance criteria and acceptable solutions of PBP (NSW RFS 2006);
- maintain a reduced fuel zone (APZ or defendable space) around each of the WTGs, substation and compounds to ensure adequate defendable space in accordance with the performance criteria and acceptable solutions of PBP (NSW RFS 2006);
- appropriate location of water access points will assist safe, effective and timely fire suppression activities. To ensure adequate access to water for RFS and fire-fighting crews, the allocation of static water supplies is necessary and will be further detailed in the Bushfire Management and Emergency Response Plan. A water supply reserve dedicated to fire-fighting purposes should be installed and maintained as per the performance criteria and acceptable solutions of PBP (NSW RFS 2006). It is recommended that as a minimum 30,000 litre water tanks, dams or other static water supplies are to be provided across the PA. The exact number and location will be confirmed in consultation with the local RFS and detailed in the Bushfire Management and Emergency Response Plan;
- provide and maintain public and property access roads as per the performance criteria and acceptable solutions of PBP (NSW RFS 2006). This includes, but is not limited to, ensuring that fire fighters are provided with safe all weather access to structures, that public road widths, design and capacity allow for fire fighter access and resident evacuation, and that roads are clearly signposted;
- safe working procedures and emergency response procedures should be developed and strictly implemented for all work tasks, with all employees and visitors involved in the operation and maintenance of the Project routinely trained in the safe operating procedures and the basic first response fire-fighting techniques including:
 - maintaining a 10 m wide fuel reduced zone around construction activities that may result in ignition of a fire e.g. welding;
 - ignition creating activities such as welding should not be undertaken on days of total fire ban;
 - communication and reporting requirements such as alerting emergency crews (000) and reporting details of location, size, proximity to assets and access capabilities. Reporting procedures and mechanisms should be efficient and simple to ensure that potential issues are identified, inspected and rectified in a timely manner;
 - maintaining provision for mobile telephone and UHF radio communications;
 - use of 4WD striker unit (to be available on site daily during the construction and maintenance phases of the Project);
 - use of a dedicated 10,000 litre tanker (to be available on site daily during the construction phase of the Project); and
 - use and location of extinguishers, knap-sacks and hoses.

Residual Risk

Despite the treatments that are put in place (above) some bushfire risk will remain (residual risk) and it is important that an Bushfire Management and Emergency Response Plan is prepared in accordance with the Guide to Developing a Bushfire Evacuation Plan (NSW RFS, 2004) and the AS 3745:2010 - Planning for Emergencies in Facilities. The emergency plan should be developed in conjunction with relevant stakeholders, including local fire services, adjoining property owners and employees.

16.7

Conclusion

An assessment of potential hazards and risks associated with the Project concluded that:

- potential impacts on aviation safety and aerial agricultural operations can be readily mitigated to promote safe aviation activities in proximity to the Project;
- for dwellings potentially affected by interference to television reception, an assessment of the potentially affected dwellings, and at the request of any landholders of other dwellings, will be undertaken to mitigate impacts considered to be caused by the Project;
- other communications services including radio broadcasting, mobile phones, internet and CB radio are unlikely to be affected by the Project;
- potential shadow flicker impacts, which exceed the recommended limit of 30 hours per year, are confined to four dwellings owned by involved landholders. Signed agreements from these affected landholders have been obtained by Newtricity and mitigation measures will be implemented where feasible and applicable at the request of the landholder;
- based on the literature available, there is no consistent evidence that wind farm developments cause adverse health effects in humans. As such, the Project is not expected to impact on the health of residents surrounding the PA; and
- the risk of bushfire from wind farm developments is considered low given the on-board control systems designed to mitigate the risk of fire. All WTGs are located in areas mapped as low fire hazard and with the implementation of the prescribed measures, the risk of bushfire can be effectively managed.

17 CUMULATIVE IMPACTS

This chapter discusses the potential cumulative impacts arising from the Project and outlines the required mitigation measures to manage any adverse cumulative impacts.

17.1 Introduction

This chapter draws on the relevant assessments undertaken as part of the preparation of this EIS, which have identified and addressed potential cumulative impacts. These include biodiversity (refer *Chapter 9*); noise and vibration (refer *Chapter 10*); landscape and visual (refer *Chapter 11*), traffic and transport (refer *Chapter 13*) and socio-economic (refer *Chapter 15*), as well as the specialist assessments which informed these chapters.

17.2 Existing and Proposed Wind Farms

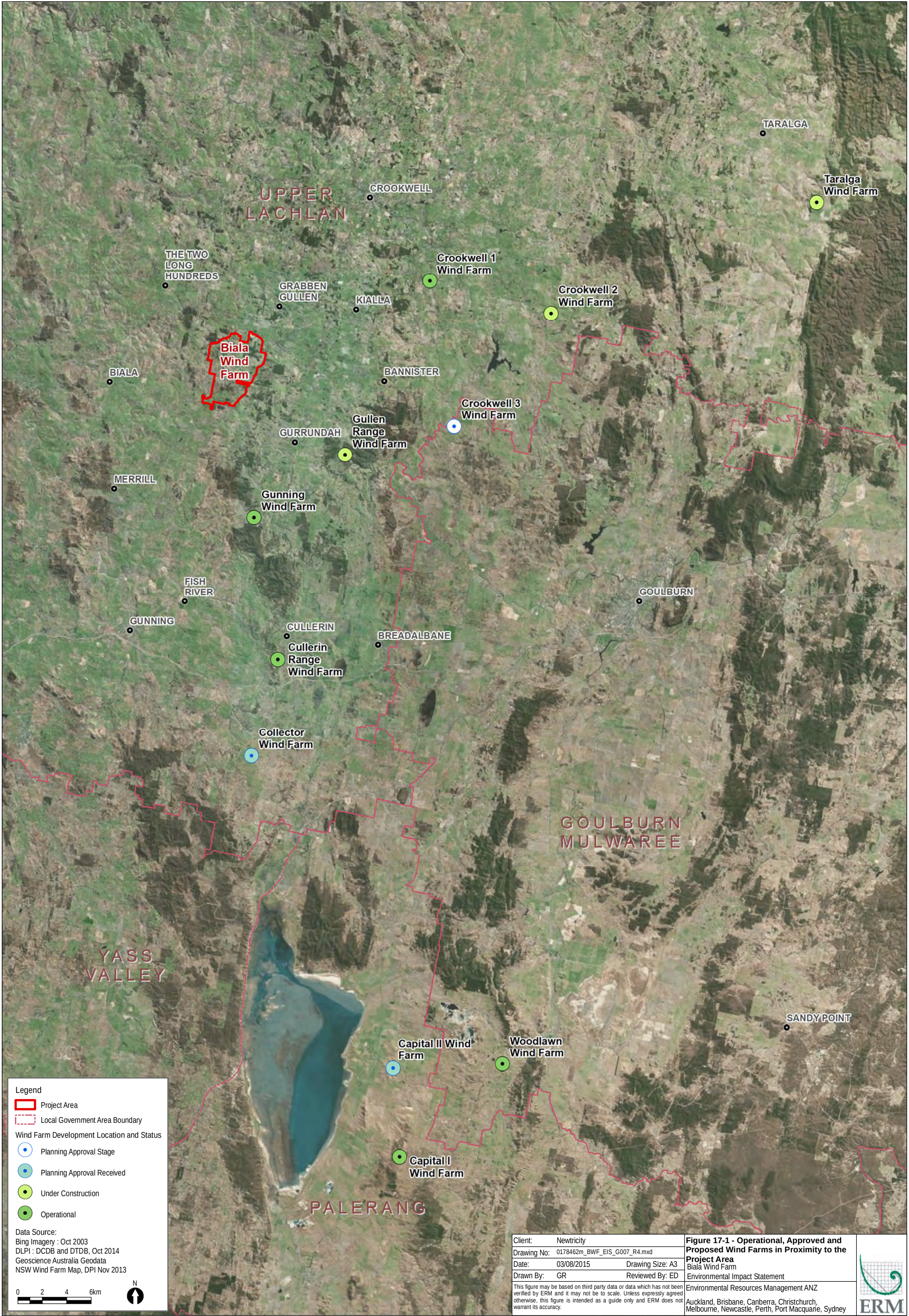
To adequately assess potential cumulative impacts there is a requirement to identify other existing and proposed wind farms and other developments (e.g. transmission line infrastructure) within the vicinity of the Project.

Given the suitability of the Southern Tablelands region for wind energy developments, there are several operational, approved or proposed wind farms within the vicinity of the proposed site for the Biala Wind Farm. A summary of the operational and proposed wind farms near the PA is provided in *Table 17-1* and the locations of these wind farms in relation to the PA is shown in *Figure 17-1*. A number of other proposed wind farms may be in feasibility, planning and investigation stages however, this provides a synthesis of the publically available information.

There are other proposed wind farm developments beyond a 15 km radius from the PA, however they are not considered to contribute to any cumulative impacts associated with the Project, should they be approved and constructed.

Table 17-1 *Operational, Approved and Proposed Wind Farms in Proximity to the Project Area*

Wind Farm	Status	Size (WTGs or MW)	Approximate Distance and Direction from the Biala Wind Farm
Gullen Range ¹	Under construction	73 WTGs; 165.5 MW	5.5 km east
Gunning ²	Operational	31 WTGs; 46.5 MW	7.2 km south-east
Crookwell 1	Operational	8 WTGs	16.1 km north-east
Crookwell 2 ³	Under construction	46 WTGs; 92 MW	15 km east
Crookwell 3 ⁴	Planning approval stage	30 WTGs; 54-102 MW	15 km east
Cullerin Range ⁵	Operational	31 WTGs	20.9 km south
Collector	Planning approval received	55 WTGs	25 km south
Taralga ⁶	Under construction	51 WTGs	45.9 km north-east
Woodlawn ⁷	Operational	23 WTGs; 48.3 MW	55 km south-east
Capital I ⁸	Operational	67 WTGs; 140.7 MW	60 km south-east
Capital II ⁹	Planning approval received	41 WTGs	55 km south
1. Goldwind (2015) 2. Acciona Energy (2015) 3. Union Fenosa (2015a) 4. Union Fenosa (2015b) 5. Origin Energy (2015) 6. Taralga Wind Farm (2015) 7. Infigen (2015c) 8. Infigen (2015a) 9. Infigen (2015b)			



17.3

Potential Cumulative Impacts

The previous chapters within this EIS have identified the existing conditions and potential environmental impacts of the Project, along with proposed mitigation measures that will assist in managing potential adverse impacts.

The Draft Wind Farm Guidelines (DP&I 2011) state that:

"Cumulative impacts may occur where other existing or future activities have impacts similar to the development proposed. It includes wind farms, but is not limited to wind farms, and could include other types of development. The area that needs to be considered will vary depending on the issue, and the spatial extent of the associated impact."

With reference to the above, cumulative impacts are an additional way in which a specific environmental aspect may be affected by a new wind farm project or another development. Cumulative impacts have two key characteristics:

- they occur over a geographical area; and
- they occur over time.

There is the potential for some impacts to intersect and potentially increase as a result of additional wind farm developments, including the Biala Wind Farm. It should be noted that no other major developments were identified to occur in the vicinity of the Project, which have the potential to contribute to additional impacts.

A cumulative impact assessment has been undertaken for the following key environmental aspects:

- biodiversity impacts;
- noise impacts;
- landscape and visual impacts;
- traffic impacts;
- EMI impacts; and
- aviation impacts.

An assessment of the potential cumulative impacts on other environmental aspects including: cultural heritage, shadow flicker and blade glint, soil and water, and land use has not been undertaken as it is considered that these potential impacts are primarily confined to the PA.

17.3.1

Biodiversity Impacts

Cumulative impacts on biodiversity associated with wind farm developments are commonly associated with the increased risk of avifauna strikes and the alteration of flight paths for migratory species as more WTGs are constructed across the landscape.

As outlined in *Table 17-1*, the majority of wind farm developments in the region are beyond 15 km from the PA. Any contribution the Project may make to the regional ecological impacts caused by those developments is difficult to determine. Notwithstanding this, Gullen Range Wind Farm and Gunning Wind Farm, located 5.5 km and 7.2 km from the PA respectively, has the potential to contribute to the regional ecological impacts when considered in combination with the Project as discussed below.

Cumulative Habitat Loss and Fragmentation

The Project is not directly adjacent to the Gullen Range and Gunning Wind Farms and will not form a continuous length of wind farms across the landscape. Based on the highly disturbed and fragmented nature of available habitat (as described in *Chapter 9*), and the absence of any large wetlands, rivers or Important Bird Areas, the PA is not likely to be located on a major migratory route for wetland birds or long range migrating birds. The WTG layout has been designed to avoid high value biodiversity areas supporting good condition woodland or threatened species habitat.

For wide ranging species such as the Swift Parrot and Regent Honeyeater, even low condition vegetation can provide habitat as individuals make use of remnant woodland patches (preferred habitat) separated by areas of pasture (non-preferred habitat). For Australian species, defined migration routes that are used regularly each year are not common. Australian species are more likely responding to ephemeral resource availability and utilising changing routes to access these (Epurion 2014). As such, foraging routes have not been mapped for the PA or surrounds. With respect to cumulative impacts and given the nature of wind farms in the region, WTG placement occurs on the high ridges and cumulative impacts on these species, which prefer the lower landscape positions, seems unlikely. On this basis, the Project is not considered to significantly contribute to cumulative loss of habitat for any of the species assessed.

Cumulative Collision Risk Impacts

The operational and proposed wind farms outlined in *Table 17-1* may involve overlapping bird and bat territories and migration routes. For this reason, the impact assessment considers the risks of species with the potential to occur at RSA height, as well as the habitat features that may contribute to collision risks.

Within the locality of the Project, the principal flight paths for woodland bird species are likely to follow slopes, riparian corridors and lowland areas supporting remnant woodland. Birds moving at tree canopy height through these corridors are unlikely to be affected by the WTGs located on adjacent ridges.

The difficulty in drawing conclusions about cumulative operational risk are highlighted by Biosis (2006). Based on collision risk modelling and population viability analysis, the assessment of significance of cumulative risk from all wind farms operational in Australia at that time (2005) was inconclusive due to variation in site specific factors and poor scientific knowledge of bird populations. A commitment to a Bird and Bat Monitoring Plan will attempt to address this uncertainty and provide a mechanism for adaptive management. It will also provide more locally relevant data upon which to base future management actions. These plans are adaptive and feedback mechanisms operate to ensure management is responsive to monitoring data. While this cannot prevent mortalities, it can identify trends and where required, shut down WTGs in high risk windows, if required.

17.3.2

Noise Impacts

The nearest existing or proposed wind farm developments to the Project are Gullen Range and Gunning Wind Farms, with the nearest WTGs associated with these developments located more than 3.5 km and 6.4 km respectively from dwellings potentially affected by the Project.

Given the noise generated from these developments has the potential to result in cumulative noise impacts at nearby residential locations, the noise contribution from Gullen Range and Gunning Wind Farms was included in the wind farm noise predictions for dwellings neighbouring the Project, as documented in the Wind Farm Noise Assessment (DNV GL 2015a). All other existing and proposed wind farm development as outlined in *Table 17-1* are in excess of 15 km from the PA and are not expected to contribute to noise impacts at the residential dwellings surrounding the PA.

The Wind Farm Noise Impact Assessment prepared by DNV GL (2015a) determined that operational noise generated by the WTGs and the operation of the substation was compliant with the relevant noise criteria at all surrounding residential dwellings (involved and non-involved properties), when incorporating the cumulative noise impacts from the Gullen Range and Gunning Wind Farm.

Given the lack of other industrial development in proximity to the PA, the potential cumulative noise impacts during construction are anticipated to be negligible.

17.3.3

Landscape and Visual Impacts

The presence of multiple wind farms has the potential to result in cumulative visual impacts. This can occur when either 'combined visibility' and/or 'sequential effects' are available to WTGs and can lead to a change in perception of a region.

Combined visibility occurs where two or more developments can be seen from one viewpoint. Combined visibility may either be in combination (where several wind farms are within the observer's arc of vision at the same time) or in succession (where the observer has to turn to see the various wind farms).

Sequential impacts occur when the observer has to move to another viewpoint to see different developments. Such impacts are assessed for travel along regularly used routes like major roads, railway lines or popular paths. The level of impact can range from frequent (where features appear regularly with a short time lapse between) to occasional (long time lapses between appearances) depending on speed of travel and the distance between the viewpoints.

There is potential for WTGs associated with the Project to be visible, both combined or sequentially, with other nearby developments including Crookwell 1, 2 and 3 Wind Farms, Gullen Range Wind Farm and Gunning Wind Farm. All other wind farm developments are located beyond 20 km from the PA and are not considered to contribute to any cumulative visual impacts.

Combined Visibility Assessment

The assessment of the combined views of the Biala, Gullen Range, Crookwell and Gunning wind farms undertaken by Clouston Associates (2015) indicated there would be opportunities for combined views of the wind farms from only a limited number of surrounding residential dwellings and local roads. The combined visibility towards these wind farms is largely restricted by tree cover and undulating landform.

Potential combined visual impacts from private viewpoints are largely confined to non-involved properties located on Sapphire Road and Church Lane, with elevated panoramic views of Gunning and Gullen Range Wind Farms. These impacts are considered minor in nature given the distance between the impacted viewpoints and the two wind farms (14 km), with WTGs appearing as small features on the horizon as part of a wider panoramic view. Properties with elevated panoramic views along Church Lane may also have visual accessibility to both the Project and Crookwell Wind Farm, however the distance of that development from the impacted viewpoints (over 20 km) will make any cumulative visual impact insignificant.

Sequential Visibility Assessment

Sequential views of Biala, Gullen Range, Gunning and Crookwell Wind Farms would occur for motorists travelling along Grabben Gullen Road, Biala Gurrundah Road and Range Road. Despite the presence of additional wind farm developments, motorists would experience a range of views extending toward and beyond WTGs within the landscape. The roads follow the low undulating nature of a landform typical across much of the NSW Southern Tablelands, where views may extend over regional areas from highpoints and ridgelines, or be contained and compartmentalised by rising or sloping landforms together with timbered and vegetated areas.

The extent and overall visibility of WTGs would be influenced by the direction of travel relative to the alignment of WTGs as well as the relatively short travel time along the highway and local road network alongside and between the WTGs.

Summary

The assessment undertaken by Clouston Associates (2015) determined that the Project is unlikely to result in any significant combined or sequential cumulative visual impacts resulting from associated views toward other wind farm developments in proximity to the PA. The Project may however, slightly increase the perceived density of wind farm development within this area of the Southern Tablelands. Any future developments in the area should consider the Biala Wind Farm within any cumulative impact assessment.

17.3.4

Traffic Impacts

Once operational, wind farms are generally low generators of traffic and therefore, they are not expected to have a noticeable impact on the existing road network. However, if multiple wind farms were constructed concurrently, there is the potential that the transportation of equipment and construction materials could have an impact on local roads.

Subject to obtaining relevant approvals from RMS and Upper Lachlan Shire Council, it is proposed that RAVs will haul equipment from Port Kembla to the PA via Goulburn and Crookwell (identified as Route 4A in *Chapter 13*). An assessment of the potential spare capacity to accommodate any additional traffic volumes on the surrounding road network was undertaken by GTA Consultants (2015).

There are a number of potential developments in the vicinity of the site that may be constructed or operational concurrently with the construction of the proposed wind farm. These developments include other potential wind farms and other rural land uses such as poultry farms. In addition, the nearby Gullen Range Wind Farm which is currently in the final stages of construction is likely to be operational by the time construction commences on the Project.

Based on the assessment undertaken by GTA Consultants, it was determined that the surrounding road network has ample spare capacity to accommodate the likely cumulative traffic generation of the Project and any nearby future developments.

17.3.5

Electromagnetic Interference

Potential cumulative EMI impacts as a result of the Project and the nearest wind farms, including Gullen Range, Gunning Wind Farm and the Crookwell Wind Farms, were addressed in the EMI assessment undertaken by DNV GL (2015b). This assessment concluded as follows:

- Whilst three fixed point to point microwave links pass over the PA, these links do not cross the Gunning or Crookwell Wind Farms. Following consultation with the NSW RFS, one of the operators of the links, a new exclusion zone has been established and up to 16 of the WTGs proposed as part of the Project are now located within the new exclusion zone. No WTGs associated with the Gullen Range Wind Farm fall within the new exclusion zone. On this basis, the Project is unlikely to contribute to cumulative impacts on the identified fixed point to point microwave links.
- There are two point-to-multipoint base stations located within 20 km of the PA and operated by the Upper Lachlan Shire Council. It is common practice for point-to-multipoint stations to have several unregistered end points and therefore, it is not possible at this stage to determine whether the links pass through the neighbouring wind farms as well. Given the nearest point-to-multipoint station is located 16 km from the PA and interference from the Project is considered unlikely, the potential for cumulative impacts is also considered unlikely.

- DNV GL does not expect any direct interference from the Project on other communications services including emergency services, radio broadcasting, mobile phones, internet and CB radio and therefore no cumulative impacts are anticipated.
- The Project together with the two nearest wind farms, Gullen Range and Gunning Wind Farms, have the potential to contribute to cumulative impacts on terrestrial television for residents directly between the three developments. However, it is expected that any interference to terrestrial television can be mitigated by improving the equipment at a dwelling, such as installing a high-gain directional antenna.

Having regard to the above, whilst the Project has the potential to contribute to cumulative EMI impacts and in particular terrestrial television broadcasting, the mitigation measures identified at *Section 16.2.4* will be implemented to manage these impacts.

17.3.6

Aviation Impacts

There is little guidance currently available in determining potential cumulative impacts of wind farm developments on the safe operation of aircraft. Notwithstanding this, potential cumulative impacts were assessed by determining the density of WTGs in the surrounding area and how this may potentially impact on low flying aircraft through changes in wake turbulence. Based on the cumulative assessment undertaken by Aviation Projects (2015), it was determined that aircraft flying within the confines of the PA may experience the effects of wake turbulence caused by the WTGs (subject to various environmental factors) whereas, aircraft flying between wind farm developments will more than likely avoid the effects of wake turbulence due to the lower density of WTGs in the vicinity.

The Project may impose localised restrictions on aircraft flight paths or heights, however other nearby wind farms, including Gullen Range, Gunning and Crookwell 1, 2 and 3, are sufficiently separated from the PA and will not contribute to cumulative impacts with respect to aviation safety.

17.3.7

Socio-Economic Impacts

Wind farms can provide a significant economic boost to local communities, both during the construction and operational phases. The wind energy industry has already made a significant investment in the local region, through the development of the Gullen Range, Crookwell and Gunning Wind Farms.

The economic benefits provide flow on social benefits, particularly in the provision of a range of employment opportunities for the region, upgrades to local infrastructure and increasing value to agricultural land.

At a broader social level, the development of additional wind farms reduces the community's reliance on energy derived from fossil fuels and supports the community's growing desire for renewable energy sources and a reduction in greenhouse emissions.

The Project is expected to have a positive socio-economic benefit by facilitating the economic growth of the region that is occurring through the development of the wind industry, while at the same time contributing to local, State, National and international objectives to reduce greenhouse emissions. The socio-economic impacts of the Project are discussed in *Chapter 15*.

The Project together with the other wind farms (proposed and operational) in the region, provide an opportunity to facilitate an economic boom in the region through increased construction activity, employment and expenditure. While this will provide a net economic benefit, there is the potential that the region may struggle to meet the demands of the various developments if construction activities are conducted simultaneously. For instance, there could be intensive demand for construction labour, heavy trucks and lifting equipment, however the staggering of projects will help to off-set competing demands and cumulative needs.

Given the scale of the projects and the economic opportunities that they provide to the region, it is expected that the proponents and the contractors commissioned to build the various wind farms will coordinate their activities to minimise impacts and provide for the efficient construction of individual projects.

17.4

Conclusion

An assessment of the potential cumulative impacts concluded:

- The NSW Southern Tablelands is an important region for the development of wind energy facilities. Access to good wind conditions and network connectivity make it an attractive area for the development of wind farms.
- Like all wind farms, there are a range of potential impacts associated with the Project when considered in isolation and as part of a cumulative assessment.
- Potential cumulative impacts on avifauna in terms of blade strike or alterations to flight paths are considered minor, given that there is no continuous length of WTGs between the PA and nearby wind farms developments.
- Operational noise generated by the WTGs and the substation was compliant with the relevant noise assessment criteria at all surrounding residential dwellings (involved and non-involved properties), when incorporating the cumulative noise impacts from the Gullen Range and Gunning Wind Farm.
- The Project is unlikely to contribute to any significant combined or sequential cumulative visual impacts resulting from associated views toward other wind farm developments in proximity to the PA. The Project may, however, slightly increase the perceived density of wind farm development within this area of the Southern Tablelands.
- The surrounding road network was identified to have sufficient capacity to accommodate the likely cumulative traffic generation of any nearby future developments.
- The Project is generally not expected to contribute to cumulative EMI impacts, however should impacts arise, mitigation measures have been identified to manage such impacts.
- The Project is not expected to contribute to cumulative impacts on aviation safety as the identified potential impacts relating to wake turbulence on low flying aircraft is primarily confined to the PA.

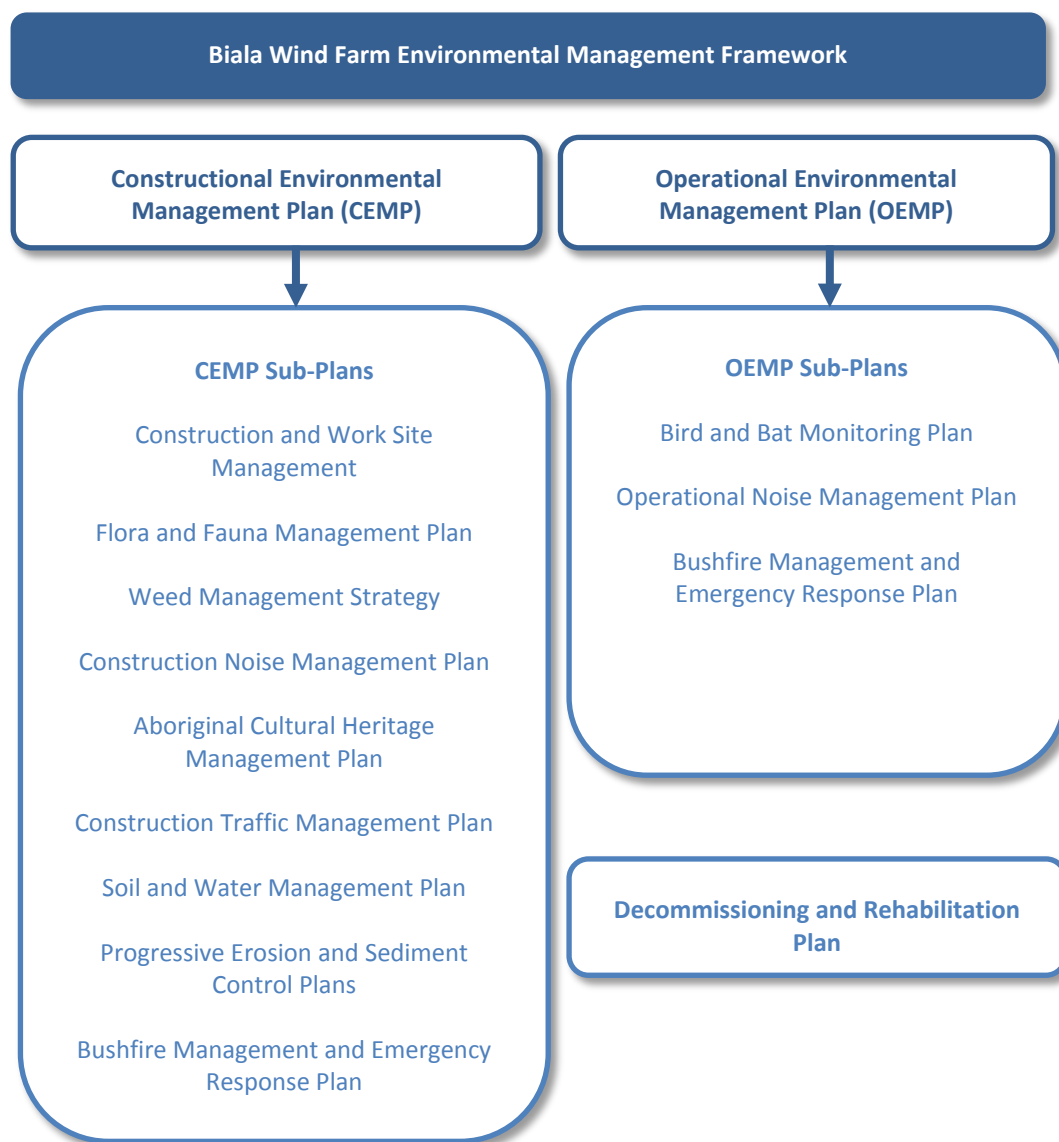
18 ENVIRONMENTAL MANAGEMENT

This chapter provides an overview of the Environmental Management Framework to be developed for the Project and includes a summary of the mitigation measures identified within Chapter 9 to Chapter 16.

18.1 Environmental Management Framework

An Environmental Management Framework will be developed to guide proposed activities associated with the construction, operation and decommissioning and rehabilitation of the Project to ensure that appropriate measures and processes are in place to manage identified environmental risks and provide for ongoing continual improvement. The Framework will be elaborated in the Construction Environmental Management Plan (CEMP), Operational Environmental Management Plan (OEMP) and Decommissioning and Rehabilitation Plan prepared for the Project. These three documents will be prepared following the approval and commissioning of the Project as appropriate. *Figure 18-1* provides an indicative overview of the Environmental Management Framework to be established for the Project.

Figure 18-1 Biala Wind Farm Environmental Management Framework



18.2

Environmental Impact Identification and Mitigation Measures

As described in *Chapter 8*, the screening and scoping stages of the environmental assessment identify the significant environmental and social impacts associated with the Project. Environmental sensitivities and potential impacts have been identified and assessed through the specialist assessments undertaken in support of the EIS.

Environmental management and mitigation measures, including requirements to prepare and issue specific management plans, have been identified to reduce and manage potential environmental impacts arising from the Project. These commitments have been informed by the mitigation measures recommended in the specialist assessments contained in *Volumes 2 to 6* and summarised in the preceding chapters of this EIS. *Table 18-1* provides a summary of the measures identified to avoid, minimise and where necessary, offset the potential environmental impacts associated with the Project.

Table 18-1 Summary of Mitigation Measures for the Project

Aspect	Potential Impact	Mitigation Measures
Biodiversity	Clearing of native vegetation.	Pre-clearance surveys, marking the extent of clearing and micro-siting of laydown areas and access tracks will be undertaken in consultation with a qualified ecologist in the vicinity of the EEC and DNG, Woodland/Forest and Open Woodland habitats. Micro-siting will minimise disturbance to the EEC, any identified threatened flora and hollow-bearing trees where possible.
	Habitat loss, fragmentation and degradation.	- A Flora and Fauna Management Plan, incorporating a Weed Management Strategy will be developed to minimise ecological impacts during the construction of the Project and will include (but is not limited to the following measures): - Clearing will be undertaken sequentially to allow fauna time to move away. If possible, clearing will be staged to direct fauna toward areas of suitable habitat. - If clearing of hollow-bearing trees is unavoidable, removed hollows will be replaced with artificial shelter prior to felling. - Habitat features such as coarse woody debris (diameter >10 cm) and large surface rocks will be relocated from the clearing area to adjacent habitat in consultation with landowners. - Measures to reduce fauna mortality on access roads within the PA will be developed and implemented, including enforcing vehicle speed limits according to habitat value and road condition, and installing signage advising of high activity wildlife areas. - Unsealed access roads and construction areas to be regularly watered to limit dust generation, particularly in windy conditions. - Imported soil and rubble will be certified as free of weeds and weed seeds. - All construction staff and sub-contractors will be educated on noxious weeds within the PA and ways to prevent spread of weeds.
	Mortality due to WTG collision and barotrauma.	A Bird and Bat Monitoring Plan will be developed with the objective of minimising the impacts of the operational wind farm on threatened bird and bat species. The Bird and Bat Monitoring Plan will outline: - the required monitoring techniques and frequency; - strike rate thresholds and corrective actions to be implemented when thresholds are reached; - requirements for reporting to State and Commonwealth agencies; - Roles and responsibilities for the Proponent, operator and agencies; and - An evaluation and adaptive management framework to provide for the incorporation of new information obtained through the monitoring program or relevant external research. Other likely management actions may include prompt removal of stock carcasses near WTGs and no lambing near WTGs. The plan will be developed in consultation with NSW Department of Planning and Environment and OEH and in consideration of the monitoring guidelines provided by the Australian Wind Energy Association (Brett Lane & Associates 2005).

Aspect	Potential Impact	Mitigation Measures
Noise and Vibration	Noise generated during the construction and decommissioning of the Project exceeding specified noise management levels at nearby receptor locations.	- Construction works will be limited to the standard hours of construction, which are Monday to Friday 7 am to 6 pm; Saturday 8 am to 1 pm; and no work on Sundays or Public Holidays. - Any works that are required outside the standard hours of construction will be strongly justified and additional noise control mitigation and management measures implemented to reduce noise to acceptable levels. These additional measures will consider the potential for sleep disturbance impacts that could occur during the night time period due peak or maximum noise level events. - Construction plant, equipment and/or machinery will be selected during the design phase to achieve the sound power level values identified in the Supplementary Acoustic Assessment. Where additional items of equipment are required for construction or where the assessed values cannot be achieved, additional noise control mitigation will be implemented. - Good practice noise control mitigation and management measures will be implemented during all construction activities to reduce noise levels and minimise any impacts as far as practicable. - When planning for and during works associated with the alternate and optional access roads, the Proponent will negotiate with the occupants of H01, H02 and DA16 (if occupied) to discuss (as a minimum) the nature of works to be carried out, the expected noise levels and duration, contact details for any complaints and agreement of preferred construction hours. This agreement will target periods where the highest noise generating events can occur based on the occupants preference. Further guidance on negotiating agreements is provided in section 7.2.2 of the ICNG. - A Construction Noise Management Plan (CNMP) will be developed to ensure that appropriate work practices are implemented during construction of the Project to minimise impact. Further guidance regarding the features and content of a CNMP is provided in section 7.2.2 of the ICNG. - Project vehicle movements will not exceed those estimated in the Transport Impact Assessment (GTA 2015) as used in the assessment to predict noise impacts. Where additional vehicles are required for unforeseen circumstances, their impact will be evaluated and additional mitigation applied if necessary. - The Proponent will plan to schedule deliveries and on-site vehicle movements for the daytime period wherever possible. If it is not possible for this to occur, the Proponent will instruct drivers to arrive and depart as quietly as possible. Whilst on-site the drivers will be instructed to implement good practice noise management measures to reduce peak noise levels and minimise any impacts as far as practicable.
	Potential exceedance of prescribed operational noise limits at surrounding receptor locations from key noise sources including WTGs and electrical substation.	- An Operational Noise Management Plan (ONMP) will be developed to ensure that appropriate management measures are implemented to minimise impacts. - Compliance testing of the operational noise generated by the Project is normally carried out following construction. The specific requirements for operational wind farm noise compliance testing are to be specified by the relevant authority, however the following noise management options are available: - receiving and documenting noise impact complaints through a dedicated, publicly advertised telephone number;

Aspect	Potential Impact	Mitigation Measures
		- once an adverse noise report is received, investigating the nature of the reported impact with further detailed noise measurement and assessment if necessary; - if required, one or more WTGs can be operated in noise optimised modes for specific direction sectors and/or wind speeds; - mitigation measures can also be applied at specific house locations, with the agreement of the resident. Such measures may include modifications to the house, including installation of screening or barriers, or planting of additional vegetation; and - entering into agreements with affected residences.
Landscape and Visual	Physical presence of Project infrastructure including but not limited to WTGs and electrical substation impacting on the visual amenity experienced at sensitive receptor locations and at nearby public viewpoints.	• The potential visual impact of the Project from the selected private viewpoints could be mitigated by planting vegetation close to the view locations. For instance, tree or large shrub planting close to a dwelling can screen potential views to individual or groups of turbines. Similarly roadside tree planting can screen potential views of turbines from particular sections of road provided the turbine is not located some distance from the road. • The location and design of screen planting used as a mitigation measure is site specific and requires detailed analysis of potential views and consultation with surrounding landowners during the detailed design phase. • Colour choice can provide an opportunity to reduce visual contrast between the WTG structures and the background against which they are viewed. The use of an appropriate off-white or grey colour for the WTGs where the visual contrast would be reduced when viewed against a background of landscape may be possible. The final colour selection would however, be subject to the availability of WTG models on the market at the time. • In terms of the proposed access roads, the following measures will be adopted: - minimise the extent of cut and fill in the construction of the roads, following contours where possible, - re-vegetating disturbed soil areas immediately after completion of construction works with local native vegetation or pasture grasses as agreed with involved landowners; and - use local materials as much as possible in road construction to minimise colour contrast. • With regards to the substation, the following measures will be adopted: - locating the substation to take advantage of natural topographical and vegetation screening; - ensuring materials are non-reflective and colours assist with blending facility with local context; and - planting additional screening vegetation.
Cultural Heritage	Potential disturbance to Aboriginal and historic heritage objects or places during construction and operation of the Project.	• Personnel involved with ground disturbance activities in the PA will undertake an Aboriginal and historic heritage awareness training/induction programme in line with Section 10.1.2 of the CHA (refer <i>Annex J</i>). • During works, the location of all previously recorded Aboriginal and historic heritage sites and those sites recorded as part of this assessment will be clearly marked on all construction plans for the PA and site foreman informed of their presence and the need to avoid disturbance.

Aspect	Potential Impact	Mitigation Measures
		• If suspected Aboriginal heritage objects are found during works the Chance Find Procedures outlined in the CHA will be followed (refer Annex J; Section 10.1.3 for Aboriginal heritage and Section 10.2.1 for historic heritage). • The PAD areas within the PA that have been identified as having moderate or high potential to reveal Aboriginal cultural heritage (refer to <i>Figure 12-3</i> and <i>Figure 12-4</i> - BWF2, BWF3, BWF10, BWF12, BWF13, BWF16, BWF19, BWF21 and BWF PAD1), will undergo a sub-surface testing programme in accordance with the CHA where disturbance to these areas cannot be avoided (refer <i>Annex J</i>). This will occur prior to ground disturbance activities commencing. • An Aboriginal Cultural Heritage Management Plan will be prepared and implemented to manage sub-surface testing activities and the Aboriginal heritage values within the PA. • Where the stone artefact scatter (BWF18) cannot be avoided, an Aboriginal Heritage Impact Permit (AHIP) will be sought from OEH to salvage this site prior to commencement of works. • Where disturbance of Aboriginal heritage sites cannot be avoided, an AHIP will be applied for with OEH. • No archaeological constraints exist for areas that have been surveyed and identified as having no heritage sites or PADs (refer to <i>Figures 12-3</i> and <i>12-4</i> together with <i>Figures 7.1</i> and <i>7.2</i> of the CHA provided in <i>Annex J</i>). • No ground disturbing components in the location of Aboriginal heritage sites or areas of PAD will take place until the sub-surface archaeological investigations outlined in this report have been undertaken and reported on. • Where possible, and in consultation with Aboriginal stakeholders, conservation areas will be established for relocation of disturbed artefacts. An interpretive strategy will also be established that describes what the area is and the past use of the landscape by Aboriginal people. • Where possible, the Proponent will provide an opportunity for registered Aboriginal stakeholders to monitor ground disturbance activities and works undertaken as part of the construction of the Project. This includes work within close proximity to recorded Aboriginal sites and areas of sensitivity and within areas known to be sensitive in the region (i.e. adjacent to Biala Creek, within flat raised landforms etc - refer to Section 5.6 of <i>Annex J</i>) (payment for these monitoring works may be made at the discretion of the Proponent).
Traffic and Transport	Damage and disruption to local roads from heavy vehicle movements particularly during construction and decommissioning.	• A Construction Traffic Management Plan will be prepared prior to the commencement of construction and will include (but not limited to) the following: - confirmation of expected traffic volumes generated by the Project for all work stages and hours of operation; - confirmation of, identification and qualification of all heavy vehicle and RAV haulage routes for all work stages; - mechanism to review identified haulage route road condition; - confirmation of required upgrade works at each of the proposed site access points off Grabben Gullen Road to ensure safe and functional access to the site; - traffic management measures required to facilitate RAVs, including functional plans detailing road widening/improvement works where required prior to the commencement of works;

Aspect	Potential Impact	Mitigation Measures
		- mechanisms/agreements to maintain haulage route roads and road infrastructure during construction works and to reinstate roads to at least pre-construction conditions; - any requirements for specific work stage construction traffic control plans; - detail a period of inactivity for construction vehicles during the time of school bus services; - relevant mechanisms for RAV permits and traffic management requirements; - any additional matters identified as required by RMS and Council; - escorts for RAVs will be provided in accordance with RMS requirements; and - to ensure that roads utilised by traffic associated with the construction of the Project are maintained to a suitable standard commensurate with their function, a joint inspection of the road surface will be undertaken by representatives of RMS, both Councils and the Proponent prior to the commencement of construction works on the PA. Upon completion of the construction works, a final joint inspection will be undertaken by representatives of RMS, both Councils and the Proponent. The purpose of this inspection will be to identify those works that will ultimately be necessary to return the roads to their pre-development condition or better.
Water Supply, Water Quality and Hydrology	Sediment run-off generated from ground disturbing activities entering existing surface water bodies within the PA. Impacts to surface water flows generated from construction activities. Impacts at watercourse crossings. Accidental spills causing localised contamination to soil, groundwater or surface water bodies.	• A detailed Soil and Water Management Plan (SWMP) will be prepared prior to construction commencing. The SWMP will be prepared by a suitably qualified person, such as a soil conservationist. • Progressive Erosion and Sediment Control Plans will be prepared as the Project progresses to address management requirements at individual work sites. • The Project will be designed and constructed to minimise land disturbance and therefore reduce the erosion hazard. • Construction activities will be staged to minimise the duration and extent of land disturbance. • Topsoil resources will be managed to minimise the risk of erosion and sedimentation, and maximize reuse of topsoil during rehabilitation. • Upslope (clean) stormwater will be diverted around the disturbed sites and capture sediment-laden runoff from within the disturbed site for diversion to sediment control devices. • The site will be rehabilitated promptly and progressively as works progress. • Erosion and sediment control devices will be inspected and maintained for the duration of the Project. • Land disturbance within 20 m of minor streams (first and second order watercourses) and 40 m of third order or higher watercourses will be avoided. • Appropriate procedures will be in place for the transport, storage and handling of fuels, oils and other hazardous substances, including availability of spill clean-up kits. • Disturbance during construction will be minimised by using existing access tracks and roads until proposed final designs are implemented.

Aspect	Potential Impact	Mitigation Measures
		• Appropriate stormwater, collection, treatment and recycling will be in place at the concrete batch plant, in accordance with relevant best practice guidelines and any requirements of the NSW EPA.
	Increase in water demand to service the Project during construction causing changes to baseline groundwater and/or surface water levels.	• Obtain any necessary water access licenses.
Socio-Economic	Impacts on the local economy, community and infrastructure.	• Where feasible and applicable, contractors and suppliers will be sourced from the broader local region during the construction phase. • Where feasible and applicable, service and maintenance staff will be sourced from the broader local region during the operation of the Project. • Prior to the commencement of operation, a community enhancement program will be established providing a voluntary annual contribution for the provision and enhancement of community facilities and Council funded infrastructure projects. • The Proponent will consult with local and regional realtors periodically in order to identify trends or changes associated with wind farm impacted properties to determine a correlation between the Project and property values in the region. • In addition to the mitigation measures outlined above, mitigation measures pertaining to the other impacts including landscape and visual, noise and vibration, traffic and transport, aviation safety and communications will be implemented.
Aviation Safety	Impacts to flight paths for commercial and recreational aircraft. WTGs impacting on the safe operation of aircraft in the region for agricultural purposes and the aerial-based water application for fighting bushfires.	• WTG and monitoring mast heights and co-ordinates will be notified to CASA, DoD, ASA and AAAA as well as other aircraft operators in the region for inclusion in databases and navigational charts of the area. • Consideration will be given to marking the wind monitoring towers with bands of contrasting colour according to the requirements set out in MOS 139 Section 8.10 - Obstacle Markings. • The lowest safe altitude (LSALT) for airway W423 will be increased by 100 ft to 4,700 ft. • Prior to undertaking aerial application operations, if it is determined there is an unacceptable risk in operating fixed wing aircraft on properties adjoining the PA, helicopters will be utilised as they can operate in closer proximity to obstacles such as WTGs. • The heights and co-ordinates of WTGs and wind monitoring masts will be provided to emergency services operating in the vicinity of the Project. • Obstacle lighting is not considered to be required, however if obstacle lighting is ultimately installed it would be designed in a manner to reduce visual impact.
Electromagnetic Interference	Potential for WTGs to cause electromagnetic interference (EMI) by blocking, scattering or reflecting waves between transmitters and receivers. This may include television, radar and radio transmissions.	• Following construction, an assessment of the potentially affected dwellings, and at the request of the landholder of any other dwellings, will be undertaken to mitigate television reception impacts considered to be caused from the Project. Mitigation options to be considered will include a combination of the following: - realigning the householder's TV antenna more directly towards their existing transmitter; - tuning the householder's antenna into alternative sources of the same or suitable signal; - installation of more directional and/or higher gain antenna at the affected dwelling;

Aspect	Potential Impact	Mitigation Measures
		- relocating the antenna to a less affected position; - installation of cable/satellite television at the affected dwelling; and - installation of a television relay station. • any interference to radio broadcasting can be mitigated through the installation of a high quality antenna and/or amplifier; • at the expense of the Proponent, the fixed point-to-point link within the PA operated by NSW RFS will be re-routed to avoid any obstruction to the service; and • the potentially affected point-to-point link operated by Council will be re-routed, with the Proponent to lodge an agreed bond amount at the request of Council and supply all relevant Project information to undertake the works.
Shadow Flicker	Impacts on human health related to shadow flicker.	• The following mitigation measures will be investigated and implemented in consultation with involved landholders affected by shadow flicker: - installation of screening structures or the planting of trees to block shadows cast by the WTGs; and - the use of WTG control strategies which shut down WTGs when shadow flicker is likely to occur or relocation of the WTG.
Blade Throw	Accidental release of WTG blades during operation.	• The WTG model selected for the Project will be certified to the relevant international standards and has an adequate lightning protection system and shutdown system. • An ongoing operation and maintenance program will be implemented throughout the lifetime of the Project.
Health	Impacts on human health pertaining to audible and inaudible noise, blade glint, shadow flicker and electromagnetic fields.	• WTG blades will be coated with a non-reflective finish to avoid the occurrence of blade glint. • The WTG model ultimately selected for the Project will meet the relevant Australian design and safety standards. • The mitigation measures pertaining to potential noise and shadow flicker impacts will be implemented.
Bushfire Risk	Impacts to/from the Project on bushfire risk (accidental ignition of bushfire during construction and operation of the Project). Impacts of the Project on bushfire management capabilities.	• A Bushfire Management and Emergency Response Plan will be prepared in consultation with the NSW RFS and other relevant stakeholders, prior to the commencement of any construction. • Fire weather to be monitored daily on the NSW RFS website. Fire weather to be displayed on-site and activities modified accordingly. • Locate electricity services to limit the possibility of ignition of surrounding bushland or the fabric of buildings and undertake regular inspections of lines to ensure they are not fouled by branches, as per the performance criteria and acceptable solutions of PBP (NSW RFS2006). • Maintain a reduced fuel zone (APZ or defendable space) around each of the WTGs, substation and compounds to ensure adequate defendable space in accordance with the performance criteria and acceptable solutions of PBP (NSW RFS 2006). • Appropriate location of water access points will assist safe, effective and timely fire suppression activities. To ensure adequate access to water for RFS and fire-fighting crews, the allocation of static water supplies is necessary and will be further detailed in the Bushfire Management and Emergency Response Plan. A water supply reserve dedicated to fire-fighting purposes will be installed and maintained as per the performance criteria and acceptable solutions of PBP (NSW RFS 2006). A minimum of 30,000 litres of water tanks, dams or other static water supplies are to be provided across the PA. The

Aspect	Potential Impact	Mitigation Measures
		exact number and location will be confirmed in consultation with the local RFS and detailed in the Bushfire Management and Emergency Response Plan. • Provide and maintain public and property access roads as per the performance criteria and acceptable solutions of PBP (NSW RFS 2006). This includes, but is not limited to, ensuring that fire fighters are provided with safe all weather access to structures, that public road widths, design and capacity allow for fire fighter access and resident evacuation, and that roads are clearly signposted. • Safe working procedures and emergency response procedures will be developed and strictly implemented for all work tasks, with all employees and visitors involved in the operation and maintenance of the Project routinely trained in the safe operating procedures and the basic first response fire-fighting techniques including: - maintaining a 10 m wide fuel reduced zone around construction activities that may result in ignition of a fire e.g. welding; - ignition creating activities such as welding will not be undertaken on days of total fire ban; - communication and reporting requirements such as alerting emergency crews (000) and reporting details of location, size, proximity to assets and access capabilities. Reporting procedures and mechanisms will be efficient and simple to ensure that potential issues are identified, inspected and rectified in a timely manner; - maintaining provision for mobile telephone and UHF radio communications; - use of 4WD striker unit (to be available on site daily during the construction and maintenance phases of the Project); - use of a dedicated 10,000 litre tanker (to be available on site daily during the construction phase of the Project); and - use and location of extinguishers, knap-sacks and hoses.

19

CONCLUSION

This chapter provides a brief summary of the EIS and provides information on how to provide your opinion and comment during the public exhibition of the SSD submission.

19.1

Summary

The Biala Wind Farm is expected to make an important contribution to the local and regional economy and contribute positively to the achievement of State and Federal policy objectives by increasing the supply of renewable energy and reducing GHG emissions.

The Project involves a generating capacity of approximately 77.5 MW and an estimated capital investment value of \$192 million and will provide significant benefits at the State, regional and local level by:

- supplementing the renewable energy supply in NSW and producing clean electricity to power up to 33,200 homes per annum;
- supporting increased direct and indirect employment opportunities at the State, regional and local levels during the construction and operational phases of the Project;
- increasing demand for local goods and services during the construction and operational phases of the Project;
- diversifying existing income streams for involved landholders whilst supporting the continued use of land for productive agricultural operations; and
- improving the local road network surrounding the PA and contributing to local community facilities and infrastructure through the Community Enhancement Program.

Whilst Newtricity considered other potential locations for the Project, the PA near Biala is ideally suited for a wind farm development due to favourable wind speeds having been measured since 2010, low density of residential properties in the surrounding area and proximity to the existing electricity grid in the form of the 132 kV Yass to Goulburn network. The location of the PA at significant distances from the townships of Crookwell, Goulburn and Gunning as well as the limited number of dwellings surrounding the PA have assisted in reducing the visual and amenity impacts often associated with developments of this nature.

Newtricity is committed to ongoing and thorough community engagement with all stakeholders. A community consultation program has been implemented including community information sessions and individual meetings with stakeholders, the distribution of newsletters, and a Project website. Community engagement will continue throughout the public exhibition of the EIS, post approval, and during construction and operation of the Project. Throughout this time the Community Consultative Committee (CCC) will assist in raising and addressing community concerns and will provide ongoing information and support to the community.

Detailed specialist assessments have been undertaken in accordance with the SEARs issued for the Project in May 2015, the Draft Wind Farm Guidelines (DP&I 2011) and other relevant guidelines and policies.

An iterative design process was adopted for the Project, which allowed the results of specialist environmental assessments and outcomes of the consultation undertaken between Newtricity and local landholders (involved and non-involved) to develop a robust wind farm layout. Some of the key constraints incorporated into the design process included:

- 50 m setbacks from mapped areas of Aboriginal heritage;
- 100 m setbacks from identified ecological sensitive areas;
- WTGs sited in excess of 2 km from non-involved landholder dwellings;
- at the involved landholder's request, no WTGs located within 1 km of DA16 (an approved but not yet constructed dwelling); and
- 50 m setbacks from existing water bodies.

Potential environmental impacts arising from the Project have been identified and corresponding mitigation measures proposed where avoidance strategies have not been feasible.

In summary:

- The PA and broader region consists of large and extensively cleared rural land parcels for the purpose of agricultural grazing and the Project will not impact on the continuation of these land uses. The Project is compatible with the zoning of the land under the Upper Lachlan LEP 2010 and is consistent with facilitating the sustainable management and development of natural resources and agricultural land.
- The wind farm layout has considered ecological sensitive areas, with WTGs and associated infrastructure generally sited to avoid areas of remnant woodland vegetation and riparian areas. The ecological surveys undertaken were used to inform the removal and/or siting of WTGs and infrastructure to take into account site-specific environmental issues and minimise on-ground ecological impacts.
- No threatened flora species were reported within the PA, however five threatened bird species and two threatened bat species were recorded, all listed as Vulnerable under the TSC Act. In addition, one EEC, Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland, is present within the PA, however the proposed disturbance is estimated to be equivalent to less than 0.01% of the EEC within the PA. Provided the mitigation measures outlined in this EIS and the development and implementation of CEMP; Flora and Fauna Management Plan; and Bird and Bat Monitoring Strategy, the Project is not likely to result in a significant impact on flora or fauna listed under the TSC Act or EPBC Act.
- The acoustic assessment has indicated that operational noise (noise generated from WTGs and the substation) will comply with the relevant noise assessment criteria at all surrounding residential properties (involved and non-involved landholders) considered in the assessment. Noise generated during construction activities and traffic movement is unlikely to impact on the noise amenity of the surrounding area.
- The Project has a relatively limited visual catchment and overall moderate to moderate/low visual impact as a result of the wind farm development. The greatest potential for visual impacts to occur is to neighbouring, non-involved residential properties located 2 to 3 km from a WTG. If required post construction, landscape mitigation measures can be used for affected dwellings and would be agreed between the Proponent and the affected landholder.
- No items or places of historic heritage are located within the PA. Twenty-one Aboriginal cultural heritage objects and areas of sensitivity were identified within the PA. The development footprint largely avoids recorded Aboriginal heritage objects and areas of sensitivity, however some recorded sites will need to be salvaged or re-located in line with the recommendations outlined in the Aboriginal and Historic Cultural Heritage Assessment. Impacts to Aboriginal heritage objects outside the development footprint will be avoided through clearly marking their locations on all relevant construction maps, and providing a heritage induction to site personnel.

- Based on the estimated traffic generation associated with the Project and the existing spare capacity in the road network surrounding the PA, no significant impacts on the capacity of the road network or road users are anticipated. A Construction Traffic Management Plan (CTMP) will be prepared following Project approval and will include detailed measures to address traffic generation, measures to minimise impacts to existing road users and to maintain and rectify haulage route roads and road infrastructure.
- The risk of erosion and associated impacts on existing surface water bodies across the PA is considered low and can be readily managed through the implementation of sediment controls. A Soil and Water Management Plan will be prepared prior to the commencement of construction to manage potential soils, surface water and groundwater impacts.
- The PA has sufficient capacity to supply water for the Project via on-site dams subject to relevant approvals and consultation with the involved landholders.
- The Project has the potential to impact on terrestrial television broadcasting in the vicinity of the PA. It is expected that any interference to terrestrial television can be mitigated by identified strategies including improvements to the equipment at the affected dwelling.
- Potential shadow flicker impacts, which exceed the recommended limit of 30 hours per year, are confined to four dwellings owned by involved landholders. Signed agreements from these affected landholders have been obtained by Newtricity and mitigation measures will be implemented where feasible and applicable at the request of the landholder.
- Any potential blade glint impacts will be minimised or eliminated by the use of a non-reflective surface treatment for the blades.
- All WTGs are located in areas mapped as low fire hazard and with the implementation of the prescribed measures; the risk of bushfire can be effectively managed.
- The Project may prevent aerial fire-fighting operations within the PA; however the network of internal access roads for the Project will improve vehicle access within and across the PA and enhance ground-based means of fighting bushfire.
- There are a number of operational, existing and proposed wind farms in the region surrounding the Project. Given the separation distances to these surrounding wind farms, the Project is not expected to contribute to unreasonable cumulative impacts.
- The Project is estimated to result in the creation of 74 direct full time positions during the construction phase and seven direct full-time positions once the Project is operational.

Having regard to the above, the EIS and supporting specialist assessments have concluded that the Project is compatible with the existing agricultural uses evident in the area, can appropriately manage potential environmental and social impacts, and accords with the planning and environmental provisions relevant to the PA. As a result, the Project is regarded to be in the public interest.

19.2

The Way Forward

The next steps for the Project generally involve the following:

- **Exhibition the EIS** - the EIS will be placed on public exhibition for a period of up to 60 days by DP&E. During this period, the general public and relevant stakeholders, Council and state agencies will be invited to make submissions. Submissions can be lodged on the DP&E Major Projects website: www.planning.nsw.gov.au.
- **Response to Submissions** - following the receipt of the submissions, Newtricity would prepare a submissions report addressing the key issues raised. This submissions report would be forwarded to DP&E in a timely manner following the public exhibition period.
- **Approvals Stage** - DP&E will consult further with Upper Lachlan Shire Council and the relevant State agencies on draft conditions of consent. The assessment report will then be finalised and determined by either a delegated officer of DP&E, the Minister or forwarded to the PAC for determination. If approved, a list of consent conditions will be provided with the letter of determination.

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