

# Glen Innes

## 5

### Existing Environment



## 5. Existing Environment

This chapter of the Environmental Assessment provides a review of selected aspects of the existing environment of the proposed Glen Innes Wind Farm site and its surrounds, together with a review of potential impacts and measures for their mitigation.

It is complemented by subsequent Chapters 6 to 13 which address the more significant aspects of the environment relative to the potential impacts arising from the development of the Glen Innes Wind Farm. Those chapters and the associated Appendices C to I provide comprehensive assessments of specific environmental aspects that have been undertaken and include a review of the existing environment for those issues.

A guide to the location of the respective information is provided in Table 5.1.

**Table 5.1 - Key to location of sections describing the existing environment**

Chapter 5		Subsequent Chapters		
Environmental Aspect	Section	Environmental Aspect	Section	Appendix
Regional Setting	5.1	Visual & Shadow Flicker	6	C & D
Climate	5.2	Flora and Fauna (incl. Bats)	7	F & G
Air Quality	5.3	Heritage	8	E
Geology	5.4	Traffic and Transport	9	I
Soils	5.5	Noise	10	H
Site Drainage	5.6	Telecommunications	11	--
Land Use	5.7	Safety Aspects	12	--
Socio-Economic	5.8 & 5.9	Greenhouse Issues	13	--

### 5.1 Regional setting and topography

The proposed Glen Innes Wind Farm is located within the New England Region of New South Wales and on the Waterloo Range about 12 kilometres to the west of Glen Innes. Overall the topography in the region decreases in height from the elevated Ben Lomond tableland (at about 1400 metres) about 10 kilometres to the south of the wind farm site to the Wellingrove Creek Valley (at a level of about 950 metres) several kilometres to the west of the site.

The general topographic variations in the immediate project area are shown in Figure 5.1. The north-south feature of the Waterloo Range is clearly seen and provides the elevated land on which the proposed turbine sites are located. The selected sites along the Waterloo Range offer good potential in terms of wind energy, direct access from the Gwydir Highway and flat to gently sloping sites facilitating the turbine construction. The development does not constrain existing land use and environmental issues are manageable.

The proposed wind farm comprises up to 27 wind turbine sites located on ridges at elevations of between 1160 and 1275 metres above sea level in the arrangement shown in Figure 1.4. The ridges where the wind farm will be located are between about 120 to 280 metres above the level of the lowlands to the east and west of the site respectively.

The highest topographic points within the wind farm site are at its southern extent at an elevation of about 1275 metres above sea level and for the northern section at 1235 metres at Ross Hill. The level of the Wellingrove Creek is about 950 metres at a distance of about 1 to 2 km west of the Waterloo Range while the valleys to the east are at a higher level at about 1100 metres or slightly less for Reddestone and Furracabad Creeks. Figure 5.5 shows that the steeper slopes are on the western side of the Waterloo Range.

The project area is entirely located within the Border Rivers catchment. The ridges are dissected by intermittent creeks that drain ultimately to the north. The Ben Lomond Tableland to the south of the project area provides the southern rim of the Border Rivers catchment at this locality.

The wind farm site has been mostly cleared for grazing (Plates 5.1 to 5.3). However, areas of remnant woodland occur in close proximity to the wind farm, primarily on its western side where the land is steeper and less suitable for pastoral purposes (Plates 5.4 and 5.5). The mixture of cleared grazing land and scattered woodland provides an element of visual diversity in the landscape.

The density of rural settlement is variable, from absent to very low density for the elevated and exposed properties where the turbines will be located, to low density for lower elevation holdings located in the adjacent valleys.



**Plate 5.1 – Northern end of Waterloo Range looking south to Ross Hill**



**Plate 5.2 – View of Turbine sites 8 and 9 from southern end of Ross Hill.  
Existing Telstra Repeater Station in mid distance**



**Plate 5.3 – Turbine site 12B near Mast site M4 and rocky hillock**



**Plate 5.4 – View to the Turbine Sites 16B & 16C from Turbine Site 13B showing woodland remnant on western slope of Range**



**Plate 5.5 View to Turbine Site 19 at southern end of wind farm from Turbine Site 16B.**

## 5.2 Climate

### 5.2.1 Climate data

This section provides an overview of climate characteristics for the Glen Innes Wind Farm locality based on the Bureau of Meteorology (BOM) climate data for the nearest monitoring stations and wind monitoring data for the wind farm site. Stations that have been referred to are shown in Table 5.2.

**Table 5.2 - Locations of climate data stations**

Station	Elevation (m)	Ref no.	Period of data	Distance from site
Glen Innes Agricultural Research Station	1060	BOM – 056013	1910 to 2004	8 km north east of the site
Glen Innes Post Office	1065	BOM – 056011	1881 to 2004	12 km east of the site
Inverell comparison		BOM – 056017	1874 to 1997	50 km west of the site
Wind farm site meteorological masts	1160 - 1250	M1 to M3	2005 to 2007	on site

The climate characteristics summarised in this chapter should be regarded as indicative only, as the wind farm site is distant from and more elevated than the reference BOM monitoring stations.

There are minor differences between the nearby Glen Innes and Inverell locations, which are only about 60 kilometres apart. Inverell has a lower rainfall than Glen Innes and broader range in temperatures. As the wind farm site is closer to Glen Innes it is more likely to have climate characteristics similar to Glen Innes rather than Inverell. There may also be minor differences between the wind farm site and Glen Innes due to the wind farm's elevated location relative to Glen Innes township.

The statistics for the BOM stations represent historical data over the period that the stations have operated. Future climate data may differ due to the effects of enhanced climate change or other causes. Considerable information is appearing in the media and scientific reports that indicate a trend towards global warming, an associated increase in erratic weather characteristics and, for parts of the east coast of Australia, drier conditions. While it is difficult to quantify the extent of such changes, allowance should be made for variation beyond the climate ranges presented in the following sections.

### 5.2.2 Precipitation

Glen Innes Agricultural Research Station and Glen Innes post office have average annual rainfall of 848 mm and 858 mm respectively as shown in Tables 5.3 and 5.4. The 9<sup>th</sup> decile rainfall at the Glen Innes Agricultural Research Station as recorded by BOM is 1068mm, whereas the 1<sup>st</sup> decile rainfall is recorded as 581mm. The average annual rainfall for the Inverell Comparison Station is 794.3mm with annual rainfall varying from 527 mm (1<sup>st</sup> decile) to 988 mm (9<sup>th</sup> decile), as shown in Table 5.5. While the wind farm site is to the west of Glen Innes toward the drier Inverell locality its elevated position could mean that it receives higher rainfall than for Glen Innes.

Mean monthly rainfall values show lower winter rainfall than for summer rainfall.

The New England Tableland and north-west areas of NSW have been subject to drought conditions over the last several years. However, Glen Innes received above average rainfall in 2007 with annual rainfall 39.1 mm above average.

Snow also occurs on the higher parts of the New England area including Waterloo Range. Snow was observed on Waterloo Range in August 2007 during survey work. However, locals have indicated that snow is not a regular feature of winters despite the low winter temperatures characteristic of the Glen Innes area.

**Table 5.3 - Rainfall statistics for Glen Innes Agricultural Research Station**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Years of data	94	94	94	94	94	94	94	94	94	94	94	94	-
Mean (mm)	105.7	93.9	71.8	40.6	49.7	52.9	57.5	49.2	54.5	77.8	86.7	107.7	<b>848</b>
Lowest (mm)	6.2	2	0.8	0	0	0.6	0	0.6	3.2	12.9	8	5.4	<b>581</b>
Highest (mm)	282.8	313.5	231.6	201.6	203.1	198	177.8	135	276.4	267.1	214.4	283	<b>1,068</b>

**Table 5.4 - Rainfall statistics for Glen Innes Post Office**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Years of data	123	123	123	123	123	123	123	123	123	123	123	123	-
Mean (mm)	112.9	91.9	71.9	43.1	49.1	55.2	54.9	50.4	55.5	80.2	85.7	106.8	<b>857.7</b>
Lowest (mm)	13.2	1.3	0.5	0.3	0	0	2.8	0	3.2	12.2	3.6	4.8	<b>625</b>
Highest (mm)	303.1	267.7	293	219.7	219.8	195	177.7	157.5	280.1	247.1	231.2	288.8	<b>1,099</b>

**Table 5.5 - Rainfall statistics for Inverell comparison**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Years of data	123	123	123	123	123	123	123	123	123	123	123	123	-
Mean (mm)	98.7	83.6	65.1	43.3	47.9	49.7	50.7	44.4	48.5	67.7	73.9	90.8	<b>794.3</b>
Lowest (mm)	3.7	0.5	2	0	0	1.4	0	0	0	7.4	0.3	5.6	<b>527</b>
Highest (mm)	266.2	313.1	209.8	218.8	212.3	166.9	174.1	158.4	238	207.7	276	312.7	<b>988</b>

### 5.2.3 Temperature

The mean minimum and maximum temperature data for each of the Glen Innes and Inverell BOM weather stations for the respective record periods is outlined in Table 5.6. Mean maximum temperatures at Glen Innes site are cooler than for Inverell. In summer, the higher altitude of the wind farm site may mean that temperatures are cooler than for Glen Innes.

**Table 5.6 - Temperature statistics for relevant BOM stations**

Station	Minimum mean daily temperature		Maximum mean daily temperature	
	Temperature (°C)	Month	Temperature (°C)	Month
Glen Innes - Ag Research	0.7	July	25.2	January
Glen Innes Post office	0.5	July	26.5	January
Inverell comparison	-0.2	July	30.6	January

Temperature inversions are considered a possible feature of the lowland areas within this location. Atmospheric stability is discussed further in Chapter 10 in relation to noise propagation.

### 5.2.4 Solar incidence and evaporation

Although evaporation data is limited, there is sufficient data to confirm that evaporation is as expected, greatest in summer and least in winter. The lower evaporation during winter would normally give rise to higher

soil moisture contents over winter months, however, this may be balanced by higher summer rainfall. The higher soil moisture conditions during winter are a characteristic of many locations on the Waterloo Range.

### 5.2.5 Wind data collected at the site

Detailed wind speed and direction data has been collected at and adjacent to the Glen Innes Wind Farm site since 1995. On-site data was initially obtained at Site M4 using a 40 metre wind monitoring mast. This mast formed part of NSW network of wind monitoring sites installed by the former Sustainable Energy Development Authority (SEDA). The role of SEDA is now undertaken by the Department of Water and Energy (DWE).

The proponent has more recently installed three additional 80 metre wind monitoring masts at the locality that have each operated for about three to four years. Data gained from the new masts provides more detail of the wind resource to assist the final design of the wind farm layout and equipment specifications. The 80m monitoring level provides greater confidence in predicting wind energy for the type of wind turbine equipment being considered for the site. As discussed in Chapter 3, temporary and permanent masts are required for performance monitoring of the installed wind farm. Monitoring masts, M1 to M3 (Figure 1.4) are likely to remain as permanent masts but if they prove to be unsuitable for performance verification or ongoing monitoring, permanent masts in other locations may be erected. However, the DWE mast will need to be removed as it coincides with turbine site 12B. An additional permanent mast may be installed as well as four temporary wind monitoring masts required for the site. The four temporary masts would be removed prior to the construction of the footings at those sites.

A graphic representation of the distribution of wind speed and direction at the site based on the Glenroy (M3) mast is shown in Figure 5.2 together with a view of the M3 monitoring mast.

As can be seen in Figure 5.2 the predominant wind direction (more than 30% of the time) at the Glen Innes Wind Farm site is from the east. The next most prominent wind direction is from the west and together the easterly and westerly winds account for about 50% of the winds measured at the site. The contributions from the north and south are only about 8% of the wind at the site.

The final layout and detail of siting of the wind farm will rely on the results of detailed analysis of the wind speed data and an energy model derived from data gained from the three monitoring masts (M1 to M3).

### 5.2.6 Wind energy model

Modelling of wind energy data has confirmed the site's capability to sustain a viable wind farm. A wind energy map showing relative wind power distribution for the site is included as Figure 5.3. Turbine locations can be seen relative to the energy zones but the locations of turbine sites shown differ slightly from that in the proposed array. Some high energy locations have not been selected due to environmental and/or access constraints.

## 5.3 Air quality aspects

### 5.3.1 Existing air quality

Due to the moderate rainfall in the Glen Innes area and reasonable grass cover there is less likelihood of air borne dust than for other drier parts of the state.

The existing air quality in the Glen Innes-Severn Shire can vary with the seasons in response to airborne particulate matter associated with windy and dusty conditions and events such as bushfires. Visibility can be affected under severe conditions and it is possible that some people could experience some discomfort associated with the conditions. Visibility can also be affected by climatic factors such as low cloud cover on the ranges and fog and mist in the lower areas.

The locality is distant from major industry and accordingly air quality at the location is not likely to be significantly affected by visible industrial air emissions. The site is also distant from the New England

Highway, some 12 kilometres to the east and traffic volumes for the Gwydir Highway in the immediate locality of the wind farm are low to moderate. It is unlikely that any impact from highway vehicle emissions on air quality at the wind farm site would be significant.

A small quarry site exists to the north of the wind farm adjacent to Sinclair Lookout access road. While it appears abandoned and not currently in use, if operated in an uncontrolled fashion it may be associated with some local dust generation.

Agricultural activities such as ploughing of fields can also be associated with air borne dust.

### **5.3.2 Impacts of the operation wind farm on air quality**

The wind farm represents a low emission form of electricity generation that will have very little impact on the air quality of the locality once operational.

The turbines will not produce emissions at the site. The very low emissions associated with the project are mainly associated with the manufacturing of equipment at other locations and transport of equipment and materials to the site. When operational, vehicle emissions associated with the small number of operators and maintenance staff visiting the site will be negligible. Overall, there will be net savings in emissions for electricity generation associated with this renewable energy project to the extent that fossil fuelled electricity generation at other sites is displaced (Chapter 13).

Dust generation can be associated with construction earthworks and control measures will be employed to address this aspect. Due to the small areas of earthworks required for the wind farm relative to local rural activities such as ploughing of fields, dust generation is likely to be relatively minor compared to agricultural activities in the broader area.

### **5.3.3 Impacts on air quality during the construction stage**

The construction stage involves a significant amount of earthworks and the transport of large amounts of equipment and materials to the site as described below.

#### **5.3.3.1 Earthworks**

Exposure of soils for foundations and access track construction and the formation of topsoil and weathered rock stockpiles means that there is potential for the wind to create airborne dust that could degrade local air quality, albeit temporarily. Control measures will be incorporated in the works to ensure that such impacts are minimised. The controls could include:

- rolling and possibly wetting of access tracks with water to compact loose soil exposed during initial track formation
- if necessary, application of approved wetting agent to exposed soil during dry and windy periods
- capping of access tracks with gravel to suit the track usage requirements and limit dust generation
- stabilisation of exposed soils and stockpiles
- where necessary, placement of stockpiles in locations sheltered from wind and surface flows
- restoration of disturbed areas as soon as possible

These measures will be integrated in the project Soil and Water Management Plan (see also Section 5.5.4). Where use of local water supplies is required for dust control the extent of water use can be balanced against water supply availability and severity of dust events in the context of other rural activities. This may require consultation with Council and DECC to determine the approach that is acceptable for addressing air pollution while conserving local water resources.

### 5.3.3.2 Vehicle movements

All vehicles delivering equipment, materials and personnel to the site during the construction stage will be registered vehicles that are required to maintain the necessary emission controls. These vehicle movements will be confined to the construction period of six to twelve months and their impact on local air quality is likely to be negligible.

## 5.4 Geology

This section of the Environmental Assessment describes the geology of the project area, the associated mineral resources, geotechnical considerations and earthquake potential for the site. Measures incorporated in the project to address these aspects are outlined in the following sections.

### 5.4.1 Regional and site geology

The Waterloo Range is within a geological domain comprising extensive cover of Tertiary basalt rocks. Underlying rocks include the Emmaville Volcanics a sub group of the Late Permian Wandsworth Volcanics. Alluvial sediments derived from generally volcanic rocks are present in the valleys along water courses. The geology of the area in the vicinity of the Glen Innes Wind Farm site is illustrated on Figure 5.4 which is based on information published by the NSW Department of Mineral Resources (DPI, 2007).

The whole of the wind farm site is represented by Tertiary basaltic rocks that have been subject to varying degrees of weathering. Weathering of the basaltic rocks has resulted in red brown and black soils. The rocks are in places exposed at the surface and elsewhere on the ridges are generally at shallow depth.

The basaltic rocks demonstrate a layered structure with some layers appearing more resistant to weathering than others. The more resistant horizons have formed small plateau areas flanked by steeper and in places rocky slopes. The less resistant horizons show less rock outcrop and a more rounded surface, for example the upper part of Reddestone Creek. In places rocky hills (eg Waterloo Sugarloaf) and rocky hillocks (two are located between Turbine Sites 12B and 12C – see Plate 5.6) can be observed and some observers have suggested that these are former igneous vents. Outcrop of more resistant rocks is in some places seen as benches or breaks in the slopes surrounding the ridges.

The access tracks for the project follow the ridges and in places cross the lower topographic areas including saddles and creek crossings but are mainly located in the upper parts of the creek catchments where alluvial deposits are less well developed.

Areas of alluvium are present along the four adjacent creeks, namely Wellingrove Creek, Furracabad Creek, Boyds Creek and Reddestone Creek. These creeks in the past have been associated with prospecting and in places mining of gemstones.

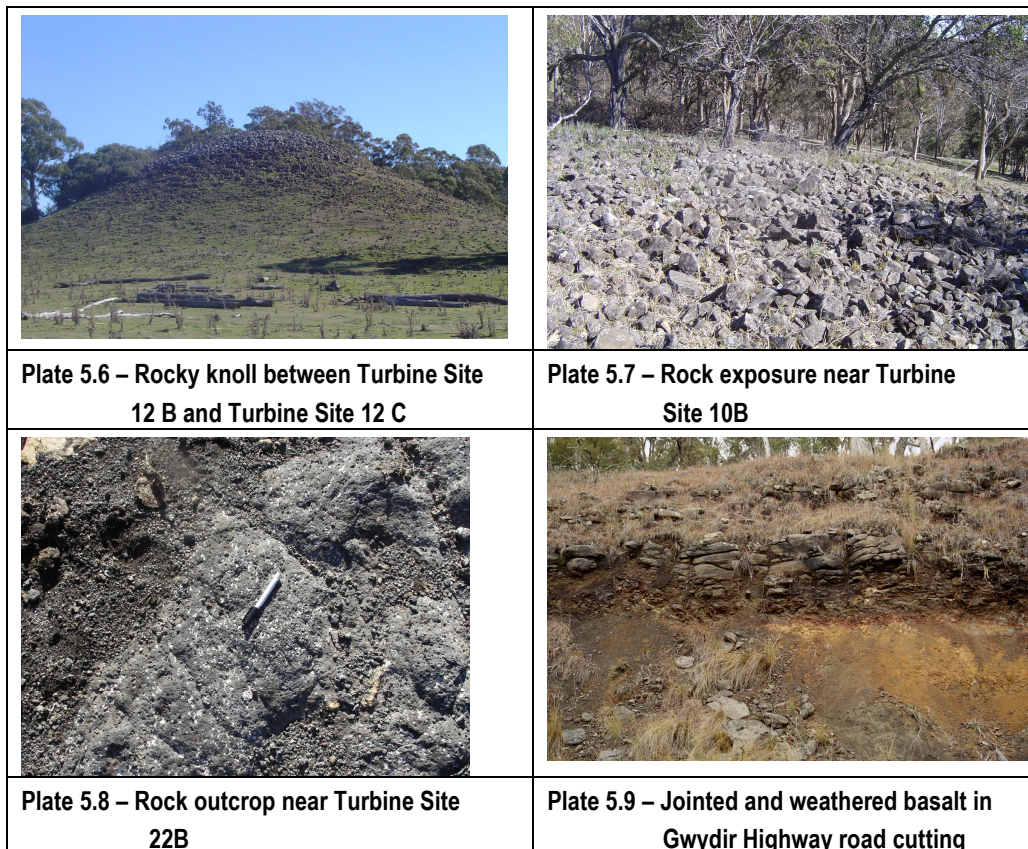
### 5.4.2 Geological structure

The geological domain is referred to as the New England Fold Belt, which extends from the Hunter Valley in the south northward into Queensland. Major faults and fractures divide the Belt into distinct blocks, the Glen Innes area being the central block which is overlain by Tertiary volcanic rocks and in the lowland areas, Quaternary sediments.

The geological sequence has been faulted and folded with several major north–south trending thrust faults recognised in the area. A number of large faults occur several kilometres from the wind farm site. No major faults are shown through the middle of the site but the presence of widespread basalt in this area may mean that such features would be less easily distinguished or may have preceded the Tertiary basalt cover and be only applicable for the underlying strata.

The main geological structure evident at the site is the gently sloping basalt layers of which the more resistant ones form the flat ridge-top areas. The more resistant basalt horizons can also be seen to form benches on slopes flanking the more elevated ridges.

The weathering process has resulted in the formation of broad flat alluvial soil deposits in the valleys of the creeks that surround the project area.



#### 5.4.3 Mineral potential

The main mineral deposits that have been mined in the Glen Innes locality include gemstones, particularly sapphires and to the north, alluvial tin, bismuth and molybdenite. Much of the mining in the region has now ceased and rehabilitation of mined areas effected. There are indicated to be small occurrence based mineral deposits, such as clay, tin, gold, arsenic and sapphires, located in close proximity to the proposed wind farm site. The NSW Department of Mineral Resources has indicated that the Wellingrove Creek (to the west of the proposed wind farm), Furracabad Creek (to the south east of the proposed wind farm), Boyd Creek (to the west of the proposed wind farm) and Reddestone Creek (to the East of the proposed wind farm) are potentially sapphire bearing creeks and it is indicated these have been worked in the past. The project does not impact these locations.

There is no indication of any other metalliferous mineral deposit within the project area that could conflict with the development of the wind farm project. A review of the NSW Department of Mineral Resources' records showed that Hardy Marr Constructions Pty Ltd holds the nearest exploration licence title for structural clay. A representative of Hardy Marr Constructions was contacted regarding the proposed wind turbine development but indicated that its exploration licence area is close to town and there will be no impact on its operations.

#### 5.4.4 Geotechnical assessment

A preliminary field inspection of the site has assessed the nature of the ground in the vicinity of the turbine sites and the likely underground cable routes. This will be supplemented by a geotechnical investigation for the contract works to assess the subsurface characteristics. Initial assessment has revealed some variability in rock characteristics but no obvious geotechnical constraints that would preclude the proposed development. The preliminary survey found that:

- The potential turbine sites are located on stable ground on the ridge tops comprising basaltic rocks and appear to have acceptable foundation conditions. Rock outcrops are also located along the ridge tops and in grass covered areas rock is expected to be at shallow depth. A significant proportion of the turbine footings may intersect resistant rock requiring hydraulic rock breakers. It is not expected that any low level blasting will be required to remove the basalt as the rock is expected to be jointed enabling removal with the hydraulic rock hammers and bulldozers or excavators. Plate 5.9 shows jointed basalt exposed in a road cutting for the Gwydir Highway where it crosses Waterloo Range. Softer clay layers are also apparent in the road cutting exposure.
- In the unlikely event that low level blasting is required, it will be confined to small localised areas and performed in a controlled environment in accordance with all statutory and project approval requirements. Potential impacts from blasting may include noise, ground vibrations and overpressure, however, on such a small scale no landscape changes will occur. Mitigation measures to address potential impacts from blasting are outlined in Chapter 10. In addition, DECC requirements will be adhered to in respect to controlling blasting impacts at residence, should low level blasting occur.
- As far as possible, the locations of the access tracks have been selected to avoid steep slopes and provide reasonable grades. Based on the initial observations, the existing ground surface is stable and in most cases appears to provide a solid sub-base material for access track construction. The existing track to Ross Hill does not show any signs of erosion. Some areas of high erodibility in valley areas and for steep sections of track may require special treatment to avoid erosion of the track. Suitable roadbase material is likely to be imported from outside the project area (subject to appropriate testing and any approvals required). Where access tracks cross any alluvium filled creek valleys it may be necessary to increase the thickness of road base material and provide suitable drainage measures.
- Installation of underground cables is likely to require some excavation in rock and will encounter a range of conditions given the observed variation in the basaltic rocks.

Further geotechnical assessment will be undertaken prior to finalising the project design.

#### 5.4.5 Geological hazards

The region in which the project is located is indicated to have low earthquake activity. Two relatively recent earthquakes occurred between Glen Innes and Inverell in April 1999. The two earthquakes were separated by 12 minutes and registered 2.8 and 3.0 Richter Magnitude Level (RML). There are no known major active volcanic or surface tectonic structures in the project area.

The structure of the basaltic rocks at the site has produced a generally rolling topography with limited areas of small basalt cliffs (or steeper slopes) mainly for the southern half of the wind farm. For areas of steeper slopes, slumping can be a hazard that may be initiated by heavy rain and exacerbated by poor drainage design. A landslide in February 1997 occurred just 15 kilometres south of Glen Innes on the New England Highway. The landslide was triggered by 102 mm of rain in a 24 hour time period, which caused loose soil to slide over a part of the highway, where it cuts through an embankment. There were no fatalities. There is no evidence of any large scale landslides at the site which could influence tower or access track stability. Nevertheless attention will need to be paid to formation of tracks on the steeper slopes and formation of associated drainage.

Footings for the towers that support the wind turbines will be designed in accordance with the relevant engineering standards.

## 5.5 Soils assessment

This section of the Environmental Assessment provides a description of soils within the project area, the potential impacts of the project on the soils and measures to mitigate the impacts.

### 5.5.1 Soil landscapes

No recent soil landscape mapping has been published for the Glen Innes locality. Contact was made with staff of DECC soils section who advised that soils landscape mapping is being undertaken but results are not able to be released yet. The soils characteristics provided here for the project site is based on visual observations of land forms and two local soil studies conducted in 1977 and 1994.

The typical landscape of the area encompasses broad valleys surrounded by basaltic hills that show distinctive benches and terraces. Along the ridgetops the soils are predominantly shallow, skeletal soils, with deeper soils found on the lower slopes, valley floors and drainage lines.

The substation and turbines will be predominantly located on Chocolate-Prairie soils on the upper slopes of basaltic knolls and ridges. The Chocolate-Black soils, which are generally below the level of the wind farm, occur on the lower slopes and valley floors. The main features of the relevant soil types are summarised in Table 5.7.

**Table 5.7 – Summary of soil landscape characteristics at the wind farm locality**

Soil Type	Main rock types	Soil Landscape – main characteristics	Erodibility
Chocolate-Prairie	Basaltic	Chocolate soils – Red / Chocolate in colour, shallow (less than 1 metre), stony in places. Surface soils are usually clay loams or silty clay loams to light clays. Clay content increases with depth and shows a tendency to crack into the subsoil. Well drained, but become saturated with prolonged rain.  Prairie soils – deeper, high organic matter, excellent medium angular blocky structure and clay loam to clay texture.	Slight to moderate sheet erosion. Some local severe sheet erosion and rilling on steeper slopes
Chocolate-Black Earths	Alluvium	Infiltration and drainage is poor, causing localised waterlogging. A large proportion of the black soils have high clay content and tend to shrink, swell and crack with changes in moisture content, especially if the black earths are greater than one metre in depth.	Slight to moderate sheet erosion. Gully erosion along drainage lines.

Within each soil landscape there is scope for variation in the characteristics of any particular location based mainly on:

- the lithological variation within the underlying rock unit
- the degree of deformation, alteration, metamorphism or weathering that the rocks have undergone
- the aspect and slope of the location that influences drainage and weathering characteristics

Plate 5.10 shows the soils exposed in Seven Mile Gully (east of Turbine Site 17). Plate 5.11 shows soil excavated at a small farm quarry site to the east of the wind farm. Instances of erosion are rare and for most parts of the site, substantial grass cover is present.



**Plate 5.10 – Soil exposed a crossing of the upper part of Seven Mile Gully east of Turbine Site 17**



**Plate 5.11 – Soil stockpiled adjacent small, shallow quarry west of Reddestone Creek**

### 5.5.2 Potential impact on the soils

The erodibility of the relevant soil types is indicated in Table 5.7. The Chocolate-Prairie soil types, which cover a high proportion of the wind farm site, have a low to moderate potential for sheet erosion. Observations of slopes in these areas indicate reasonable stability and resistance to erosion. In general, the project will involve limited extent of disturbance of the slopes. Given the nature of the construction works, comprehensive controls to minimise erosion will be applied to limit any potential for erosion.

It is noted that the area has moderate rainfall with higher rainfall in summer. Soil moisture will be dependent on time of year. While summer periods generally have higher rainfall and potentially are associated with moist soils this may be balanced by higher evaporation rates. Given the elevated nature of the sites and occurrence of strong winds the potential for dust generation is an important consideration for earthworks. This is particularly applicable for construction undertaken during dry periods with low soil moisture.

When undertaking earthworks, it will be necessary to relate each of the component works to the soils impacted, their erodibility, the extent of soil disturbance, slopes on which the works take place and the season and potential rainfall events. Based on these factors appropriate control measures will be assigned for the potential impacts. A Soil and Water Management Plan will be prepared for the project and the contract works will be undertaken in accordance with the plan. The plan will be prepared in conjunction with the contractor that will undertake the works based on the work methods to be used.

Restoration of areas disturbed by the construction works will also need to consider fertility of the soils in selecting vegetation species for the restoration works. In general, restoration works should have reasonable effectiveness based on the typical rainfall and the extent and appearance of the existing groundcover.

### 5.5.3 Slope analysis

A slope analysis for the wind farm site is shown in Figure 5.5. The steepest slopes at the wind farm site are for small cliffs around some of the peaks at the site and for the western side of the site where it falls away steeply to Wellingrove Valley. None of the access tracks are located on the steeper western slopes of the Waterloo Range and there will be limited disturbance of the steeper areas at the wind farm locality. Most of the development, including the access tracks will be on flat to gently sloping ground. A number of points on the access tracks will need to be designed to minimise the grade and include drainage to avoid erosion of the various slopes. These locations include the track between turbines 9 and 10B, from turbine 16 to 17, the

ascent to the ridge where turbines 18 and 19 are located and the ascent on to the ridges where turbines 10 and 20B-22B are located. Earthworks in these areas will be designed to ensure that the completed formations are stable in the longer term.

The development of the wind farm will only affect a small part of the total land area and landowners will continue to use the wind farm site for its prior grazing purpose with little reduction in the grazing area available.

#### **5.5.4 Measures to mitigate erosion and sediment discharges**

A Soil and Water Management Plan (SWMP) including erosion and sediment controls will set out the measures to mitigate the potential impacts of the construction works on the soils at the wind farm site. The measures are outlined below and will be incorporated into the management of construction works as outlined in Section 15. The SWMP and detail of specific measures to be used will be provided prior to construction commencing. Erosion and sediment control measures will be designed to:

- divert surface runoff away from areas of earthworks or soil stockpiles
- reduce the energy of surface flows in areas of potential erosion
- prevent sediment laden or contaminated water leaving the construction site
- provide containment for sediment entrained in surface flows
- reduce susceptibility of disturbed areas to erosion and include prompt revegetation of disturbed areas

Such measures may include:

- construction of drains and check dams
- construction of diversion banks, perimeter banks and level spreader sills
- use of sediment traps
- sediment fences around stockpiles and areas of earthworks
- stabilisation of temporary and permanent batters
- straw bale and geotextile filter fabric sediment traps and filters
- minimising periods that disturbed soil is exposed with potential to be eroded

All erosion and sediment control devices will be maintained in satisfactory working order until such time as the disturbed areas have been stabilised to the satisfaction of Glen Innes Wind Power and the respective landowners. Erosion and sediment devices will be inspected regularly after each rain period and during periods of prolonged heavy rain and any defects rectified promptly.

Topsoil suitable for stripping and re-use in revegetation will be stockpiled. Stockpile sites will be clearly identified and selected to be free from traffic and away from drainage lines and watercourses. They will be managed to minimise erosion and loss of topsoil where necessary with surface stabilisation to prevent wind erosion.

Disturbed areas will be required to be stabilised in accordance with the following principles:

- temporary vegetation or mulch will be applied to all disturbed areas, including soil stockpiles that remain exposed for a period of 30 days or more
- all temporary earth diversion banks and sediment basin embankments will be seeded and fertilised as soon as practicable after construction and take into account the growing seasons
- stabilisation of all batters will be commenced within one week of completion of formation

The small size of the areas to be disturbed for the installation of the wind turbines, access tracks and associated facilities, combined with the development of detailed site management and rehabilitation

procedures will mean that potential problems due to the disturbance of soils on the site can be effectively managed.

At the conclusion of construction, all temporary tracks and areas disturbed by construction work including cable routes and hardstand areas surrounding the wind turbines will be reinstated and revegetated. All temporary control measures will be removed when revegetation has established on formerly disturbed areas and will be disposed of in a satisfactory manner. Follow up maintenance will be undertaken until the areas are satisfactorily stabilised and restored.

## 5.6 Site drainage, water resources and water quality

This section of the Environmental Assessment describes:

- the existing surface drainage of the project area
- the potential impacts of the project on the drainage systems and measures to mitigate any impacts
- the water resources required by the project, the means by which the water will be supplied and an assessment of the ability of the local resources to supply water for the project

### 5.6.1 Regional and site drainage

The project area is located on the Waterloo Range within the Border Rivers-Gwydir catchment (Severn River sub catchment) as shown in Figure 5.7. Drainage of the windfarm site is to the creeks shown in Table 5.8 to the east and west of the site and subsequently to the Severn River.

**Table 5.8 –Sub-catchments draining the wind farm site**

Sub-catchment	Description of Location
Wellingrove & Boyd Creeks (western)	Located to the west of the wind farm site. Boyd Creek is a tributary of the Wellingrove Creek. Earthworks will be on the crest of the Waterloo Range above the eastern slope of these valleys. It is not expected that Wellingrove or Boyd Catchments will be impacted by the project due to erosion and sediment controls at the site and the works being largely in the adjacent catchments.
Furracabad Creek (south east)	Located to the south east of the wind farm. Few of the works will impact this catchment and erosion and sediment controls will be used to prevent any impact.
Reddestone Creek (north east)	Located to the north east of the windfarm. The substation and the construction site office may be within this catchment. Erosion and sediment controls and for the substation oil spill containment will prevent impact on this watercourse.
Black Plain Creek Catchment (north)	Located to the north of the site in the vicinity of the access to the site. There is minimal activity with potential to impact this catchment.

During site investigations between April and August 2007 the upper parts of the creeks at the wind farm site were not observed to be flowing due to the dry conditions and also indicating that springs are not active in this part of the catchment. Based on the observations it is not expected that any significant groundwater resources are present in the elevated ridges of the Waterloo Range.

### 5.6.2 Drainage considerations and potential impacts on the watercourses

The locality has moderate annual rainfall (about 850mm/year) typical of the elevated New England areas away from the coast. Winter is generally associated with lower rainfall but due to lower evaporation, soil moisture can be higher during this time. Storms are possible at any time during the year but are more common in summer periods.

The ridges on which the turbines will be located have no permanent watercourses. There are a few dams on the upper slopes adjacent to the ridges top. Water is pumped up to a farm dam near Ross Hill. The surface

waters do not supply drinking water for humans in the immediate vicinity of the project area but can be used by stock.

All construction works will include erosion and sediment control measures to mitigate potential sedimentation impacts on watercourses (Section 5.5). All creek crossings will be constructed to avoid obstruction of natural flows or erosion of stream banks.

Flooding will not affect the ridges where the turbines will be located but at times of heavy rain parts of the access tracks may be temporarily affected by swollen creeks or ponded water. Areas of flooding hazard are not likely to significantly affect the Glen Innes Wind Farm construction or operation. The design and construction of creek crossings for site access will address the potential for occasional flooding along some of these water courses.

As most of the site constitutes elevated areas with low to moderate slopes flanking the sites the proportion of run-off to infiltration would therefore normally be high. A degree of infiltration can be expected and this will mitigate the runoff potential. It is reasonable to infer that the groundwater recharge on the ridges is likely to be less than for more low-lying areas and no springs were observed discharging from the upper slopes.

A water supply will be required for the construction stage of the project as described in Section 5.6.7. Due to the relatively short duration of the construction period it is not expected that the water resources supply to the project will have any significant impact on water resources at the locality.

The potential for the project to impact local watercourses varies with the stage of the project. The following discusses the potential impacts during the construction and operational phases of the project.

### **5.6.3 Potential impacts of the construction phase**

The construction works will involve earthworks, storage and handling of equipment, pouring of concrete for footings and use of facilities for the construction workforce.

Activities that will need to be managed to avoid impacts on the local drainage system include:

- soil disturbance associated with earthworks, including roads, trenches and foundations
- creation of temporary stockpiles of soil and rock
- works associated with crossings of watercourses
- removal of sewage effluent from construction workforce facilities
- storage and handling of fuels, oils and chemicals

Some of the activities will take place at multiple locations over a large area and will require that each location has appropriate measures to address potential impacts of the project.

A Soil and Water Management Plan will be prepared for the project (Sections 3.10.3 & 5.5.4) and form part of the project Environmental Management Plan (EMP). It will include the relevant soil and water management measures to address the potential impacts. Such measures will include:

- design of earthworks to minimise erosion and sedimentation
- diversion of water flows around disturbed areas or stockpile areas
- sedimentation controls (eg. sediment fences, hay bales, contour drains) below work areas and below stockpiles
- stabilisation of stockpiles until required
- excavations kept open for a minimal period
- disturbed areas to be stabilised and revegetated promptly after works are undertaken
- where possible, timing of earth works to target favourable weather conditions
- bunding of any fuel or oil storage

- a sediment detention pond will be installed at the Site Office. The pond will be sized in accordance with the CALM Method for sediment basin design that includes consideration of soil characteristics, rainfall intensity, ground cover and slope. In practice, the site office area will be compacted by vehicle movements and have a lesser potential for erosion and sediment transfer than would otherwise be the case.

#### **5.6.4 Potential impacts of the operational phase**

The operational phase of the wind farm will have minor potential for impact on the local drainage system. Potential impacts could relate to:

- a low potential for loss of oil from electrical or mechanical equipment which is discussed below
- the installation of a septic system at the facilities building.

#### **5.6.5 Oil in transformers**

Some of the transformers to be installed as part of the development will contain oil and it is possible that loss of oil may occur due to equipment failure. In order to minimise the risk of water or soil contamination by oil, the following measures are proposed:

- One or two 33,000 volt to 132,000 (or 66,000) volt transformers with a combined rating of 50 to 85 MVA will be located within the substation. Together they may contain about 25,000 litres of oil. Accordingly, the transformer(s) will be located within a bunded area designed to contain any transformer oil in the event of leakage or spillage. Secondary containment, utilising an earth dam with underflow discharge or oil/water separator will also be provided. This secondary containment will be of sufficient size to retain the transformer oil in the unlikely event that it was released from the transformer and not contained in the transformer bund. Spill response equipment will be maintained on site and the site will maintain a site-specific emergency response plan. In addition, the proposed site is located on relatively flat land distant from watercourses which will further reduce the potential for environmental impact.
- The 690 volt to 33,000 volt generator transformers associated with each turbine site will be either oil filled if on a pad near the base of the tower or dry type if located in the nacelle. If oil filled transformers are used they would include internal oil containment to retain any oil leakage. Any leakage that escaped the containment would only affect a relatively small area around the transformer that could be effectively remediated. Regular inspection of the transformers and associated turbine equipment will be carried out to ensure that they remain in good working condition and are leak free.
- The nacelles and supporting tower structures will be designed to contain any lubricating or hydraulic oil in the event of spillage or leakage.
- A small store of oil will be maintained on-site for maintenance purposes. Any facility for storage of oil will be purpose designed with sufficient containment for potential spillage and include spill recovery equipment and materials. Procedures for maintenance will be documented and followed by maintenance staff.

#### **5.6.6 Battery systems**

A small bank of batteries will be required at the substation to supply backup power for control systems in the event of failure of the grid supply. These batteries will be located in the facilities and/or auxiliary services buildings and will be maintained by routine checking and adjustment of electrolyte levels and as necessary replacement of batteries. The building design will ensure that any spillage is unlikely to escape the building.

### 5.6.7 Water supply for the project

Once operational, the project will require a relatively small water supply and this will be supplied primarily from roof drainage at the facilities and auxiliary services buildings and if necessary by importing water.

The construction phase will have a greater requirement for water and it is expected that water may be imported during that time. The quantity of water required on site for dust control, domestic use and fire fighting reserves may vary depending on the timing of the works, weather conditions and site practices. Over the construction period a total amount of about 2-5 megalitres (ML) may be required for activities undertaken on site. Where the construction phase corresponds with drier conditions this may necessitate more water for dust control.

If a concrete batching plant were to be used on site then additional water may be required but as mentioned previously concrete is likely to be imported to the site

The water supply for the construction phase is likely to be obtained from local water supply sources as required. Potential sources of water supply could include:

- Glen Innes water supply. Adequate supply indicated and short cartage distance, about 12 kilometres.
- Severn River may be a possible supply, but has not been assessed
- Inverell water resource may be more constrained than Glen Innes, and cartage would involve transport of about 50 kilometres
- Groundwater supplies may be obtained in valleys around the site. However, that could conflict with local users. The short term nature of the extraction is unlikely to significantly affect the potentially large water resource contained in alluvial sediments.

Glen Innes currently sources its water from the Beardy Waters (river) that has a current capacity of 488ML. In addition the Glen Innes Severn Council has implemented recent initiatives to ensure a secure supply for the next 20 years. These initiatives include:

- Drought management plan implemented
- Demand management plan implemented
- Pressure management and leakage control project in progress
- Groundwater bores in process of being brought on-line
- Saleyards truck wash water recycling being investigated

Council also has a backup water supply located on the Mann River, just east of Glen Innes. The Mann River is an eastward flowing river in the Northern Rivers Catchment (as opposed to the Beardy Waters which is a westward flowing river in the Border Rivers Catchment). The town of Deepwater has its own separate supply off the Deepwater River.

Glen Innes has a modern water filtration plant with a capacity of 15 ML per day. Typical daily consumption is indicated to be 2-3 ML per day which is about the order of on site water supply required over the full construction period for the Glen Innes Wind Farm.

Subject to agreement of Council, the use of the water supply from Glen Innes for the construction phase is considered to be the most likely source. The total amount represents a small proportion of the available local water supply. Use of Glen Innes water supply will not compete with other users of local surface water supplies. The contractor will be required to negotiate arrangements for water supply at the time of construction and the actual amount will depend on the work methods proposed by the contractor as well as conditions at the time.

## 5.7 Land use

This section of the Environmental Assessment describes the land use applicable to the wind farm site, the neighbouring properties and the immediate locality. The locality comprises mainly cleared pastoral land with low to moderate density rural residential development. The site and the neighbouring lands are wholly within Zone 1(a) (Rural) of the Severn Local Environmental Plan (LEP). The objectives of Zone 1(a) include protecting and conserving the productive capacity of the land for uses such as agriculture, forestry, mining, water resources and rural residential. The wind farm development is able to co-exist with the existing use of the land for grazing and is considered as consistent with the productive use of the natural resources of the locality including harnessing the wind energy resource at the locality. The existing land use of the wind farm site and neighbouring areas are described in the following sections.

### 5.7.1 Existing land use on the wind farm properties

The wind farm site is located on five moderate sized rural properties that are predominantly used for grazing. The five landowners have entered into lease agreements with Glen Innes Wind Power for the co-use of the property for a wind farm. The locations and extent of the properties on which the wind farm would be located are shown in Figure 1.5. As shown in Table 1.1, there are up to 27 turbines proposed to be located on the five properties. The turbines are spread along the range occupying the elevated areas with suitable wind energy resource. The number of turbines proposed for the site has been influenced by the capacity of the grid to which the wind farm will connect and the negotiations with the landowners involved.

Each of the properties has extensive clearing and now comprises large areas of grassland with varying degrees of scattered trees. Some remnant woodland areas have been retained on parts of some of the properties but these areas are generally unsuitable for wind farm development and have not been included as part of the development. The density of rural settlement in the vicinity of wind farm site is low and contrasts with the low to moderate settlement density closer to the Glen Innes township. The pastoral and residential activities will continue and will not be significantly affected by the operation of the wind farm. Some disruption to the normal land use is expected during the construction stage.

The Ross Trig Station is close to Turbine 7, which will be located so that survey operations at the trig station are not impacted by the development. Two communications facilities are also located toward the middle of the wind farm site. Details of the communication facilities and potential impacts are provided in Chapter 11.

Existing land uses that are applicable to the wind farm site include:

- grazing currently occurs across the whole of the wind farm site
- three rural residences on two properties, one of the residences (Hillside) is vacant
- survey reference point at Ross Trig Station
- two communications facilities near Ross Hill (Telstra and NPWS facilities)

### 5.7.2 Land use of properties adjacent to the wind farm site

Neighbouring properties to the wind farm site vary in size (see Figure 1.5). Most are primarily used for grazing of various types of stock with or without rural residential use and limited cropping. Several of the smaller neighbouring properties appear to have residential usage as their primary function. The locations of rural residences surrounding of the wind farm site are shown on Figure 10.1. The closest neighbouring residence, Mayvona, is at 850 metres from the nearest turbine but the residence is dilapidated and not occupied. The owner of Mayvona has a residence to the east of Cherry Tree Road about 1920 metres from the nearest turbine. The closest occupied residence is Highfields at 950 metres. All other neighbouring residences are at distances greater than one kilometre.

There is a public lookout at the northern end of the wind farm which can be reached by a short section of unsealed road from the Gwydir Highway. Sinclair lookout is represented by a turning circle at the top of the access road and has no facilities to encourage visitors to stay on at this location. Its position on the ridgeline

provides views of the country to the west of Waterloo Range. The lookout could serve an additional purpose as a wind farm viewing area once the wind farm is installed with close views to the northern end of the wind farm, particularly in respect of Turbine 1.

### 5.7.3 Review of land use types for the wind farm locality

**Grazing:** The use of grazing land for development of the wind farm will not significantly affect its future potential for grazing. Once developed, the area of land required by the wind farm structures will be a minor fraction of each property. During construction there may be a greater impact due to the increased numbers of people on-site, movement of large equipment and materials, earthworks and temporary storage of equipment. The areas affected during construction will depend on arrangements with the landowner and the contractor's scheduling of the various construction activities. The environmental management for the construction works is described in Section 3.10. Grazing activities on neighbouring properties will not be impacted by the construction or operation of the wind farm.

**Rural residential:** The density of rural residential settlement in the area surrounding the wind farm is mostly low. About 30 residences are located within 3 kilometres of the wind farm site. The distribution of the neighboring residences within 3 kilometres of the wind farm is shown in Table 5.9 below. The residence categories in Table 5.9 distinguish occupancy status and whether the owner is a participant (wind-farmer) and has leased their land for the purpose of the wind farm development.

Preliminary information on the proposed development has been made available to the local community and a range of views on the development have been obtained as discussed in Chapter 4.

**Table 5.9 – Proximity of neighbouring residences to the wind farm**

Distance of residence from nearest turbine	Total Number of residences	Wind-Farmer		Non-Wind-Farmer (neighbour)	
		Vacant	Occupied	Vacant	Occupied
0 to 1 kilometres	3	1	0	1	1
1 to 2 kilometres	7	0	1	1	5
2 to 3 kilometres	17	0	2	2	13
0-3 kilometres	27	1	3	4	19

Note: A wind-farmer residence is one where the owner has leased their land for the wind farm development

Issues that are often raised as potential impacts of wind farm projects on neighbouring residences are visual, noise, shadow flicker, interference to telecommunications, traffic impacts during construction and reduced property values. Each of the issues has been described by this Environmental Assessment as well as the controls to mitigate any potential impacts. The Approval Authority will also review the material provided in the Environmental Assessment together with any submissions of agencies, neighbours and the broader community in the determination of the appropriateness of the proposed development and any approval conditions to be applied.

**Trigonometrical Stations:** There is one trigonometrical (Trig) Station within a relatively close distance of the wind farm. The proposed Turbine No. 7 is located about 50 metres to the south of the Ross Hill Trig Station. A second Trig Station is located on Waterloo Sugarloaf about 500 metres west of Turbine 13B. Table 5.10 summarises the relevant details of each of these Trig Stations.

Line of sight between Trig Stations can also be a consideration for the project's impact on survey operations. The final locations of the turbines will be assessed in relation to the existing survey sight lines and where possible the turbine locations will ensure that sight lines are unaffected or that alternative sight markings are provided either on selected turbine towers or by other means as agreed with the NSW Lands Department.

**Table 5.10 – Trigonometrical stations in the project area**

Trig Station	Group of turbines	Date Installed	Description	Land Title	Status for survey work
Ross	Within Northern Group (near Turbine 7)	Circa	Concrete pillar with mast and vanes. Two reference marks.	Non-reserve	Major station
Waterloo Sugarloaf	500 m west of South Western Group	Circa	Cairn and mast	Non-reserve	Minor station

The potential impacts of the development on the use of the Trig Stations by surveyors relates to:

- Interruption to the “line of sight” to overhead GPS satellites
- Interruption to line of sight for making direct observations between adjoining trig stations using conventional angle and distance observations

The details of the project have been provided to the Survey Infrastructure & Geodesy section of the Department of Lands seeking comments on any potential impacts on the surveying operations that use the Trig Stations in the wind farm location. A response was obtained in November 2007 (Appendix B2) and the following summarises the key points from the Lands Department response.

Extensive investigations of the wind farm proposal for Waterloo Range were conducted by Lands Department based on the project information provided to the Department. The investigations concluded that Trig Station Ross is an important trigonometrical station, as it is one of NSW fundamental stations that is known as a "Spine" station, having the highest order of accuracy in the State's geodetic survey network. In addition, Trig Station Ross is indicated to have orthometric level values, which significantly add to its strategic survey value, and in respect of the creation of an accurate terrain model of the State.

Due to the Turbine 7 being located to the south of the mark and that it may in fact not be operating all of the time, the Lands Department had no objections to the construction of Turbine 7 of the wind farm on Waterloo Range. However it was requested by Lands Department that a condition of the construction of the wind farm be that in the event that it is necessary for survey staff of the Lands Department to occupy Trig Station Ross for the purposes of making a satellite survey observation, that Turbine 7 be turned off, and the blades not rotate for the duration of the survey (which is usually only about 1 hour in duration). This requirement is acceptable to Glen Innes Wind Power and it is expected that Department of Planning will include this as a condition of the Project Approval.

In regards to Waterloo Sugarloaf, the Lands Department indicated that there are no control survey marks located on or near that point that may be affected by the wind farm development.

There is no Trig Station Reserve associated with Trig Station Ross and the micro-siting of Turbine 7 prior to construction will be further discussed with the Department of Lands to ensure that any adjustment does not inadvertently affect the Land's Department's Trig Station or potentially interrupt sight lines to other Trig Stations.



**Plate 5.12**

**Ross Trig Station and Turbine Site 7**

**NPWS Ross Hill Radio Station and power supply line are visible in distance**

**Landing strips:** The nearest aerodrome is north west of Glen Innes and approximately 9 km from the wind farm site. There are also seven local airstrips within 5 kilometres of the wind farm. The details pertaining to the Glen Innes aerodrome and the seven airstrips can be found in Chapter 12 and Figure 12.1. The wind farm development is not expected to affect the current use of these air traffic facilities.

**Utility infrastructure within the locality:** The local area has a network of local roads, power lines and communications. The Gwydir Highway is immediately north of the site and the New England Highway is about 12 kilometres east of the site at Glen Innes. Minor local roads are located to the east and the west of the site and have low usage by local residents, school bus, stock transport, delivery and service vehicles and occasional tourists (see Chapter 9 and Appendix I).

A 66,000 volt line between Glen Innes and Inverell passes to the north of the wind farm site but does not directly connect to the local electricity grid that supplies local properties. TransGrid is proposing to replace this line with a 132,000 volt line in the near future (expected in 2009). It is proposed that the wind farm be connected to this line via a 33,000 volt / 132,000 volt (or 66,000 volt) substation. Other lower voltage lines serve local properties.

Communications services in the wind farm locality include, telephone landlines, mobile phone coverage, various radio licences and satellite services. Two communications facilities are located on Waterloo Range. The NPWS Ross Hill radio station can be seen in the distance in Plate 5.12. It is possible to locate the turbines on the Range without adversely impacting performance of these facilities. Residents also have access to broadcast services including radio and television. Potential impacts on telecommunications services are described in Chapter 11.

**Future changes to land use:** The potential future changes to land use at the locality could include different types of pastoral activities, possible subdivision of land and increasing rural residential or industrial development. Such changes may arise from changed economic circumstances, shifting population from cities to rural areas, variations to local climate characteristics or from changed landowner circumstances.

In relative terms the land is sparsely settled and significant change would need to occur before there was a need for development of a service centre at the wind farm locality. Glen Innes and Inverell are likely to continue as the closest service towns to the site.

The installation of the wind farm will not limit the future use of the land for grazing. It does not compete for resources in the local area and its benefits flow through to the broader community.

## 5.8 Social aspects

The following section reviews the existing social context of the development and its potential social impacts. It refers to the former Shire areas for which data was available and for which the assessment was undertaken. All statistics in Section 5.8.1 were sourced from the 2006 Census conducted by the Australian Bureau of Statistics.

### 5.8.1 Existing social characteristics of the Glen Innes statistical local area

The region of New England has a predominant rural character with the majority of the rural activity being sheep, cattle and horse grazing and limited cropping. Statistics for Glen Innes and Inverell local areas have been used to describe the social characteristics of this region.

The Glen Innes Severn area has a population of 8,780 (2006 census) spread over some 5,487 square kilometres, representing a density of approximately 1.6 people per square kilometre. Over a five-year period, between the 2001 and 2006 census, the population increased by 136, which is equivalent to 2.3% in total and an annual population increase of 0.47%. The nearest town centres have populations as shown in Table 5.11 below.

**Table 5.11 – Population for main population centres close to the Glen Innes Wind Farm**

City or Town	Population	Reference
Glen Innes	5,944	Census 2006
Inverell	9,749	Census 2006

The 2006 Census data identified some 2,355 family households with a mean household size of 2.4. The bulk of the population lives in stand-alone houses, with minor townhouse or flat type accommodation. There are indicated to be 572 unoccupied private dwellings within the Glen Innes area, some of which are likely to be temporary residences for their off-site owners and some which may be in a state of disrepair.

The region has approximately equal numbers of male and female constituents. The median age for the region is 43. In respect to education, 25.1% of respondents indicated that the highest level of schooling completed was Year 12 or equivalent. Approximately 4,369 persons indicated that their highest level of schooling was less than Year 12 or equivalent. About 3,095 persons (44% of people over the age of 15) indicated attainment of a non-school certificate, diploma or degree. The most common qualifications were attained in agriculture and wool sciences, nursing and health related industries, teaching and secretarial and clerical administration.

In terms of employment, 3,307 persons indicated that they are employed, of which 1,997 are employed on a full-time basis. The unemployment rate was 7.7% in 2006, which was approximately 2.5% higher than the national average at the same time. There is a high reliance on motor vehicles for transport which includes work related vehicle use.

Table 5.12 shows the distribution of employment in the top 12 industry sectors for the Glen Innes locality. The most common industries of employment are sheep, beef and cattle, education, residential care, local government and hospitals.

**Table 5.12– Glen Innes (2006) employment in top 12 industry sectors (by occupation)**

Industry Sector	Number employed	Percentage
Agriculture, Forestry and Fishing	716	24
Retail Trade	385	12.9
Health care and social assistance	368	12.3
Public administration and safety	265	8.9
Accommodation and food services	225	7.5
Education and training	209	7
Construction	179	6
Transport, postal and warehousing	155	5.2
Other Services	141	4.7
Manufacturing	140	4.7
Professional, scientific and technical services	112	3.7
Wholesale Trade	92	3.1
<b>Total (Top 12 industries)</b>	<b>2,987</b>	<b>100</b>
Total Employed Glen Innes	3,307	

### 5.8.2 Social impacts of the wind farm development

The potential factors that could contribute to social impacts of wind farm development include:

- influx of skilled people into the region during construction
- small on-site workforce once operational
- small increase in local business and some additional employment opportunities in the region
- increased activity for the immediate wind farm locality during construction
- slight increase in tourist visitation to the local area once the wind farm is operational
- any changes to the social structure of the region

The wind farm site is located on moderate to large sized rural properties. Those properties are productive and appear to be successful rural businesses. Owners have indicated that the wind farm income from leases will support maintenance of their properties. The development of the wind farm is unlikely to affect the ongoing rural use of the neighbouring lands. Neighbouring properties include both small to medium properties and larger holdings.

During the consultation undertaken to date, neighbours to the wind farm site have expressed various views in regard to the project. While many have indicated support for the project others have expressed concerns relating to visual and noise aspects of the wind farm and potential impact on land values. Visual issues for the Glen Innes Wind Farm are addressed in Chapter 6, noise issues in Chapter 10 and the issue of land value is addressed in Section 5.8.3.

Employment opportunities may flow to residents of the local Shire through direct employment during the construction stage of the project or as a result of increased commercial activity flowing to the local area. This impact is expected to be minor and is not expected to place undue pressure on local resources. Services such as accommodation, vehicle maintenance, refuelling and food are likely to benefit from the influx of construction staff. Provision of these services may be spread between nearby Glen Innes and perhaps the more distant Inverell, as well as the broader rural areas.

Persons who could benefit from the employment opportunities may include immediate neighbours to the wind farm or persons living in local towns or on rural properties within the area.

Any influx of tourists that may visit the area to view the wind farm is likely to be relatively small, but even small numbers can have a significant impact on the local small businesses. The nearby existing lookout may provide a viewing point for the wind farm and is easy to access from the Gwydir Highway. This facility would adequately provide for the needs of most tourists and visitors. Glen Innes, and to a lesser extent Inverell, will be well placed to take advantage of any increased tourist visitation to the region once the wind farm is operating.

### 5.8.3 Impact on land values

Some neighbours to the wind farm have expressed concern that their land values may be negatively impacted by the wind farm development. As there have been only a few NSW wind farms developed there is limited quantifiable information available on the impact of wind farm development on land values for NSW. This issue had been raised previously by neighbours at the Crookwell and Blayney wind farm sites during the Development Application review process. However, once the wind farm was operating the concerns of neighbours appeared to be diminished and the outcome of a number of sales following the wind farm installation did not appear to support the view that the wind farms had resulted in reduced land values.

A review in February, 2006 of the impact of the Crookwell Wind Farm development on land values (based on sales 1990 to 2006) was conducted by property consultants, Henderson and Horning. Their analysis did not identify any measurable reduction in land values.

In the USA the issue that land values may be impacted by wind farm developments led to a comprehensive and systematic review of sales prices for properties in the viewshed of wind farms developments during 1998 to 2002 and comparison with land values at unaffected locations. During that period the installed capacity of wind farms in the USA increased from 1,848 MW to 4,685 MW, an increase of 2,837 MW. An analytical report entitled "*The effect of Wind Development on Local Property Values*" (Sterzinger *et al.*, 2003) was prepared under the Renewable Energy Policy Project (REPP) in May 2003. The report involved studies of various aspects of land values and reviewed data for some 25,000 property sales. Only wind farm projects of greater than 10 MW were considered by the REPP project. In addition, the review sought projects where there would be sufficient sales data to derive statistically meaningful conclusions from the data.

The REPP report indicated that property values for those properties within a wind farm viewshed have increased faster than those properties outside the wind farm viewshed. While it is difficult to expect the situation to be consistent between areas the case for a negative impact on land values does not appear to be confirmed. Nevertheless, it can be expected that the decisions of some potential purchasers may be affected by the presence of a wind farm and they may decide to purchase elsewhere. While the evidence does not support the conclusion that wind farm development leads to reduced land values it is not unusual for neighbours to developments whether they are wind farms or other developments to have concerns about changes to the existing environment and the concerns to be a source of anxiety for neighbours to such developments.

### 5.8.4 Consultation with the local community

As part of the wind farm planning process community consultation has been undertaken to seek the local community views on the development, identify any issues which may require further investigation and to incorporate relevant matters in the wind farm design parameters. Initial consultation (via individual meetings with neighbours to the wind farm, written communications and community open days) has experienced a range of views on the project, with some demonstrating positive acceptance of wind energy development and others indicating concerns in regard to issues such as visual amenity and noise. The availability of the Environmental Assessment will provide a further basis for the local community members to make their own

assessment of the impacts and to raise any concerns with Glen Innes Wind Power or the NSW Department of Planning.

Articles in the local community newspaper (the Glen Innes Examiner) over the last couple of years have introduced the local community to the prospect of a wind farm on Waterloo Range and in December 2007 Glen Innes Wind Power held two information days at the Glen Innes Library and Learning Centre. A range of views were received on the development with many attendees mainly just interested in what is proposed, others supportive and some indicating that they would prefer not to have the development on Waterloo Range. In particular, a number of residents in the southern part of Furracabad Valley have indicated they will oppose the development. The assessment of impacts at the closest residences in that area is included in this Environmental Assessment.

### **5.8.5 Development of renewable technology within the community**

Over the last 12 months there has been an increasing awareness in the Australian community of the potential impacts of anthropogenic climate change. Associated with this awareness there is also an increased understanding that low emission renewable energy technologies such as wind energy will play an important part in reducing greenhouse gas emissions from electricity generation. As has been observed at other wind farms, it is possible that the proposed Glen Innes Wind Farm could be supported by many in the Glen Innes community as they associate the wind farm in their community as being a positive step in the right direction. The proximity of the wind farm to Glen Innes will mean there will be a strong association between the township of Glen Innes and the wind farm.

### **5.8.6 Summary of social impacts**

The proposed project will introduce a visible renewable energy project into the rural setting. It will provide a small stimulus to permanent local employment and is likely to improve the financial situation of some members of the local community. It is unlikely to affect the social structure of the locality or to place an excessive demand on local resources.

The initial planning phase has encountered some anxiety from some neighbours to the wind farm and submissions opposing the project are expected. Similar situations at other NSW wind farm sites have been followed by a reduction in concerns once the wind farms were installed. Overall, the development is likely to have a minor impact on the towns of Glen Innes and Inverell. It is likely to provide a small boost to local businesses and may provide a range of employment opportunities for locals. During the construction stage it is anticipated that much of the construction workforce could be accommodated in Glen Innes due to its close proximity while a smaller proportion of the workforce may stay in Inverell or other smaller centres.

## **5.9 Economic Aspects**

This section reviews the existing economic context of the development and the project's impacts on the local and Australian economy.

### **5.9.1 Key economic considerations**

The key economic considerations for assessing the merits of the Glen Innes Wind Farm development relate to:

- the economic viability of the development (for the developer and for the broader community)
- the place of renewable energy projects in Australia's future economy
- the wind farm's contribution to the local economy
- whether it has any adverse economic impacts

### 5.9.2 Economic viability

The Glen Innes Wind Farm is being developed by Glen Innes Wind Power as a commercially viable project. The international wind industry has been recently growing at approximately 25 to 30 % per year and with the growth of the industry and improvements to equipment there have been substantial reductions in the cost of electricity generated from wind energy. However, in recent years there has been some increase in the wind turbine costs due to the increased worldwide demand for turbines.

Glen Innes Wind Power will operate in the competitive National Electricity Market and therefore must ensure that its operations are commercially viable. It has undertaken a rigorous review of the income and cost considerations for the project and is satisfied that development of the Glen Innes Wind Farm is a financially viable development. The output from the wind farm will be sold to customers under the terms of long term power purchase agreements and other market mechanisms. The viability of the Glen Innes Wind Farm is expected to be supported by the recently announced expansion of the Mandatory Renewable Energy Target Scheme (MRET) (Section 2.1.2). The “Carbon Pollution Reduction Scheme” announced in July 2008 may also improve the viability of renewable energy projects and their competitiveness with fossil fuel based forms of generation (Section 2.1.2).

### 5.9.3 Wind energy’s role in Australia’s future economy

Predicting Australia’s future economic health over the life of the wind farm is indeed difficult in the context of the volatile and changing global circumstances. Australia has traditionally been sustained by strong rural and mineral production and this is likely to continue for some time. Due to the country’s vast expanse, a large use of fuels has been required to sustain the rural and mining sectors. Also the associated wealth of the country and its high standard of living has resulted in one of the world’s highest per capita consumption of energy. In the past few decades, Australia has consumed a large part of its own oil resources to the extent that these are in decline and Australia is expected to import increasing quantities of oil to maintain our existing lifestyles and sustain our economy.

The outcome of increased reliance on imports of oil mean:

- a greater exposure to global increases in oil price fluctuations, currently at very high levels and predicted to increase further
- a negative impact on our trade deficit which in recent times is indicated to be at unfavourably high levels

In addition, the global decline in oil availability and the likely progressive rise in the price of oil will mean that increased attention will be given to alternative fuel sources, coal, gas, nuclear and renewables. As renewables have no associated fuel costs, they provide a degree of insulation from global energy price increases.

While increased supply of electricity from wind energy is unlikely to change our pattern of oil it can result in net savings of other fossil fuels such as coal and gas and thereby increase our energy supply options for the future or enable sale of coal for export where not required for Australia’s electricity generation.

Given the above, the development of wind energy facilities appears to be a sensible and forward looking investment in alternative energy sources and future energy security.

The development of the Glen Innes Wind Farm also offers increased employment opportunities for the local and broader Australian communities. The above factors provide positive economic support for wind energy developments and the Glen Innes Wind Farm development.

The interim ‘Garnaut Climate Change Review’ to the Commonwealth, State and Territory Governments of Australia released in February 2008 indicates that Australia “must now put in place effective policies to

achieve major reductions in emissions”. The Glen Innes Wind Farm development would appear to be consistent with the directions given in the ‘Garnaut review’

#### **5.9.4 Contribution to the local economy**

The Glen Innes Severn Council website indicates that the local economy is strongly based on agriculture (41.9%) with a significant tourism/service sector (32%) also operating. The remainder of the economy is made up of retail trade (14%), and health and community services (12.1%). Opportunities are indicated for most forms of agriculture and the area is well suited for stud livestock enterprises, equestrian pursuits and intensive livestock industries.

The development of the Glen Innes Wind Farm will contribute to the local community through stimulation of the local economy and by providing employment opportunities within the Shire, particularly during the construction phase.

It is likely that increased income will flow to the local community as a result of the development by way of:

- payments to landowners on which the wind farm is located
- payments to Glen Innes - Severn Council associated with contribution to local infrastructure or community benefit fund
- income to local service suppliers such as accommodation (motel, hotel and guest houses), food and general supplies (cafes, general stores and newsagents), service stations (fuel and vehicle servicing), engagement of local contractors for specific components of the works and purchase of supplies and services from local outlets (maintenance of equipment or supply of various items required by the construction workforce)
- increased employment and associated incomes either directly by involvement in the project or indirectly by employment in service industries

The construction phase, with its import of a temporary workforce into the locality, is likely to provide the greatest stimulus to the local economy with the ongoing operations and maintenance activities having a lesser impact. A small number of on-site staff will be required during the operations phase.

An increase in income to the local community is likely to flow into other areas and have a multiplier effect for the local economy. The local community includes rural residents and nearby towns of Glen Innes and Inverell. The impacts on economic activity are likely to be spread throughout the region and as such it is expected that the economic impact on the local community will be well within its capacity to assimilate.

#### **5.9.5 Costs that could be incurred by the local community**

Overall the project is expected to provide financial benefits to local businesses and the community.

In recent times, rural areas have become increasingly targeted for rural residential development. This has meant that large properties have been carved up to provide smaller properties that are often used for residential purposes rather than their previous pastoral purposes. With this development has come the change in character of the landscape with an increasing number of residences and associated sheds and fencing dotted through rural landscapes and potentially reduced agricultural productivity.

One possible consequence of the wind farm developments is that much of the rural land surrounding the wind farm site will be less likely to experience subdivision with the proliferation of residences and urbanisation of the rural landscapes and maintenance of agricultural potential. Different people will have varying views on whether the inclusion of wind turbines or residential development in the rural landscape is preferable. It is understood that Council Policy has been to restrict carving up of pastoral land further from Glen Innes with a view to maintaining the agricultural potential of the region consistent with the Zone 1(a) (Rural) objectives.

As indicated in Section 5.8.3 some neighbours to the wind farm have expressed concern that their land values may be negatively impacted by the wind farm development. Studies in the USA have indicated that property values for those properties within a wind farm viewshed have increased faster than those properties outside the wind farm viewshed (Sterzinger *et al.*, 2003). While there is limited quantifiable information on the impact of wind farm developments on neighbouring property values within NSW it could be possible that with some stimulus to the local economy that land values for the Glen Innes locality could increase marginally. Such an increase would be expected to be minor and unlikely to significantly affect the affordability of properties in the area.

The construction phase of the project will involve a temporary increase in traffic on the access roads to the site and may increase the wear and tear on those roads. Glen Innes Wind Power will consult with Council regarding any use of local roads for the project and any additional maintenance requirements.

#### **5.9.6 Summary of economic issues**

Overall, the development has been assessed by Glen Innes Wind Power to be financially viable. It is also considered to have potential to contribute to the income of landowners at the site and for parts of the local economy through local service provision and employment and community benefit contributions. The timing of the contributions to the rural economy is considered to be favourable when farming costs are rising and drought related stresses are impacting farm incomes and rural areas.

Given the evident directions of the global economy particularly, the likely decline in oil resources and increased pricing of fossil fuel energy sources possible pricing on carbon emissions, the strengthening of our renewable energy generation capability can deliver greater supply diversity leading to positive returns to Australia generally and at the same time assisting local communities. The project development appears consistent with the findings in the 2008 'Garnaut Climate Change Review' publications and the Federal government's proposed expansion of the national renewable energy target scheme as indicated above.

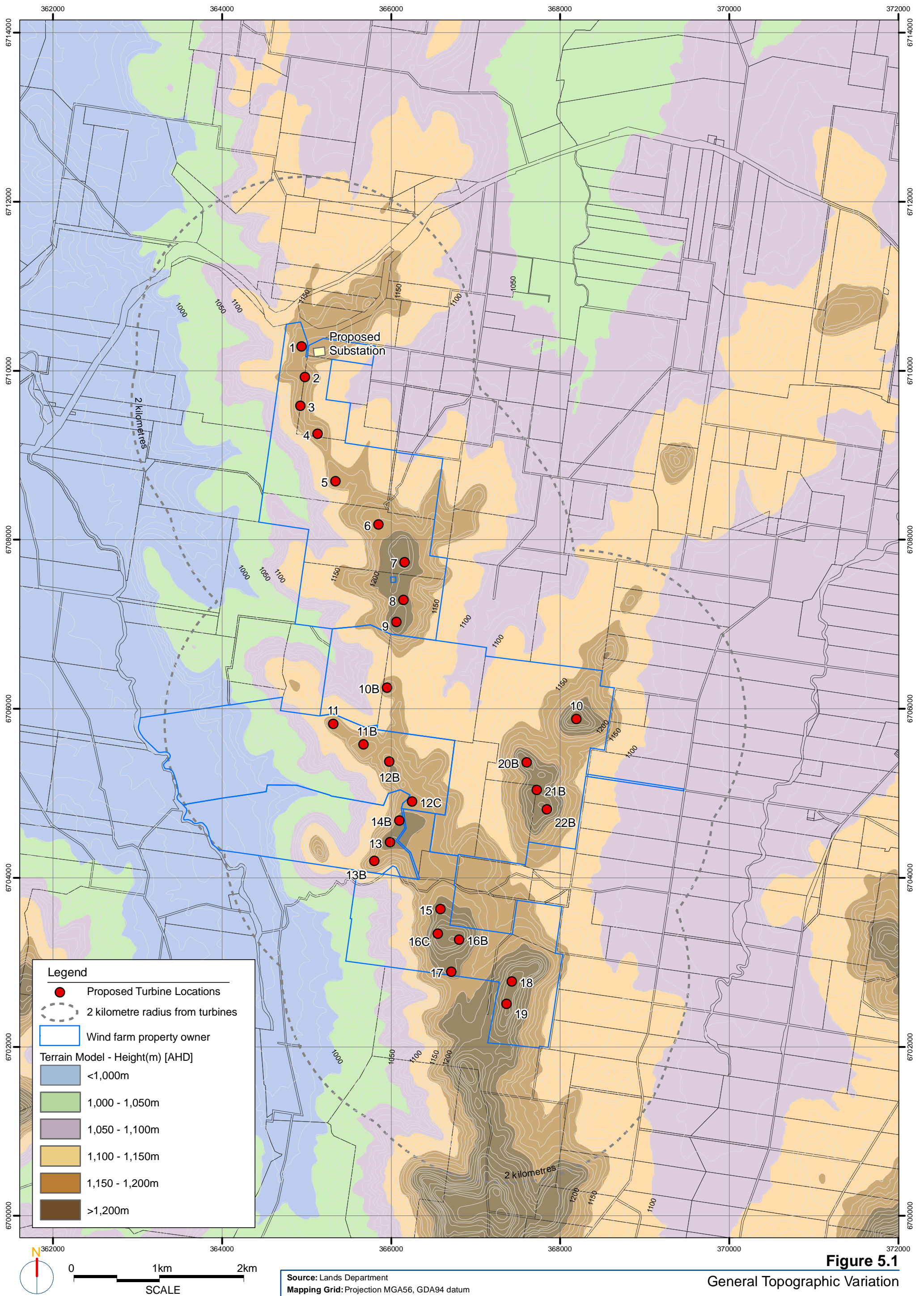
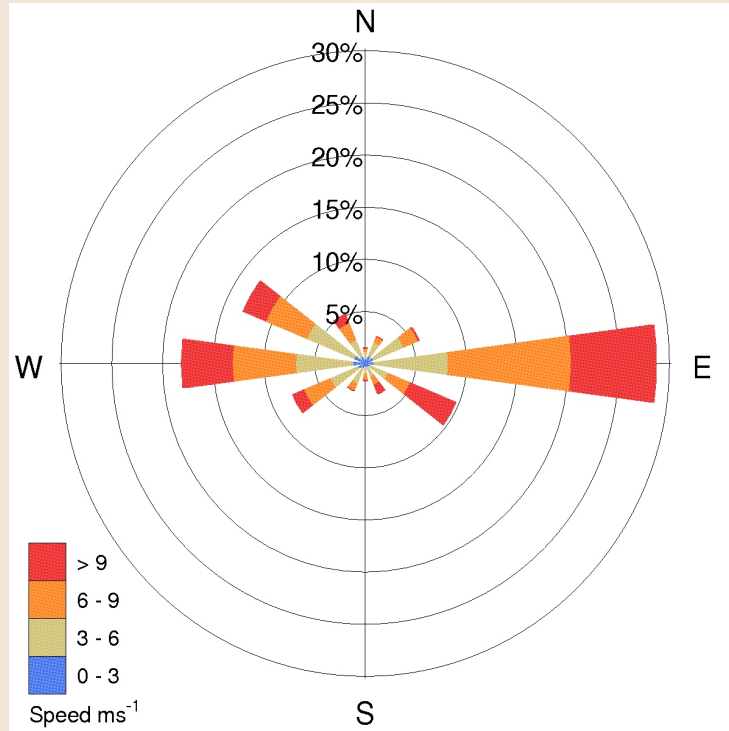


Figure 5.1

General Topographic Variation



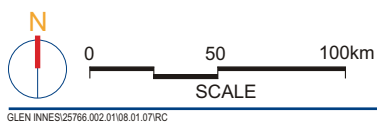
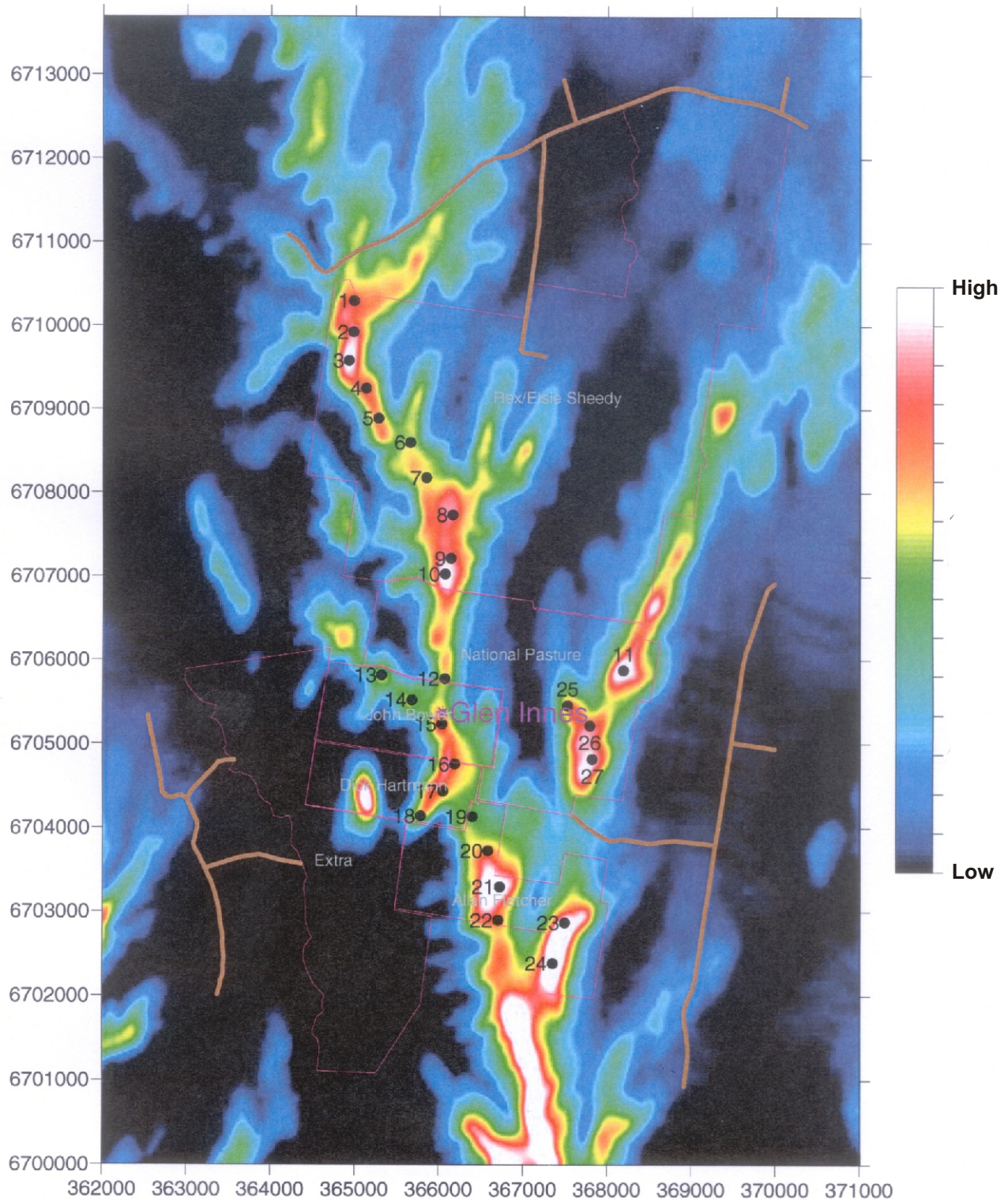
Wind monitoring results - M3



Glenroy meteorological mast - M3

Figure 5.2

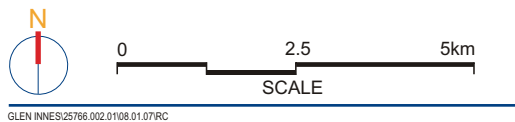
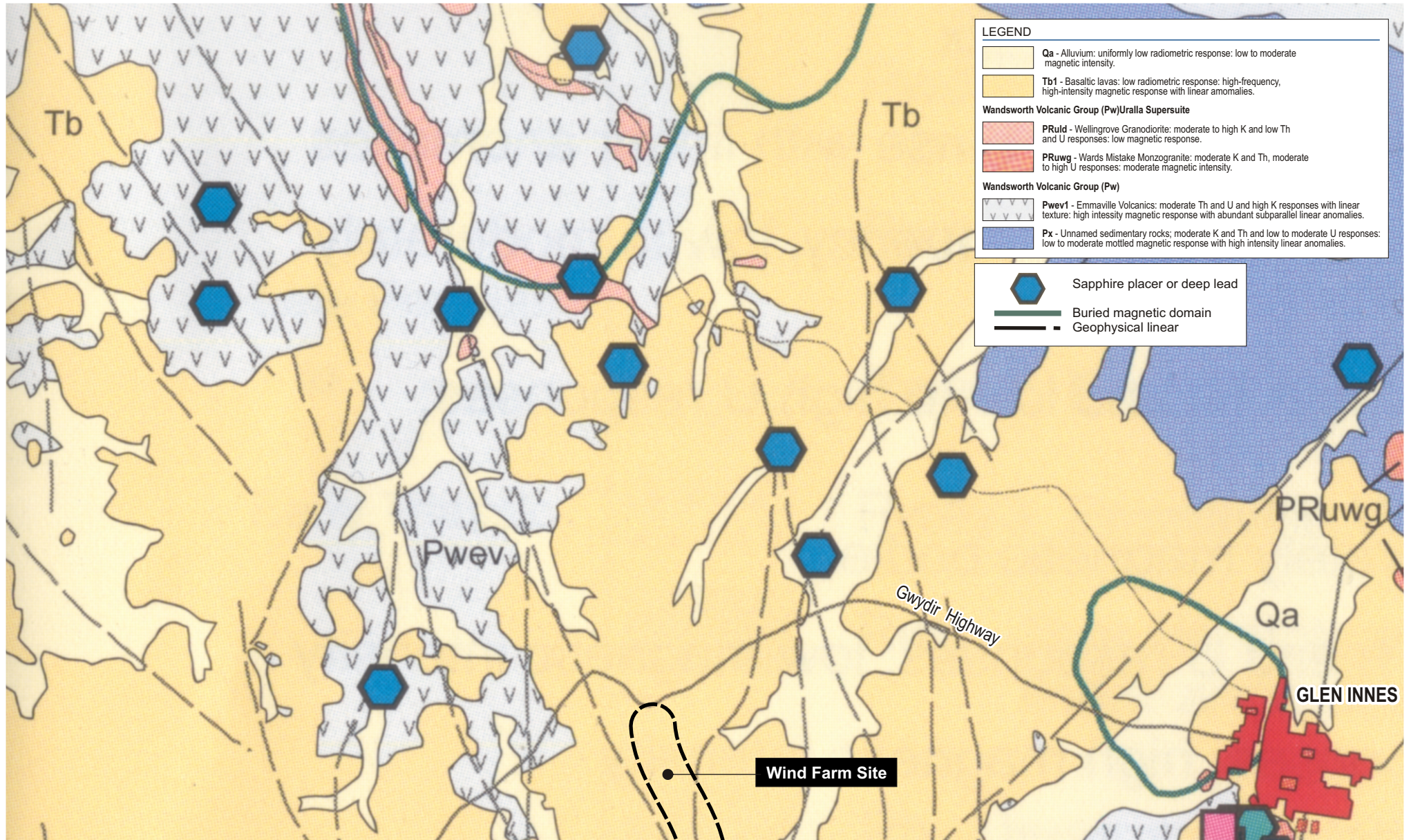
Wind Monitoring Results



Note: Numbering of turbines differs from current array

Figure 5.3

Wind Energy



Source: NSW DPI Quarterly Notes July 2006 No. 121

**Figure 5.4**  
Regional Geology

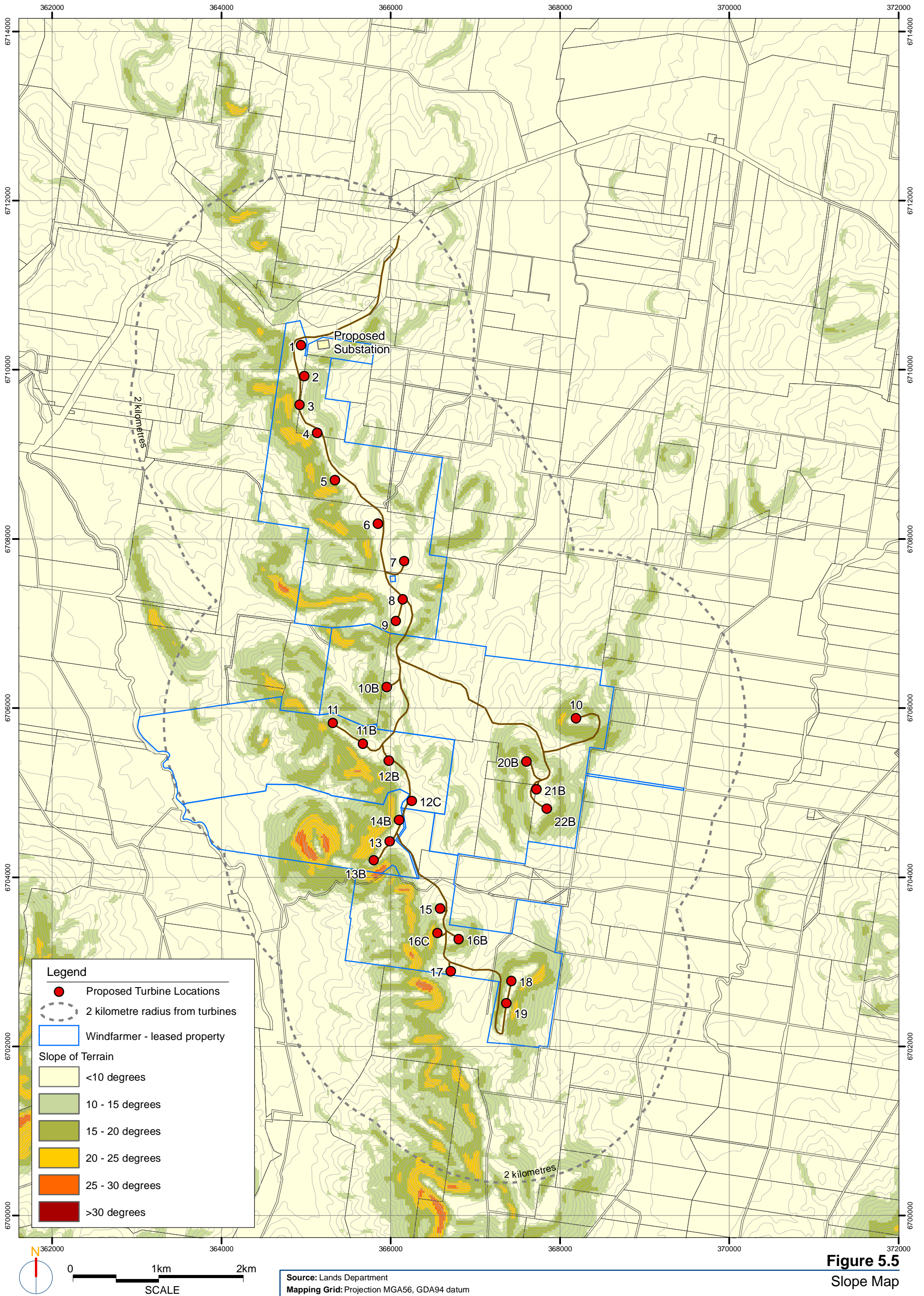


Figure 5.5  
Slope Map

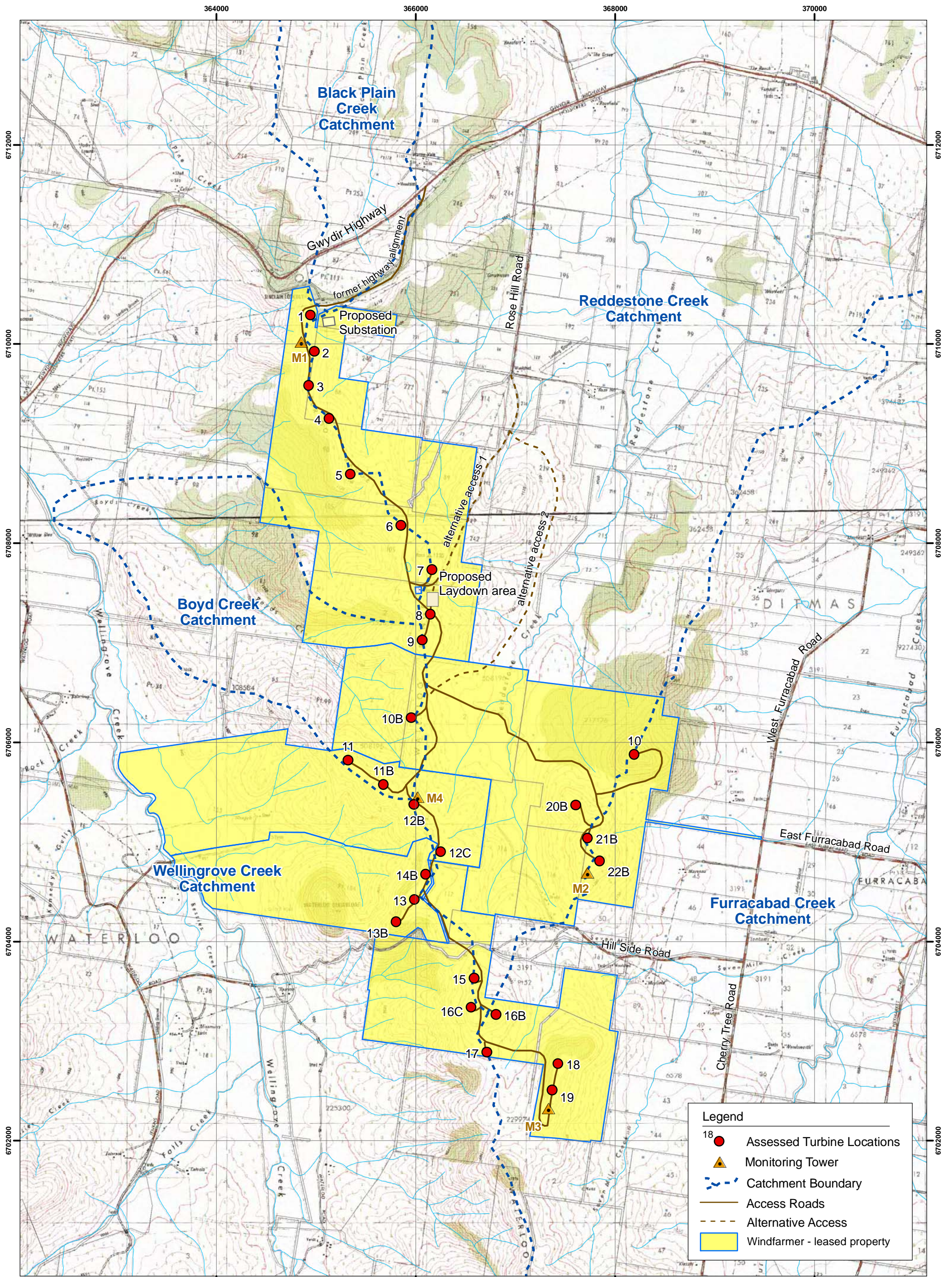


Figure 5.6

Site Drainage and Catchments

Source: Lands Department  
 Mapping Grid: Projection MGA56, GDA94 datum