

APPENDIX 20

Crudine Ridge Wind Farm Bushfire Risk Assessment

Eco Logical Australia Pty Ltd



Crudine Ridge Wind Farm

Bushfire Hazard and Risk Assessment

Prepared for
Wind Prospect CWP Pty Ltd

19 August 2011





Bushfire Hazard & Risk Assessment

CRUDINE RIDGE WIND FARM

PREPARED FOR Wind Prospect CWP Pty Ltd

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Executive Summary

This Bushfire Risk Assessment describes the objectives, strategies and activities for the treatment of bushfire risk that may be presented during construction, operation and maintenance of the proposed Crudine Ridge Wind Farm. The development is to be located approximately 40 km north of Bathurst and 50 km south of Mudgee in the mid-west of New South Wales. The proposal consists of the construction and operation of between 77 and 106 wind turbines (depending on the final turbine selection) and associated infrastructure.

The purpose of this assessment is to provide an analysis and justified treatment of bushfire risk to address responsibilities under the *Rural Fires Act 1997* based on the risk management process as defined by AS/NZS ISO 31000:2009 'Risk management – Principles and guidelines' (Standards Australia 2009) recommended within the NSW Bushfire Coordinating Committee (BFCC) Guidelines (2008) and the National Inquiry on Bushfire Mitigation and Management (COAG 2004). An assessment of the proposal against the state guidelines 'Planning for Bush Fire Protection 2006' (NSW Rural Fire Service 2006) for development in bushfire prone areas is also included.

The development site is amongst predominantly cleared plains for many kilometres. The nearest community is the small township of Crudine which is approximately 4 km east of the northern portion of proposed turbines. The much larger townships of Bathurst and Mudgee are greater than 40 km from the development site, and the built assets and human life in the area are those associated with farm houses, associated agricultural infrastructure and small farming communities. The site consists of cleared native pasture with areas of both Open Forest and Grassy Woodlands in various conditions.

The site and surrounding area has an uneventful recent fire history and an analysis of bushfire hazard demonstrated an isolated and scattered pattern of both 'high' and 'medium' bushfire hazard on the steeper slopes supporting remnants of good condition Open Forest. The vast majority of the hazard is rated as either 'low' or 'negligible' due to the prevalence of grasslands within the area.

An assessment of the risk of fire spreading from the site and impacting on nearby assets was undertaken whereby a risk classification scheme developed through qualitative scales of likelihood and of consequence resulted generally in a 'medium' risk to the potential for loss of human life and the potential for ecological damage at a variety of scales. A 'low' risk of a widespread loss of property and damage to wind farm assets was also recorded.

Bushfire risk treatment aimed at reducing both the likelihood and consequences of bushfires was recommended based on an understanding of the risk. In line with AS/NZS ISO 31000:2009 'Risk management – Principles and guidelines' (Standards Australia 2009) and the NSW Bushfire Coordinating Committee (BFCC) Guidelines (2008), six broad groups of risk treatment options were identified, each having one or more specific strategies (risk treatments):

1. Avoid the risk – Limit or prohibit ignition creation activities;
2. Reduce the hazard – Education and training;
3. Reduce consequence – Fuel reduced zone establishment and maintain access roads;
4. Accept risk – Suppression and response;
5. Transfer the risk – Insurance review;
6. Retain the risk – Bushfire Emergency and Evacuation Plan.

1 Introduction and Context

1.1 INTRODUCTION, LOCATION AND BACKGROUND

This Bushfire Hazard and Risk Assessment (the Assessment) was prepared for Wind Prospect CWP Pty Ltd. The report describes the objectives, strategies and activities for addressing bushfire risk management for the construction, operation and maintenance of the Crudine Ridge Wind Farm, situated near the towns of Crudine and Sofala in the mid-western region of New South Wales, approximately 50 km north of Bathurst and 40 km south of Mudgee. The development site spans two local government areas; Mid-Western Regional Council and Bathurst Regional Council. Figure 1 locates the proposed wind farm site.

All figures are located in Appendix 1.

The need for a Bushfire Risk Assessment was identified within the Director General's Requirements (DGRs) for the further assessment and subsequent approval of the construction and operation of the wind farm. The *Rural Fires Act 1997* imposes obligations on land managers to take all reasonable measures to prevent the occurrence and spread of wildfire to adjoining lands from lands under their care and management. This report contains risk treatment recommendations designed to address the land manager's risk management obligations.

This assessment is a technical report that is to be appended to, and read in conjunction with, the Crudine Ridge Environmental Assessment prepared by Wind Prospect CWP Pty Ltd. More detailed background information on the proposal and site characteristics can be found within the Environmental Assessment. Only those details necessary for the understanding of the Bushfire Hazard and Risk Assessment are provided within this report.

1.2 WIND FARM PROPOSAL

The proposal consists of the construction and operation of 77 to 106 wind turbines (depending upon final selection) and associated infrastructure for the generation and transfer of electricity. The turbines extend over a 16 km span south west to north east within a corridor-type formation, having a 3 km span width at the widest point. The individual turbine positions are located on land with elevations ranging from approximately 890 m to 1,000 m Australian Height Datum (AHD).

The wind farm has been modelled using a range of wind turbines that have rotor diameters in the range of 80 m to 120 m, with nominal capacities ranging from 1.5 MW up to 3.4 MW, based on the technology currently available on the market. The proposed layout of the Crudine Ridge Wind Farm is shown in Figure 1 (Appendix 1).

The built form will include the turbines and their footings, access roads, substations, facilities buildings, concrete batching plant, rock crushing plant, construction compound and storage, underground cabling and internal and external overhead transmission lines. The construction phase will involve the upgrading of existing roads and the creation of new ones used to access the turbine sites with some being retained to carry out future maintenance activities.

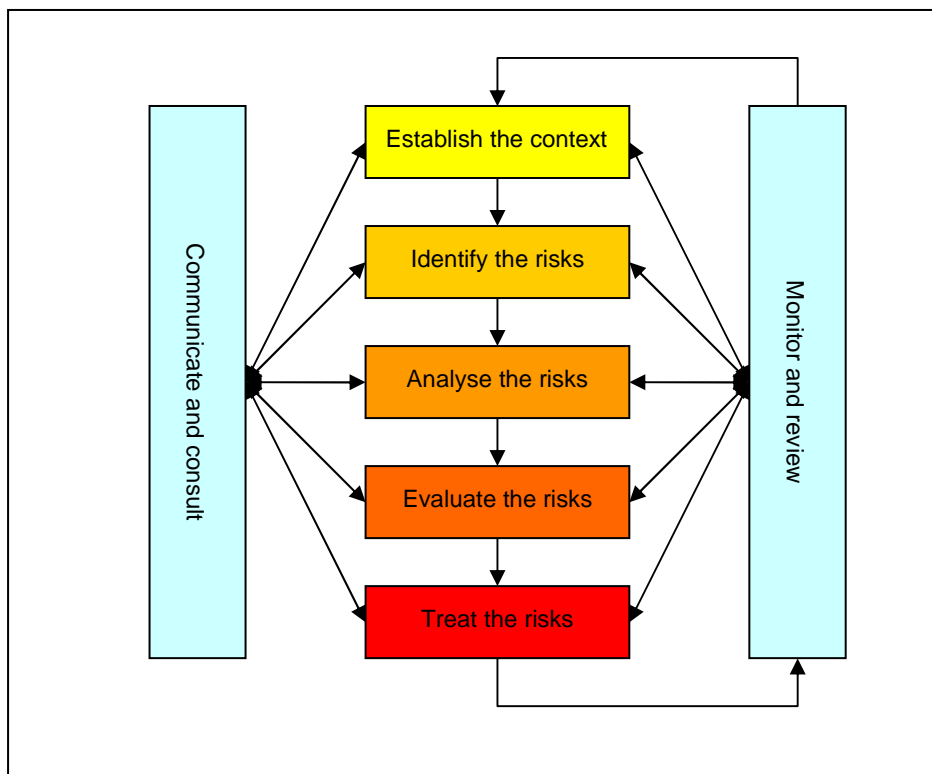
It should also be noted that in addition to the proposed turbine footprints outlined above, part of the supporting infrastructure involves the proposed extension of overhead transmission lines for approximately 15 km to the east and north east of the turbine footprints. This has also been assessed within the context of this report.

1.3 PURPOSE OF RISK ASSESSMENT

The purpose of this assessment is to provide the land manager with an analysis and justified treatment of bushfire risk to address responsibilities under the *Rural Fires Act 1997*.

Based on the risk management process as defined by AS/NZS ISO 31000:2009 'Risk management – Principles and guidelines' (Standards Australia 2009) and recommended within the NSW Bushfire Coordinating Committee (BFCC) Guidelines (2008), and National Inquiry on Bushfire Mitigation and Management (COAG 2004), the assessment is to provide an analysis and evaluation of bushfire risk and acceptable risk treatments that will avoid the risk, reduce the likelihood, reduce the consequences, accept the risk, transfer the risk and retain the risk. A flowchart illustrating the process of emergency risk management is included as Figure 2 below.

Figure 2: Emergency risk management planning after AS/NZS ISO 31000:2009 'Risk management – Principles and guidelines' (Standards Australia 2009) and COAG (2004)



1.4 OBJECTIVES OF BUSHFIRE HAZARD & RISK ASSESSMENT

The Director-General's Requirements (DGRs) for the Crudine Ridge Wind Farm Environmental Assessment (EA) issued by the Director-General for the NSW Department of Planning for the State of New South Wales on 17 March 2011, states that the EA should deal with '*potential hazards and risks associated with ... bushfires/use of bushfire prone land*'. Risk should be assessed for construction, operational and decommissioning phases of the project which would include an analysis of the consequences of bushfire impact on safety and the environment in the study area.

Bushfire management objectives for projects of this type are to:

- Prevent loss of and harm to human life;
- Minimise damage to built assets;
- Minimise disturbance to construction and plant operation; and
- Minimise impact of fire on the environment.

To achieve these objectives for this assessment, the following tasks were required:

- Identify the presence and extent of the existing bushfire hazard in the study area including known bushfire behaviour;
- With reference to applicable guidelines, standards and policy assess the bushfire risk posed by bushfire hazards during construction, operation and decommissioning phases of the project;
- Preparation of a management and mitigation plan to address bushfire risk to create an acceptable outcome within regulatory limits and guidelines, inclusive of any safety buffers and levels of construction for the development project; and
- Assessment and quantification of residual and cumulative bushfire risk.

1.5 PLANNING FRAMEWORK

The relevant planning controls and how they have been considered within this assessment are summarised below:

1.5.1 NSW Rural Fires Act 1997

The RF Act imposes obligations on land managers to take all reasonable measures to prevent the occurrence and spread of wildfire to adjoining lands from lands under their care and management. The RF Act also places emphasis on cooperative fire management and wildfire suppression planning between the various organisations involved in fire management (through the Bushfire Management Committees and by the preparation and implementation of a Bushfire Risk Management Plan).

1.5.2 Planning for Bush Fire Protection (2006)

The NSW legislative planning document Planning for Bush Fire Protection (2006) or PBP, is designed to be implemented on lands throughout the state that are designated as being bush fire prone and where there is proposed new development taking place. PBP provides an assessment framework for the potential impacts of bushfire upon the proposed new assets and establishes six key bushfire protection measures that are to be addressed and collectively form an effective mitigation strategy in order to reduce the bush fire impacts.

The subject land is identified as bush fire prone land by both Mid-Western and Bathurst Regional Councils.

It is important to note that BCA Class 5, 6, 7, 8 and 10 buildings (which include offices, factories, warehouses and other commercial or industrial facilities) do not have specific bushfire performance requirements under the BCA and as such building construction standards under AS 3959 'Construction of Buildings in Bushfire Prone Areas' (Standards Australia 2009) do not apply as a set of deemed to

satisfy provisions. The general fire safety constructions provisions within the BCA are taken as acceptable solutions, but the aim and objectives of PBP apply in relation to other matters such as access, water and services, emergency planning, and landscaping/vegetation management.

The objectives of PBP are:

- a) Afford occupants of any building adequate protection from exposure to bushfire;
- b) Provide for defensible space to be located around buildings;
- c) Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;
- d) Ensure that safe operation access and egress for emergency service personnel and residents is available;
- e) Provide for ongoing management and maintenance of bushfire protection measures, including fuel loads in the asset protection zone (APZ); and
- f) Ensure that utility services are adequate to meet the needs of fire fighters (and others assisting in bushfire fighting).

To satisfy the above objectives, an acceptable solution would be to provide an Asset Protection Zone as for residential subdivision to prevent flame contact and ignition of external building materials (see objective c). An alternative option, and one more reliant on the known design of a specific building, is to provide an APZ of a size where it acts as 'defensible space' only. PBP defines 'defensible space' as "an area within the asset protection zone that provides an environment in which a person can undertake property protection after the passage of a bushfire within some level of safety". This option relies on the high standard of construction with respect to bushfire protection.

The proposed mitigation measures as appropriate for the wind farm proposal are expressed in section 4 of this report.

1.5.3 NSW Threatened Species Conservation Act 1995

The TSC Act aims to conserve biodiversity and to promote ecologically sustainable development by preventing the extinction of, and promoting the recovery of, all threatened plants, animals and ecological communities native to NSW, excluding fish and marine vegetation.

The TSC Act requires the consideration of threatened species and their habitats in the developmental planning process and a responsibility of the proponent to determine potential impacts on listed species and Endangered Ecological Communities (EEC).

'High frequency fire', 'clearing of native vegetation' and 'removal of dead wood and dead trees', are listed by the TSC Act as 'Key Threatening Process' and need to be carefully considered and managed when implementing fire management activities.

1.5.4 Commonwealth Environmental Protection & Biodiversity Act 1999

The EPBC Act provides for the protection of the environment, and the conservation of biodiversity, especially those aspects of the environment that are of National environmental significance.

Like that of the TSC Act, the EPBC Act requires the consideration of threatened species and their habitats in the developmental planning process and it is a responsibility of the proponent to determine potential impacts on species.

1.5.5 Other Considerations

The Australian Standard AS 3959:2009 Construction of Buildings in Bushfire Prone Areas (Standards Australia, 2009) provides construction standards for buildings in a bushfire hazard area to protect against the effects of ember attack, radiant heat and flame contact. AS 3959:2009 is the approach deemed to satisfy Building Code of Australia compliance for building on bushfire prone land.

The Vegetation Management Act 1999 (Section 22A) requires a permit for vegetation clearing for the establishment of firebreaks and for projects declared to be a significant project under the State Development and Public Works Act 1971 (Section 26).

1.6 ASSESSMENT APPROACH AND METHODOLOGY

1.6.1 Assessment Approach

The approach to bushfire risk analysis and applying risk mitigation and management measures in this assessment is based on the risk management process defined by AS/NZS ISO 31000:2009 'Risk management – Principles and guidelines' (Standards Australia, 2009).

The National Inquiry on Bushfire Mitigation and Management (COAG, 2004) recommends an assessment process for:

- Analysis and evaluation of bushfire risk; and
- Acceptable risk treatments that will avoid the risk, reduce the likelihood, reduce the consequences, accept the risk, transfer the risk and retain the risk (as presented in Figure 2).

1.6.2 Method

Details on the method used are provided within each section of this document. To summarise, the method for the Bushfire Hazard and Risk Assessment is as follows;

- a. Identify the asset base requiring protection (Section 2);
- b. Identify the bushfire risk factors such as bushfire history and known bushfire behaviour in the study area and within the surrounding lands (Section 2);
- c. Determine whether the development area has been mapped as bush fire prone land and requires compliance with *Planning for Bush Fire Protection 2006* (Section 2);
- d. Map the bushfire hazard at a site specific scale following the relevant guidelines and compare with bush fire prone area mapping (Section 2);
- e. Determine assessment requirements under PBP 2006 based on results of hazard mapping (Section 3);
- f. Assess (likelihood and consequence) and evaluate bushfire risk to and from the development proposal following AS/NZS ISO 31000:2009 risk management process. Link PBP 2006 findings with this process (Section 3); and
- g. Produce risk mitigation and management treatments and satisfy PBP 2006 requirements (Section 4).

2 Bushfire Risk Identification

2.1 LIFE AND PROPERTY DESCRIPTION

The development precinct is amongst predominantly cleared plains surrounded by grazing and cropping farms existing for many kilometres. On a broad scale, the development area is bound to the north by Aarons Pass Road, to the west by Sallys Flat Road and Pyramul Road, to the south by Hill End Road and to the east by both Turondale and Crudine Roads. The meandering Crudine Creek is also situated to the east of the proposed turbine footprints. The vast majority of the properties within the vicinity are privately owned cleared rural lands, with the exception of some more heavily wooded areas to the north and north east of the proposed wind turbines. To a lesser extent there are also isolated and more heavily vegetated areas to the east of both the central and southern portions of the site.

The nearest major communities are the townships of Mudgee 40 km to the north and Bathurst 50 km to the south. The site is also surrounded by other small townships, with Crudine, Pyramul, Carcalgong, Aarons Pass, Ilford, Sofala and Sallys Flat all situated within 15 km of the proposed wind farm development. Crudine is the location that is most closely situated to the wind farm (within 4 km). The only other built assets and human life in the area are those associated with farm houses scattered across the landscape.

2.2 FIRE HISTORY

According to the Cudgegong Draft Bushfire Risk Management Plan and consultation with Garry Barrett of the Cudgegong Rural Fire District Office, the development site and surrounds have not been affected by a large bushfire within the last 10-15 years. The Crudine Ridge Wind Farm location has experienced very little fire history due to the dominance of grazing and cropping in the area. Based on past fire history, there is no clear indication of the portion of the development that is thought to be the most likely to experience a large bushfire.

The Cudgegong Bushfire Management Committee area has approximately 150 - 200 bush fires per year, of which approximately 3 - 5 can be considered to be major fires, but the occurrence of these are not uniformly spread across the landscape, and no major fires have occurred at or immediately surrounding the site for many years. The ignition of such fires is similar to other rural environments of NSW with fires commonly started by lightning strikes and as accidental fires started from rural and farming activities.

2.3 FIRE WEATHER

An analysis of the fire weather experienced in the locale and the surrounding region provides insight into bushfire behaviour potential. Days with a higher Forest Danger Index (FDI) can be expected from September to April although the peak fire season is from October to March. Those months of higher FDI are attributed to the occurrence of strong winds from the westerly sector accompanied by high daytime temperatures and low humidity. The weather and historical data plus local knowledge of fire weather patterns indicate that:

- Extreme fire weather days may occur at any time from September to April;

- Adverse fire weather conditions are likely to be associated with strong winds from the northwest; and
- Although winds are predominately from the northwest, easterly wind changes may adversely affect fire behaviour and hamper control efforts.

2.4 BUSHFIRE HAZARD

Bushfire hazard has been evaluated through analysis of a combination of slope and fuel (vegetation) as discussed in the following sections.

2.4.1 Slope

Steeper slopes can significantly increase the rate of spread of fires, and it has been shown that with each 10^0 increase or decrease in slope a corresponding doubling or halving, respectively, in the rate of spread can be expected (McArthur 1967). Thus, the relationship of the steepness of slope, and whether a fire moves upslope or downslope, is vital to understanding bushfire behaviour potential. Slope and wind are often the major factors determining the direction of fire spread.

The slope map produced for the current topography is included as Figure 3 (Appendix 1). The landscape is a basin dominated by undulating to very steep hills along the entire easterly aspect of the development precinct, causing an effective south west to north east oriented ridgeline within the local topography. The ridgeline and associated steep slopes broaden to the north and north east of the development precinct. There is a similar topographical ridge-like feature running parallel (also south west to north east) further to the south east of the development site. The presence of this feature also causes a low-lying, gentle-sloped drainage area in between the two ridgelines, which is the location of the meandering Crudine Creek.

The development precinct is generally situated along the top of the ridgeline, immediately to the west of the steeper slopes that then drop away to form steep gullies associated with some of the watercourses in the area, and then softening to form undulating rolling hills, as can be found in the vicinity of Crudine Creek.

2.4.2 Fuels (vegetation)

The district is characterised by a mix of native woodland, open-forest, native pasture, exotic pasture and cleared land. Figure 4 (Appendix 1) displays the distribution of these vegetation types. The proposed areas for the majority of turbines and infrastructure such as the transmission lines are cleared and open so as to achieve wind harvesting objectives and limit the disturbance to native vegetation and tree cover.

The majority of vegetation in the district is under various levels of disturbance and the shrub layer is generally lacking or sparse. 'Planning for Bush Fire Protection' (NSW Rural Fire Service 2006a) provides an assumed fuel load for Dry Sclerophyll Forest vegetation communities of 25 tonnes/ha surface fuel load and 30 tonnes/ha overall fuel load. Based on the vegetation mapping within Figure 4, the vast majority of the turbine development precinct is covered by a vegetation community of this nature. However, upon assessment of the current vegetation conditions, it appears that much of this Forest community has been modified to either a Grassy Woodland, or Native or Exotic Pasture vegetation structure. An Open Forest structure is likely to remain only in the extensively vegetated areas further to the north of the site, as well as isolated remnants to the east of the development precinct – in the central and southern portions of the site.

For the purpose of comparison, the areas that could be considered as Grassy Woodland, potentially throughout much of the site, and particularly to the north and north east, may have a fuel load around 10 - 15 tonnes/ha according to 'Planning for Bush Fire Protection'. Native grasslands have a much lower fuel load than the woodlands as the only contributor to the accumulation of available fuels is the grass itself.

The availability of the grassland vegetation across the study area depends on whether the grass is a native community or pasture, and whether the land is in drought. The lack of growth in pasture grasses during drought limits the spread of grass fires across pasture and farms. However, this reduction in fire behaviour amongst pasture is accompanied by an increased curing time, and hence, availability of native grasses where they occur in the more natural parts of the landscape. Recent summer rain has provided for significant growth in groundcovers which are likely to cure in the drier winter months, potentially creating higher fuels for spring grassland fires.

Generally speaking, vegetation communities can be categorised into four fuel groups based upon their estimated contribution to the potential behaviour of bushfire. The methodology for classifying these fuel groups is adapted from Dovey (1994).

The vegetation within the site is considered to be within the 'high', 'medium', 'lower' and 'negligible' fuel groups depending on the vegetation type (structure and available fuel loads) and condition (level of disturbance and regeneration), as discussed in Table 1.

Table 1: Description of the four fuel groups adapted from Dovey (1994)

Fuel group	Characteristics of each fuel group	Relevance to Crudine
High	Continuous fuels, higher quantity, available to burn during average seasons (<i>higher fire intensity expected</i>).	Only present in isolated pockets along the eastern and northern extremities of the site. Also likely to be present further to the north, north east and south east of the site where there are more extensive areas of Open Forest.
Medium	Less continuous fuels, medium level quantity, available to burn during average seasons but may be less often than high (<i>medium or high fire intensity expected</i>).	Present at the site in the form of intact and good condition Woodland, and highly disturbed / modified Open Forest areas.
Lower	Possibly discontinuous fuels, low-medium fuel quantity, moister fuels unlikely to contribute to high intensity fires in average season, fuel structure facilitates easier control (<i>fire intensities may range from low-high and generally regarded as easier to control</i>).	Present at the site in the form of poor condition Woodland and Native Grasslands.
Minimal	Unlikely to burn or always burn within controllable limits.	Present at the site in the form of pasture grass.

2.4.3 Bushfire hazard class

Bushfire hazard classes can be generated across the landscape by applying relative weightings to the varying fuel groups (see Table 1) and combining them with available slope classes (i.e. 0-5, 5-10, 10-15, >15 degrees) within a Geographic Information System (GIS) model. The result is the mapping of relative hazard in classes of 'high', 'medium', 'low', and 'not applicable'. This analysis does not indicate how often an area will receive potentially damaging fires nor the actual intensity of a fire. It does, however, provide a useful comparative ranking, indicating sites of higher and lower potential fire behaviour compared to others in an area.

The bushfire hazard map (bushfire behaviour potential) produced for the current vegetation pattern and condition is included as Figure 5 (Appendix 1). A pattern to note is that due to the steepness of the slope involved and apparent quality of the Forest vegetation, some isolated pockets of high hazard are dotted along the eastern and northern extremities of the site. This may be overly conservative as it is likely that these areas have higher levels of disturbance and would therefore behave similarly to that of a Woodland and thus be Medium hazard. Most of the hazard is rated as medium or low due to the prevalence of grasslands and poor condition woodland on flat or gentle slopes within the area.

2.5 ANALYSIS OF LIKELY BUSHFIRE BEHAVIOUR

Based on the information provided in the fire weather and fire hazard analysis above, likely fire behaviour can be predicted. It is a combination of undesirable fire weather (i.e. hot and dry westerly winds during summer) and the potential for a grassfire to spread towards farm assets in the surrounding area. A grass fire under the influence of wind may travel fast, reaching assets before fire fighters can attend the scene.

2.6 EXISTING BUSHFIRE PROTECTION MEASURES AND ARRANGEMENTS

The existing level of bushfire protection for life and property in the surrounding area is relatively good due to the existence of vast areas of cleared grazing lands combined with the compartmentalisation of the landscape by roads. Grazing land and roads provide breaks and control lines for fast spreading grass fires.

The project site and surrounding area can be well accessed by the immediate and surrounding road network providing acceptable response times for local volunteer NSW Rural Fire Service fire fighters. A volunteer RFS brigade is located at the Crudine township.

The site is covered by the Cudgegong Draft Bushfire Risk Management Plan which provides a platform to manage bushfire risk across the districts.

2.7 VULNERABILITY OF SURROUNDING ASSETS

Although separated from the development by an expanse of predominantly grazing land, the township of Crudine is thought to be the most vulnerable asset in proximity to the development. Under a strong south westerly, westerly or north westerly wind, a grass fire emanating from the Crudine Ridge Wind Farm has the potential to travel quickly towards the township.

The farming communities surrounding the site and other small townships of Pyramul, Carcalgong, Aarons Pass, Ilford, Sofala and Sallys Flat are not considered overly vulnerable to the affects of a large bushfire emanating from the site or across the district. This is due to the large cleared areas dominant across the district.

3 Bushfire Risk Assessment and Evaluation

3.1 PBP 2006 ASSESSMENT

The information in this section is required to satisfy the legislative requirements of bushfire assessment within New South Wales. It focuses on the protection of the development and its use from bushfire impact.

The Bathurst and Mid-Western Regional Councils' Bushfire-prone Land Map identifies the study area as supporting bushfire prone land. The map triggers the need to assess the proposed development against the bushfire protection provisions under PBP 2006.

Under PBP 2006 the development is required to maintain the safety of people and property by either avoiding areas of high bushfire hazard where direct flame contact may be encountered, or mitigating the risk through specific bushfire protection measures listed within PBP 2006, such as firebreaks (Asset Protection Zones), access provisions, water supplies, design and construction materials, landscaping and emergency management procedures. In this instance, these measures are addressed through the preparation of a Bushfire Management Plan. An evaluation of these measures is contained within Section 4.

3.2 AS/NZS ISO 31000:2009 RISK ASSESSMENT

3.2.1 Bushfire Risk Assessment

The following sections assess the risk of a fire being ignited at a project site, spreading and impacting assets surrounding the site. The definition of bushfire risk is the chance of a bushfire igniting, spreading and causing damage to assets of value to the community.

The method was developed for use in developing bushfire risk management plans in NSW by the Rural Fire Service (NSW Rural Fire Service, 2008). The method follows the procedures and considerations of AS/NZS ISO 31000:2009 'Risk management – Principles and guidelines' (Standards Australia, 2009); it provides a risk classification scheme through qualitative scales to assess the likelihood and consequence of fire impact.

The likelihood of bushfire risk for all assets is defined as the chance of a bushfire igniting and spreading. There are four possible likelihood ratings: unlikely, possible, likely and almost certain. It is often challenging to determine the likelihood rating for assets. This is mainly due to a lack of fire history records. Fire history data, if available or local knowledge and an understanding of the landscape may be used to determine the likelihood of a bushfire occurring. Where data is not available, subjective estimates may be used which reflect the degree of belief that a bushfire will occur. Likelihood should be considered in the context of long term planning, not just the likelihood of a bushfire occurring in the next few years. Table 2 outlines the process for determining likelihood.

Table 2: Likelihood ratings for assessing bushfire risk (NSW Rural Fire Service, 2008)

	Fires are expected to spread and reach assets	Fires are not expected to spread and reach assets
Fires occur frequently	Almost certain	Possible
Fires occur infrequently	Likely	Unlikely

Source: *Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees* (NSW Rural Fire Service 2008).

Consequence is the outcome or impact of a bushfire event. The assessment process for consequence is subjective and includes consideration of threat, vulnerability and other issues such as level of impact and recovery costs. There are four possible consequence ratings: minor, moderate, major and catastrophic. A description of each is provided in Table 3.

Table 3: Consequence ratings for assessing bushfire risk (NSW Rural Fire Service, 2008)

Consequence rating	Description
Minor	<ul style="list-style-type: none"> • No fatalities. • Some minor injuries with first aid treatment possibly required. • No persons are displaced. • Little or no personal support (physical, mental, emotional) required. • Inconsequential or no damage to an asset. • Little or no disruption to community. • Little or no financial loss.
Moderate	<ul style="list-style-type: none"> • Medical treatment required but no fatalities. Some hospitalisation. • Localised displacement of persons who return within 24 hours. • Personal support satisfied through local arrangements. • Localised damage to assets that is rectified by routine arrangements. • Community functioning as normal with some inconvenience. • Local economy impacted with additional financial support required to recover. • Small impact on environment / cultural asset with no long term effects.
Major	<ul style="list-style-type: none"> • Possible fatalities. • Extensive injuries, significant hospitalisation. • Large number of persons displaced (more than 24 hours duration). • Significant resources required for personal support. • Significant damage to assets that requires external resources. • Community only partially functioning, some services unavailable. • Local or regional economy impacted for a significant period of time with significant financial assistance required. • Significant damage to the environment/cultural asset which requires major rehabilitation or recovery works. • Localised extinction of native species.

Consequence rating	Description
Catastrophic	<ul style="list-style-type: none"> • Significant fatalities. • Large number of severe injuries. • Extended and large number requiring hospitalisation. • General and widespread displacement of persons for extended duration. • Extensive resources required for personal support. • Extensive damage to assets. • Community unable to function without significant support. • Regional or state economy impacted for an extended period of time and financial assistance required. • Permanent damage to the environment. • Extinction of a native species in nature.

Source: *Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees* (NSW Rural Fire Service 2008).

The risk level is assessed by combining the likelihood and consequence to provide either a low, medium, high, very high or extreme level of risk using the matrix in Table 4. Table 5 presents the level of risk for varying bushfire impact scenarios.

Table 4: Matrix to determine level of bushfire risk (NSW Rural Fire Service, 2008)

Consequence	Minor	Moderate	Major	Catastrophic
Likelihood				
Almost certain	High	Very High	Extreme	Extreme
Likely	Medium	High	Very High	Extreme
Possible	Low	Medium	High	Very High
Unlikely	Low	Low	Medium	High

Source: *Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees* (NSW Rural Fire Service 2008).

Table 5: Assessment of level of bushfire risk for the project

Impact	Level of risk
<p>Loss of life</p> <p><i>Likelihood = Unlikely</i></p> <p><i>Consequence = Major</i></p>	<p><u>Medium</u></p> <ul style="list-style-type: none"> The low availability of fuel across the mainland (low and medium hazard areas) combined with cleared and developed land and many roads does not lend itself to severe, widespread fires. A widespread grassfire may occur in extremely windy and dry conditions such as a 'blow-up' day. This fire could be fast moving but of lower severity than a forest fire. Residential assets in proximity to the project are generally not vulnerable to bushfire due to their location in low hazard areas. Bushland areas near high and medium hazard areas have the potential to carry a widespread fire of higher severity, however the effects of fire will be mitigated as part of the recommendations of this report.
<p>Damage to Wind Farm and surrounding rural properties</p> <p><i>Likelihood = Unlikely</i></p> <p><i>Consequence = Moderate</i></p>	<p><u>Low</u></p> <ul style="list-style-type: none"> The low availability of fuel across the mainland (low and medium hazard areas) combined with cleared and developed land and many roads does not lend itself to severe, widespread fires. A widespread grassfire may occur in extremely windy and dry conditions such as a 'blow-up' day. This fire could be fast moving but of lower severity than a forest fire. Residential assets in proximity to the project are generally not vulnerable to bushfire due to their location in low hazard areas. Bushland areas near high and medium hazard areas have the potential to carry a widespread fire of higher severity however the effects of fire will be mitigated as part of the recommendations of this report.
<p>Damage to other associated infrastructure (i.e. transmission lines)</p> <p><i>Likelihood = Unlikely</i></p> <p><i>Consequence = Minor</i></p>	<p><u>Low</u></p> <ul style="list-style-type: none"> Infrastructure assets associated with the wind farm project are generally surrounded by cleared and managed lands. Infrastructure assets associated with the wind farm project are not considered vulnerable due to their location within low hazard areas, the nature of their construction and use, and mitigation and management measures.
<p>Damage to ecological values / assets</p> <p><i>Likelihood = Likely</i></p> <p><i>Consequence = Minor</i></p>	<p><u>Medium</u></p> <ul style="list-style-type: none"> Environmental assets such as vegetation or wildlife communities of concern could be vulnerable dependant on various fire regime thresholds, which are currently unknown. Risk is typically more dependent on the fire regime than a single fire event.

3.2.2 Bushfire Risk Evaluation

The primary issues amongst the analysis of risk (Table 5) were influenced by the change in hazard, and the type and location of assets as discussed below.

The subject site is mapped as predominantly low or negligible hazard and supports generally cleared and rural developed lands. It is important to note that there are residential dwellings on rural properties scattered throughout. In terms of potential impacts upon the proposed wind farm assets, it appears that there will be no assets – being turbines and supporting infrastructure – located within areas nominated as high hazard / bushfire behaviour potential. Further to this, there are very limited proposed assets in those areas mapped as medium hazard, including a couple of turbines in the northern portion of the site, and the proposed transmission line to the north east dissects a medium hazard area.

Assuming a fire escapes the development, there is a low to medium risk of fire (adversely) impacting on the surrounding life, property and environment.

The highest risk rating scored (Table 5) was medium in two situations, these are;

- The possible chance of fatalities or major injuries to life within or surrounding the Crudine Ridge Wind Farm; and
- The possible chance of damage to ecological values within or surrounding the Crudine Ridge Wind Farm.

It is the above bushfire risks, particularly to surrounding assets, that are to be treated in the management and mitigation plan in the following Section 4.

3.2.3 Risk Acceptability

Risk acceptability is typically defined and assessed by the agency responsible for managing the land or the relevant fire authority. In this case, the risk acceptability is defined by the author based on bushfire risk management guidelines (NSW Rural Fire Service, 2008) and experience in preparing bushfire risk assessments.

Areas of low to medium risk are likely to be managed by routine procedures general to the development overall and may not require a specific allocation of a risk treatment. Generally speaking, serious consideration should be given to risks rated as high and above (includes very high and extreme risk ratings). Therefore risk ratings of low to medium are considered an acceptable level of risk, with a high risk rating being the point where risks may be considered unacceptable.

Acceptable risks should be monitored or reviewed as conditions alter over time and they may need to be amended.

4 Bushfire Risk Treatments

4.1 COMBINING PBP 2006 ASSESSMENT WITH AS/NZS ISO 31000:2009

The bushfire risk assessment undertaken against *Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees* (NSW Rural Fire Service 2008) (Section 3) is in response to a statutory responsibility required under section 62 of the *Rural Fires Act 1997* for the management of potential fire hazard area and mitigating the potential for fires to impact upon surrounding lands.

The risk assessment and associated mitigation measures are also a response to the requirements of PBP 2006, which requires adequate protection be implemented for all new development on bushfire-prone land. The mitigation (bushfire protection) measures required by PBP 2006 should be considered conditions of development approval and are included in the recommended risk treatments listed in Table 7.

4.2 BUSHFIRE RISK TREATMENT OPTIONS

Bushfire risk treatment options should aim to reduce both the likelihood and consequences of bushfires, and allow provisions for addressing the risk that remains. There are six broad groups of risk treatment options as described by AS/NZS ISO 31000:2009 'Risk management – Principles and guidelines' (Standards Australia 2009) and the NSW Bushfire Coordinating Committee (BFCC) Guidelines (2008). These options, definition and example treatments are summarised in Table 6. Implementation of these strategies provides an effective way of minimising the risk identified within this assessment.

Table 7 lists and describes those risk treatments recommended to be carried out at the development site for the construction, operation and maintenance of the wind farm and associated infrastructure.

Table 6: Six recognised bushfire risk treatment option groups (BFCC 2008)

Risk treatment option	BFCC (2008) / AS/NZS ISO 31000 definition	Example treatment
Avoid the risk	By deciding not to proceed with the activity likely to generate the bushfire risk.	Ceasing or removing activities from threat.
Reduce the likelihood	Programs to reduce the number of deliberate and accidental man-made ignitions (after BFCC 2008).	Deterrence; Community education; Access restrictions; Regulation.
Reduce the consequence	Programs to reduce the level of fuel available to burn in a bushfire (after BFCC 2008).	Asset Protection Zones; Strategic Fire Advantage Zones; Land Management Zones; Fire Exclusion Zones.

Risk treatment option	BFCC (2008) / AS/NZS ISO 31000 definition	Example treatment
Accept the risk	After risks have been reduced, some residual risks may still exist, which may need to be managed with fire response strategies (after BFCC 2008).	Detection and warning; Response planning; Suppression activities.
Transfer the risk	Involves another party sharing some part of the risk by providing capabilities or resources (after AS/NZS ISO 31000).	Insurance arrangements.
Retain the risk	After risk has been changed or shared, there may be residual risk without any specific immediate action being required (after AS/NZS ISO 31000)	Recovery planning; Evacuation planning.

Table 7: Recommended risk treatments

Risk treatment options and strategies		
Avoid the risk		
Limit or prohibit ignition creation activities	<i>What/who</i>	Site manager to limit or prohibit welding and other construction and maintenance activities that can produce sparks and/or embers during days of extreme or catastrophic fire weather and days of Total Fire Ban.
	<i>Where</i>	Entire site.
	<i>How</i>	<p>Fire weather is to be monitored daily at the NSW Rural Fire Service website at http://www.bushfire.nsw.gov.au/dsp_content.cfm?CAT_ID=1109.</p> <p>Ignition creating activities outdoors such as welding should not occur on days of Total Fire Ban, and occur only on days of Extreme and Severe fire weather with the presence of a 4WD striker with slip-on water unit equipped with diesel pump and hoses and notification of the local Fire Control Centre (RFS Cudgegong District Office, Depot Road, Mudgee – 02 6372 4434; or RFS Bathurst Regional Office, 7 Lee Street, Bathurst – 02 6333 1333)</p> <p>Ignition creating activities may occur on days of Very High fire danger and lower without these restrictions, and in combination of the measures listed under the remaining risk treatment options below.</p>
	<i>When</i>	During all phases of the development including future maintenance.
Reduce the likelihood		
Education	<i>What/who</i>	<p>Construction crew and maintenance staff should be educated on the topic of bushfire risk management and the risks that could be present at the site. This should also be included in the Construction and Operational Environmental Management Plans.</p> <p>An appreciation of the burning regulations obtained from the NSW Rural Fire Service website is essential http://www.bushfire.nsw.gov.au/dsp_content.cfm?cat_id=1108</p>
	<i>Where</i>	Facilities building or company office.

Risk treatment options and strategies		
	<i>How</i>	Brief education session ('tool-box' meeting) presenting this Bushfire Risk Assessment. Print outs from the NSW Rural Fire Service website on understanding fire weather and burning regulations.
	<i>When</i>	Prior to construction and during briefing of new contractors including maintenance contractors.
Training	<i>What/who</i>	Training construction crew and maintenance staff on basic first response fire fighting techniques including notification of fires and reporting. This training is to include the use of 4WD striker unit to be available on site on certain days of severe and extreme fire weather, extinguishers, knap-sacks and hoes. Notification and reporting of fires to follow a procedure of notifying site manager and/or calling 000 immediately and providing a description of the fire location, size, proximity to assets and current access arrangements.
	<i>Where</i>	Facilities building or company office.
	<i>How</i>	Brief education session ('tool-box' meeting).
	<i>When</i>	Prior to construction and during briefing of new contractors including maintenance contractors.
Inspection, testing and reporting	<i>What/who</i>	Ensure that the identified network assets located in bush fire prone areas are inspected, tested and maintained in accordance with the relevant maintenance schedule.
	<i>Where</i>	Transmission line.
	<i>How</i>	In accordance with the network management plan.
	<i>When</i>	During operation maintenance phases.

Risk treatment options and strategies

Reduce the consequence

Fuel reduced zone establishment for transmission lines	<i>What/who</i>	Establish a fuel reduced zone underneath transmission lines in accordance with relevant maintenance standards.
	<i>Where</i>	Underneath external transmission lines.
	<i>How</i>	Zone can be created using mechanical slasher or hand held tools such as a trimmer.
	<i>When</i>	During all phases of the development including future maintenance.
Fuel reduced zone establishment for construction activities	<i>What/who</i>	Establish a 10 m fuel reduced zone around construction activities that may result in ignition generation.
	<i>Where</i>	Around construction activities that may result in ignition generation.
	<i>How</i>	Zone can be created using mechanical slasher or hand held tools such as a trimmer.
	<i>When</i>	During all phases of the development including future maintenance.
Fuel reduced zone establishment for substations and compounds	<i>What/who</i>	Establish a 20 m fuel reduced zone around each substation and compound.
	<i>Where</i>	Around each substation and compound.
	<i>How</i>	Zone can be created using mechanical slasher or hand held tools such as a trimmer.
	<i>When</i>	During all phases of the development including future maintenance.
Building protection for substations	<i>What/who</i>	Any buildings are to be adequately enclosed or screened to prevent the entry of embers.
	<i>Where</i>	All enclosed buildings.
	<i>How</i>	By sealing gaps with steel wire mesh with a maximum aperture of 2 mm and installing seals around doors with the aim to achieve a level of ember protection comparable to BAL-12.5 of AS 3959-2009 'Construction of Buildings in Bushfire Prone Areas'.

Risk treatment options and strategies		
	<i>When</i>	Consideration at the Project approval stage and application at construction stage.
<i>Maintain access roads as proposed</i>	<i>What/who</i>	Maintain access roads to allow the passage of fire tankers. Primary constraints are 4 m wide all weather trafficable area with gradients limited to 10 degrees or below.
	<i>Where</i>	All access roads.
	<i>How</i>	Typical road maintenance activities such as grading surface and maintaining drainage controls.
	<i>When</i>	During all phases of the development including future maintenance as required.
Accept the risk		
<i>Suppression and response</i>	<i>What/who</i>	Provide and maintain fire fighting equipment capable of controlling and suppressing small initial outbreaks of fire. Equipment should include, but not necessarily be limited to, 4WD striker with slip-on water unit equipped with diesel pump and hoses, extinguishers, knap sacks, hand tools. Notify fire authorities when fire occurs that cannot be controlled by first response techniques described above.
	<i>Where</i>	Entire site.
	<i>How</i>	Initial response and suppression by construction crew followed by notification of fire authorities (000).
	<i>When</i>	During construction only for fire fighting capability, and all phases for notifying fire authorities.
Transfer the risk		
<i>Insurance review</i>	<i>What/who</i>	Conduct review of insurance policy to ensure relevancy based on the understanding of bushfire risk presented in this assessment.
	<i>Where</i>	Office of land manager or insurance broker.
	<i>How</i>	Review insurance policy.

Risk treatment options and strategies

	<i>When</i>	Prior to construction and could be reviewed again at completion of construction prior to operation and maintenance phases.
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Retain the risk

<i>Evacuation plan and residual risk</i>	<i>What/who</i>	Understand the concept of residual risk described in Section 4.3 below. Consider creation of a 'Bushfire Emergency and Evacuation Plan'.
	<i>Where</i>	Facilities building
	<i>How</i>	Bushfire Emergency and Evacuation Plan to follow 'A Guide to Developing a Bushfire Evacuation Plan' (NSW Rural Fire Service 2004) and meet the requirements of Australian Standards AS 3745-2009 ' <i>Planning for emergencies in facilities</i> '.
	<i>When</i>	During all phases of the development including future maintenance.

4.3 RESIDUAL RISK

Residual risk is defined as the bushfire risk that remains after the implementation of bushfire risk treatments. It acknowledges that despite the treatments that are able to be put in place, some bushfire risk will remain and bushfires will continue to threaten assets, at least to some extent.

The concept of residual risk is inherent in most if not all risk plans. For example, there is also no guarantee of 100% life and property protection when applying the NSW standard for new development in bushfire prone areas '*Planning for Bush Fire Protection*' (NSW Rural Fire Service 2006).

A diversity of opinions within the community is inevitable regarding what is an acceptable level of residual bushfire risk. It can be effectively argued that environmental impacts (including socio-economic impacts) will be excessive unless a higher level of residual bushfire risk is accepted, but it is clear that a higher level of residual risk includes a higher risk to life, as well as property.

Providing an acceptable level of protection and a tolerable residual risk, is to some extent a compromise between the level of threat, inconvenience, dangers, and costs (financial and environmental) involved in providing the protection.

Based on the standards for bushfire protection, this assessment notes residual risk will remain after the execution of the bushfire risk treatments recommended in Table 7.

5 Monitoring and Review

All strategies and plans must define mechanisms to allow for recommended actions to occur and to show that progress is being made in dealing with a problem or that the prescribed actions are being successfully completed. It is also necessary to determine the effectiveness of the plan and efficiency of individual actions.

Monitoring should occur at both the management level and at the field level. Monitoring and evaluation against the aims and objectives (Section 1.4) is an effective way to monitor the implementation of risk treatments. Recording of details pertaining to achievement of risk treatments, fire occurrence (including ignition source and point, spread and behaviour) and damage sustained to assets is important for continual review and update of objectives and strategies.

An evaluation, review and update of this assessment should occur annually (at the end of each bushfire season, after March each year) through the process of updating fire history and other resource data, and adjusting works programs if required. Small changes to the strategies within this report may be made without significant consultation. Matters that require a more significant variation should be discussed amongst the stakeholders prior to implementation. The objectives of a review are to:

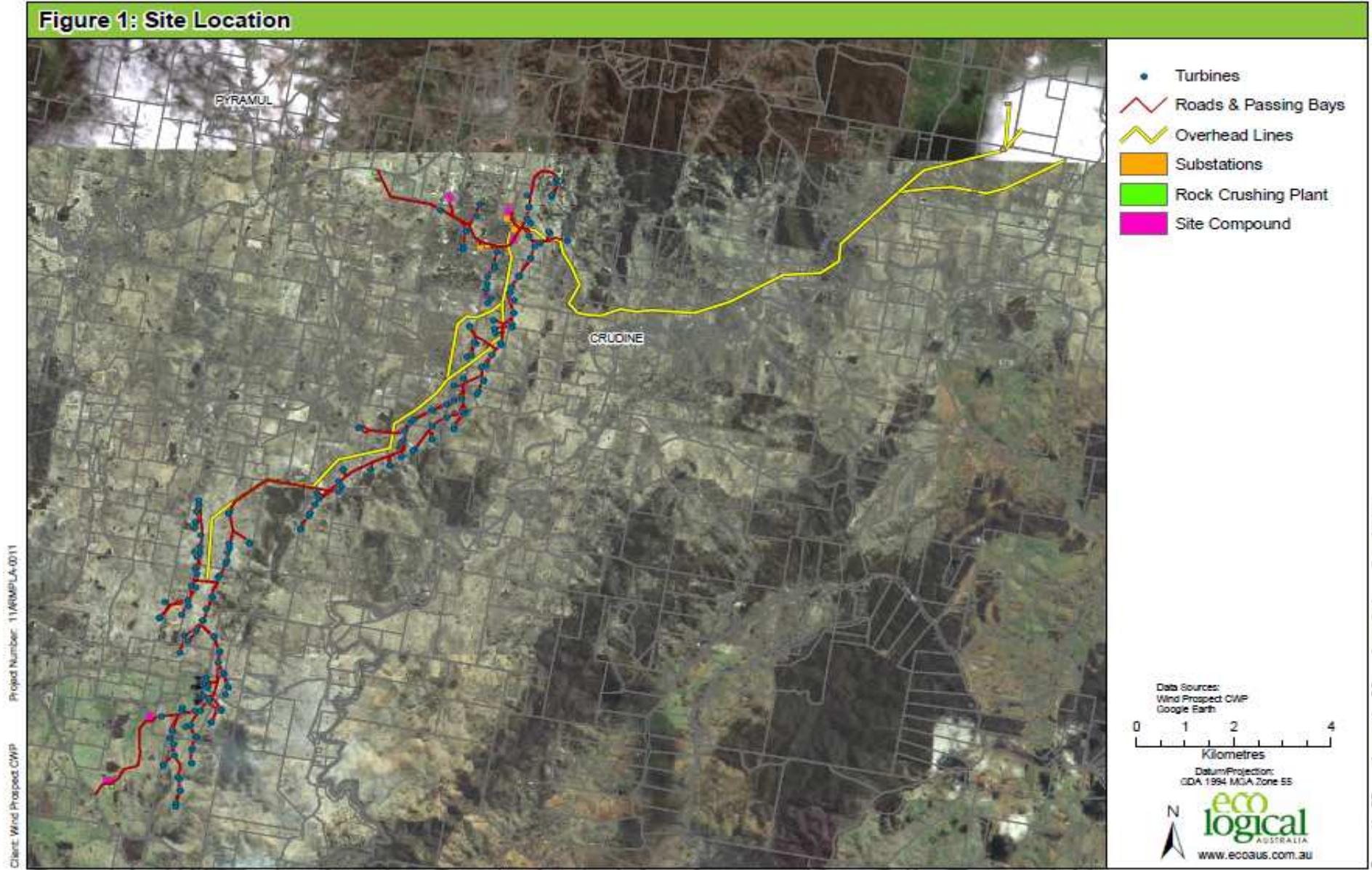
- Consider whether the aims and objectives have been achieved;
- Reassess the strategies in light of current research and management best practice;
- Reassess the strategies in light of recorded fire events within or nearby the site; and
- Reassess the strategies taking into account legislative changes, financial constraints, social philosophies, improvements in bushfire protection and suppression, and changes in vegetation.

6 References

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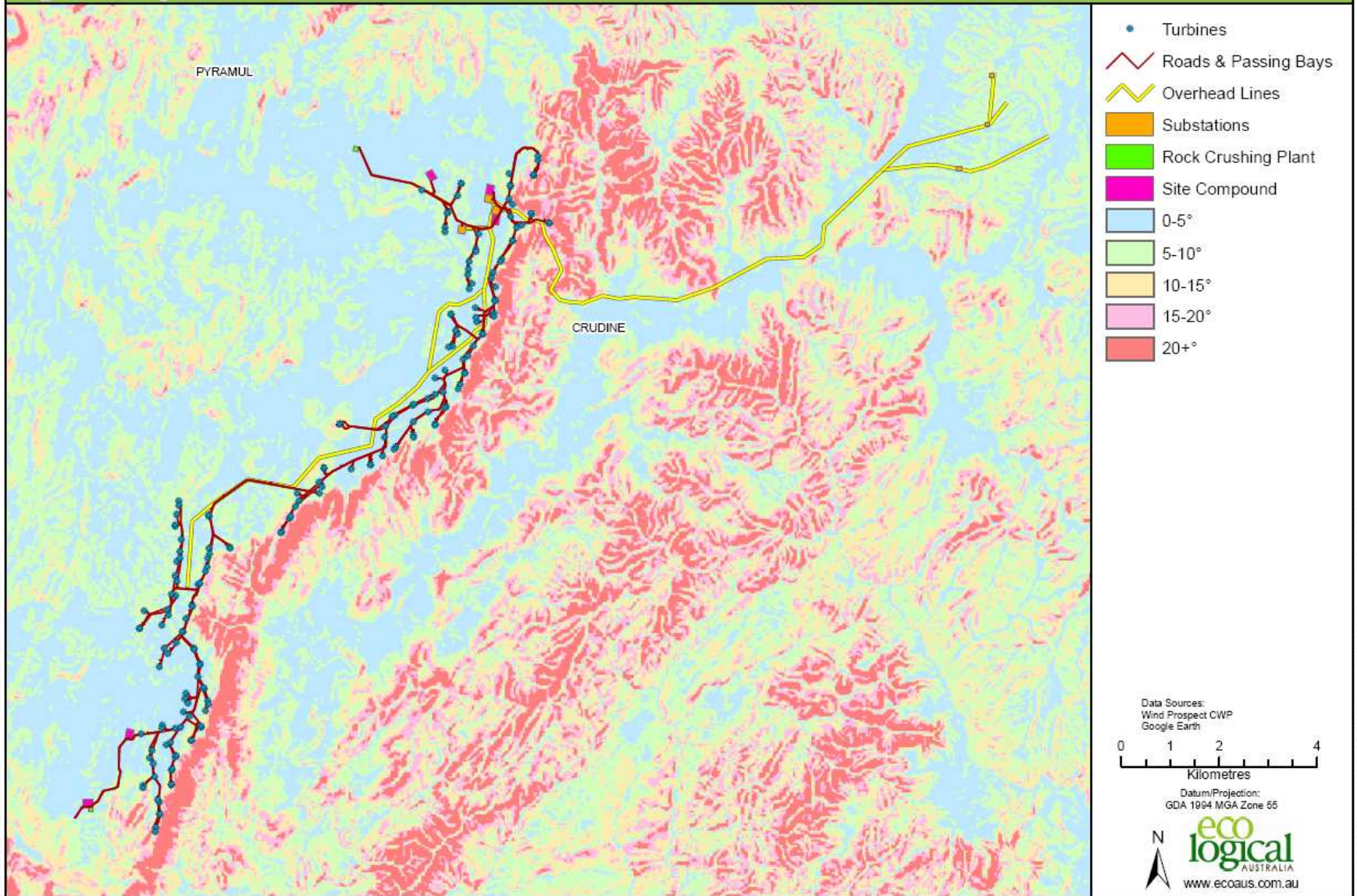
Appendix 1 – Figures 1, 3, 4, 5, & 6

Figure 1: Site Location



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Figure 3: Slope Classes

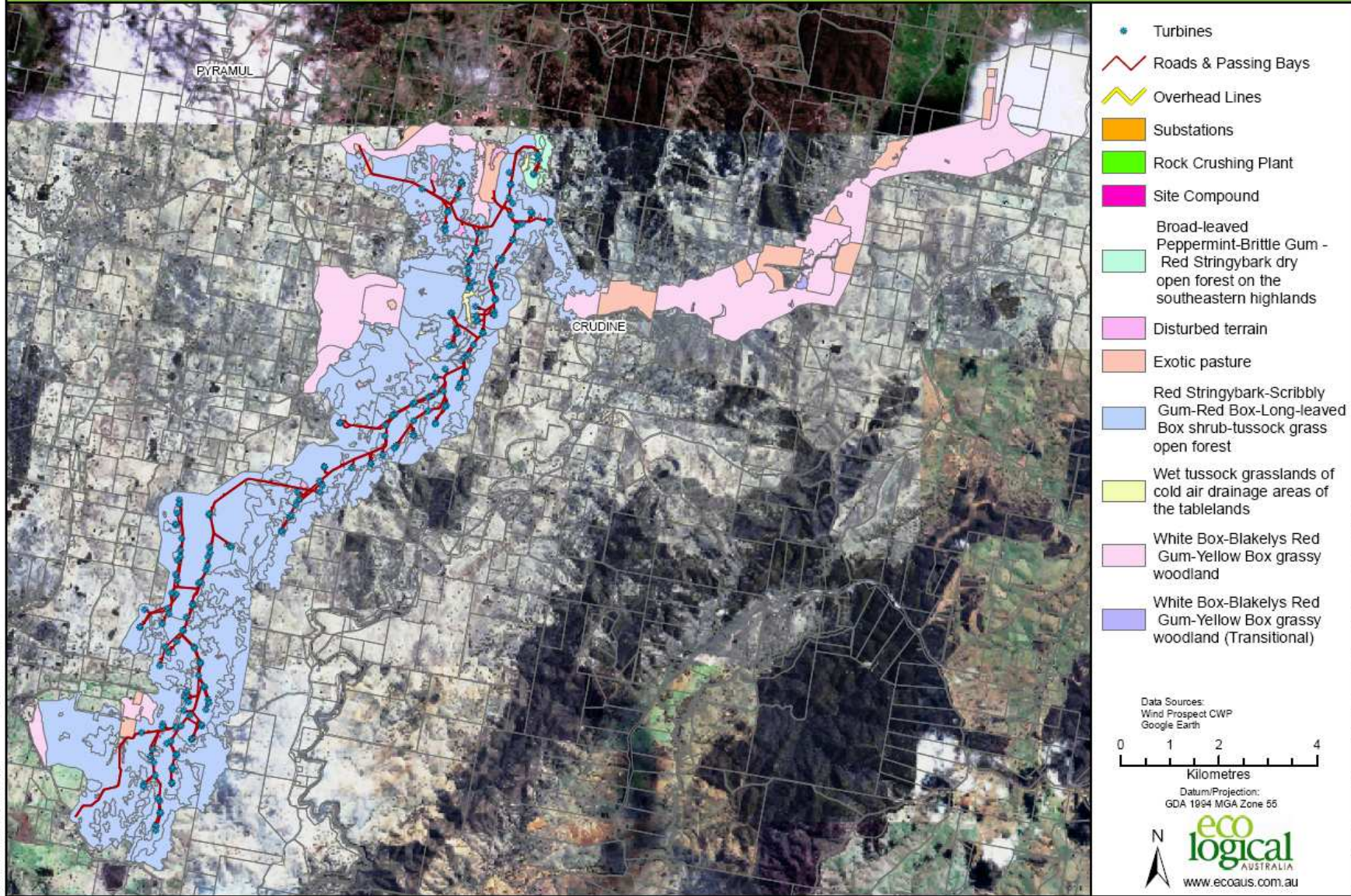


Client: Wind Prospect CWP
Project Number: 11ARMPLA-0011

Prepared by: DE
Approved by: DP
Status: Draft
Date: 04/08/11

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Figure 4: Vegetation Communities

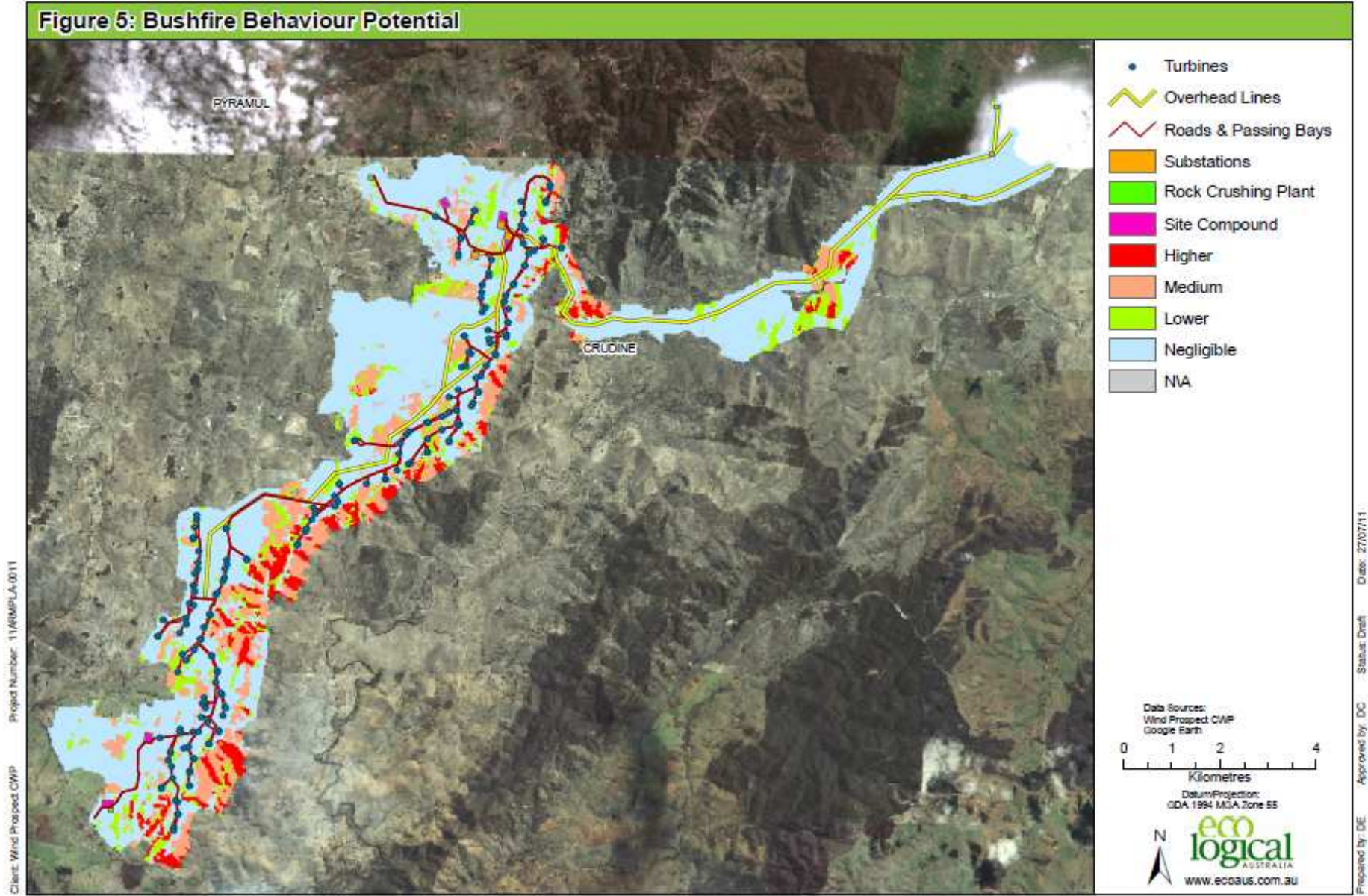


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Figure 5: Bushfire Behaviour Potential



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