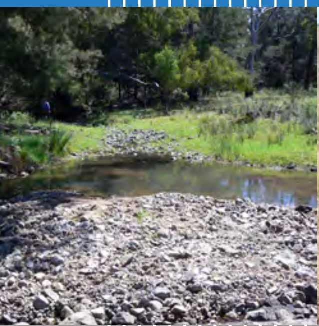


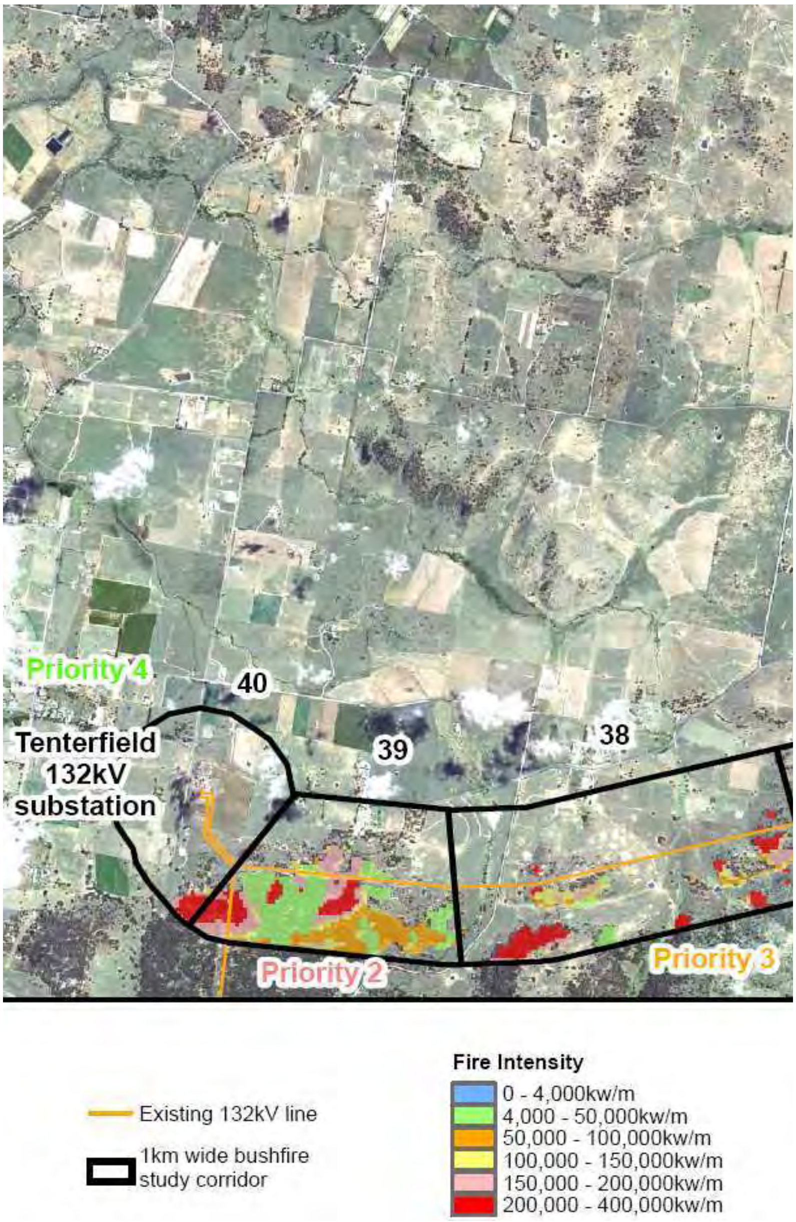


Appendix I-3
Bushfire Risk Assessment

BUSHFIRE RISK ASSESSMENT
Dumaresq – Lismore 330 kV Transmission Line

Prepared for
URS

15 March 2011



Bushfire Risk Assessment

Dumaresq – Lismore 330kV Transmission Line

PREPARED FOR	URS
PROJECT NO	10GOSBUS-0080
DATE	15 March 2011

DOCUMENT TRACKING

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Contents

Executive Summary

This Bushfire Risk Assessment analyses the bushfire risk during construction, operation and maintenance of the proposed Dumaresq - Lismore 330kV Transmission Line Project. It identifies bushfire protection measures (where appropriate) and maps ranking bushfire risk to enable strategic use of measures to reduce the bushfire risk to and from the proposed network.

The proposed transmission line is 205km long and covers five local government areas in far north-eastern NSW. The assessment specifically addresses the proposed easement and transmission line, upgrades to existing substations, construction of a new substation and the construction and upgrade of access tracks.

In order to obtain approval under Part 3A of the *Environmental Planning and Assessment Act 1979* and satisfy the Director General's Requirements (DGRs), a Bushfire Risk Assessment was required to assess the impact of bushfire to and from the Project.

This assessment is a technical report that is to be appended to, and read in conjunction with, the Dumaresq - Lismore 330kV Transmission Line Environmental Assessment prepared by URS.

The purpose of this risk assessment is two-fold: firstly, the assessment of the Project's bushfire protection measures against the NSW Rural Fire Service document 'Planning for Bushfire Protection 2006'; and secondly, a risk assessment of the impacts from the Project on surrounding land uses and assets following the risk assessment process set out in the NSW Bush Fire Coordinating Committee (BFCC) Guidelines (BFCC, 2008) which are based on the National Inquiry on Bushfire Mitigation and Management (COAG, 2004) and principles within the Australian/New Zealand Standard AS/NZS ISO 31000:2009 '*Risk management – Principles and guidelines*'.

Bushfire hazard and intensity was evaluated through analysis of a combination of fuel (vegetation), slope and aspect. A bushfire intensity model was created in a Geographical Information System (GIS) from these elements to analyse the spatial patterns of bushfire risk and allow analysis of the consequence and likelihood of bushfire damage.

The fire intensity map created by the model provides a quantifiable risk measure and has been used to rank the bushfire risk to and from the proposed Project. In summary, the map identifies that:

- higher fire intensity is predicted in the steeper forested areas;
- the highest ranked fire intensity class is found in 28% of the study corridor. If a fire occurs in these areas, an extreme fire intensity is highly probable;
- the lowest ranked fire intensity class is found in 18% of the study corridor. If a fire occurs in these areas fire intensity will be relatively low and fire control more probable; and

- the variation in predicted fire intensity enables the selection of best practice bushfire risk reduction design and maintenance (which may be more expensive), to be applied to the higher risk locations.

The potential consequence of a bushfire impacting surrounding assets and the likelihood of this occurring was also analysed and evaluated using the bushfire intensity model. A Risk Management Priority (RMP) map and table have been provided with 68 individual RMP sections created with sub-ranking of the Priority 1 sections into a further three categories. Assets adjoining the higher ranked sections are more likely to have a higher intensity bushfire attack than lower ranked sections. If fire were to result from the transmission lines in the higher risk sections under extreme conditions, it is expected they would result in a large fire which would have a greater impact on biodiversity, vulnerable built assets and possibly life. However, as there are few built assets in the bushfire study area the overall vulnerability was considered to be low. The nearby townships of Casino and Tenterfield have reasonable buffer areas of less flammable vegetation around their perimeter.

A suite of bushfire risk treatments aimed to reduce both the likelihood and consequences of bushfires is recommended in six broad groups of risk treatment options of ‘avoid the risk’, ‘reduce the likelihood’, ‘reduce the consequence’, ‘accept the risk’, ‘transfer the risk’ and ‘retain the risk’. Treatments include, but are not limited to, ignition prevention, education of contractors, asset design, fuel management, substation building protection, and suppression and response strategies. The risk treatments also include the outcomes of a Bushfire Protection Assessment (Appendix 2) prepared for the Project against the requirements of the NSW Rural Fire Service document ‘*Planning for Bushfire Protection 2006*’ (PBP). Outcomes for those components of the Project that required assessment under PBP included an Asset Protection Zone and building construction standards for the proposed Tenterfield 330kV Substation.

It is concluded that the Project would be exposed to varying levels of bushfire risk but these are within acceptable limits. It is also concluded that the transmission lines may increase the risk of bushfire ignition in the region but with appropriate design measures for higher risk locations this risk can be reduced to an appropriate level.

1 Introduction and Context

1.1 BACKGROUND

This Bushfire Risk Assessment (the Assessment) outlines the objectives, risk analysis and strategies for bushfire risk management for the construction and operation of the Dumaresq to Lismore 330kV Transmission Line Project in Far Northern NSW.

This assessment is a technical report that is to be appended to, and read in conjunction with, the Dumaresq to Lismore 330kV Transmission Line Environmental Assessment prepared by URS.

The need for a Bushfire Risk Assessment was identified within the Director General's Requirements (DGRs), being:

> *"the Environmental Assessment shall specifically consider on-going maintenance and safety management of the project, including potential impacts on and from bush fires and floods"*

The assessment specifically addresses the proposed easement and transmission line installation, upgrades to the existing substations, construction of a new substation and the construction and upgrade of access tracks.

1.2 PROJECT DESCRIPTION AND LOCATION

The proposed transmission line would be 205km long and would be located within five local government areas in north-eastern NSW (Inverell, Tenterfield, Kyogle, Richmond Valley and Lismore) and two Rural Fire Districts (Tenterfield and Northern Rivers). The location of the proposed Project is shown in Figure 1.

The Project would consist of:

- a 330kV easement incorporating pole and tower structures and comprising:
    - o construction of a new 96km 330kV transmission line and 60m easement through greenfield areas from Dumaresq Switching Station to the proposed location of the new Tenterfield 330/132kV Substation (Tenterfield 330kV Substation);
    - o removal of 95km of the existing 132kV transmission line between the proposed Tenterfield 330kV Substation and structure 395 to the south of Casino;
    - o construction of a new 109km 330kV transmission line between the Tenterfield 330kV Substation and Lismore Substation. Between the Tenterfield 330 kV Substation and Casino (95km), the 330kV transmission line would be located on the route of the former 132kV transmission line. The existing 45m easement would be extended to 60m. Between Casino and Lismore Substation (14km), the new 330kV transmission line would run adjacent to the existing 132kV transmission line. The existing 45m easement would be extended to 90m for this section.
- upgrades to the Lismore Substation and Dumaresq Switching Station. Upgrades would be within the existing sub/switching station footprints;

- establishment of a new 330/132kV substation approximately 14km north east of Tenterfield to maintain the existing 132kV connection to the Tenterfield 132kV Substation;
- establishment of access tracks both within the easement and outside the easement for the purposes of transmission line construction and operational maintenance; and
- replacing and restringing the existing earthwire between the new Tenterfield 330kV Substation and the existing Tenterfield 132kV Substation with optical ground wire (OPGW).

More detailed information on the Project and site characteristics can be found within the Environmental Assessment. Only those details necessary for the understanding of the Bushfire Risk Assessment are included within this report.

1.3 PURPOSE AND OBJECTIVES OF BUSHFIRE RISK ASSESSMENT

The purpose of this Assessment is to satisfy the DGRs and to outline the strategies for bushfire risk management for the Project. To fulfil this purpose the following assessment objectives have been identified by URS and Eco Logical Australia:

Impacts on the Project-

- assess the Project proposal in accordance with *Planning for Bushfire Protection* (PBP) *2006* (NSW Rural Fire Service, 2006) and
- recommend bushfire risk treatments to afford the Project an adequate level of protection from bushfire in accordance with the PBP guidelines.

Impacts from the Project-

- assess the bushfire risk presented by the Project within a risk assessment and management framework recommended by NSW Bush Fire Coordinating Committee Bush Fire Risk Management Planning Guidelines (BFCC, 2008) which are based on the National Inquiry on Bushfire Mitigation and Management (COAG, 2004) and the principles of the Australian/New Zealand Standard AS/NZS ISO 31000:2009 '*Risk management – Principles and guidelines*'; and
- recommend and prioritise bushfire risk treatments to create an acceptable level of risk for the project within NSW regulatory limits and guidelines for bushfire risk management .

Figure 1: Location of the Project

1.4 BUSHFIRE PLANNING FRAMEWORK

This section outlines the legislation and policy requirements for the bushfire assessment.

1.4.1 NSW Environmental Planning and Assessment Act 1979

The process for assessment under Part 3A of the EP&A Act requires consultation with the NSW Rural Fire Service if the proposal is within land defined as bush fire prone land (see *Rural Fires Act 1997* below). The assessment of bush fire protection for development within bush fire prone land would follow the PBP guideline (NSW Rural Fire Service, 2006). The Dumaresq – Lismore 330kV Transmission Line Project is herein assessed against PBP.

1.4.2 NSW Rural Fires Act 1997

The NSW *Rural Fires Act 1997* (RF Act) (Part 4, Division 1) 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 risk assessment with risk treatment actions herein satisfies the design elements of these obligations.

1.4.3 Bushfire Risk Management Plans

The RF Act also requires the preparation of a Bushfire Risk Management Plan for each Rural Fire District based on BFCC Guidance (2008). Approximately two thirds of the proposed project would be situated within the district managed by the Draft Northern Tablelands Bushfire Risk Management Plan (NTBFMC, 2010) and the remaining third would be situated within the Northern Rivers Bushfire Risk Management Plan (NRBFMC, 2010). This assessment ensures the Project is consistent with these Risk Plans.

1.4.4 Australian Standard AS 3959-2009 Construction of buildings in bushfire prone areas

The Australian Standard AS 3959-2009 '*Construction of buildings in bushfire-prone areas*' (Standards Australia, 2009) provides construction standards for buildings in a bush fire prone area to protect against the effects of ember attack, radiant heat and flame contact. AS3959 is the deemed-to-satisfy approach to achieving '*Building Code of Australia*' (BCA) compliance for building on bush fire prone land.

2 Assessment Approach and Methods

2.1 ASSESSMENT APPROACH

The approach to the bushfire risk assessment is two-fold and designed to satisfy the DGRs which include "*…impacts on and from bush fires…*".

The assessment of the impact of bushfire on the Project has been completed using the process within PBP. The aim of the PBP assessment process is:

> "*…to use the NSW development assessment system to provide for the protection of human life (including fire fighters) and to minimise impacts on property from the threat of bush fire, while having due regard to the development potential, on-site amenity and protection of the environment.*"

The assessment of the impact of bushfire from the Project is based on the NSW Rural Fire Service Bush Fire Coordinating Committee (BFCC, 2008) guidelines of managing bushfire risk to existing assets as recommended by the National Inquiry on Bushfire Mitigation and Management (COAG, 2004) and based on the principles within Australian/New Zealand Standard AS/NZS ISO 31000:2009 Risk management – Principles and guidelines. The BFCC recommends an assessment process for bushfire risk and the formulation of risk mitigation treatments by providing:

- an identification, 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 shown in Figure 2.

2.2 METHODOLOGY

The assessment was based on a desktop study only. Details on the method followed are provided at the beginning of each section of this document. To summarise, the primary steps in the assessment are as follows:

a. identify the factors that create the bushfire risk, including:
    a. the asset base requiring protection, i.e. the assets include those associated with the Project as well as other assets on adjoining lands;
    b. the historical pattern of bushfires and damage caused by fire;
    c. local weather that contributes to problematic bushfire behaviour;
    d. potential ignition causes;
    e. the bushfire hazard based upon assessment of vegetation (fuels), topography and aspect;
    f. the potential bushfire intensity under extreme conditions as identified through a GIS model;

g. the potential bushfire behaviour and threats to assets;

h. existing risk treatment measures and arrangements; and

i. vulnerability of life, property and environment associated with the proposal and on adjoining lands.

b. analyse and evaluate bushfire risk by:

a. assessing the adequacy of bushfire protection for the proposal under PBP; and

b. using the risk management process to assess the risk of fire from the proposal to assets on adjoining lands.

c. identify and prioritise bushfire risk treatments by:

a. classification of risk from GIS analysis of bushfire attack potential;

b. providing recommendations to ensure compliance of the proposal with PBP; and

c. producing risk treatment options to manage the risk to surrounding lands.

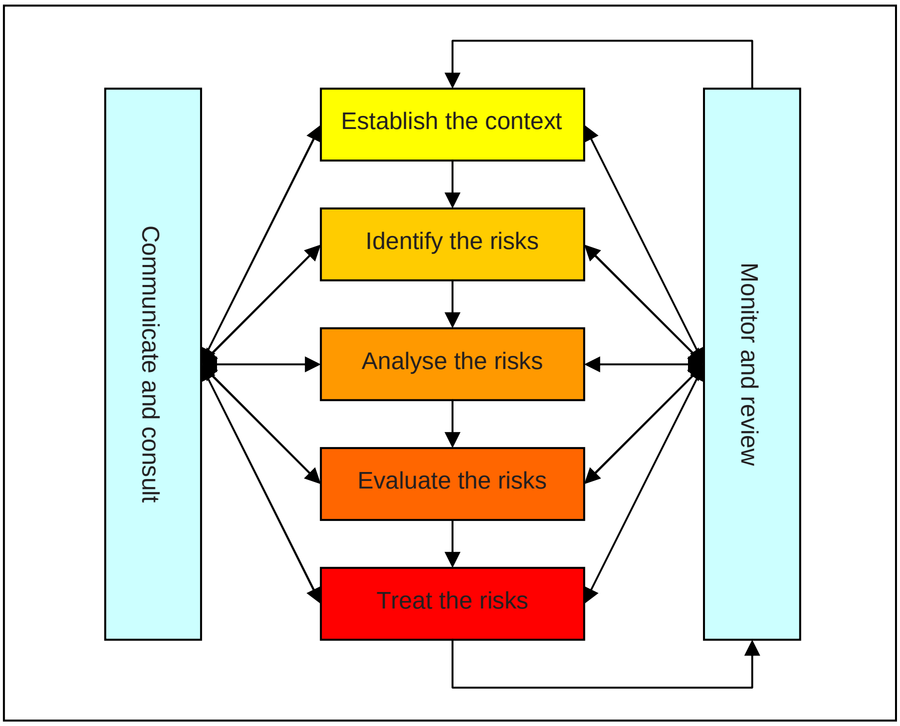

Figure 2: Bushfire risk management planning following AS/NZS ISO 31000-2009, BFCC (2008) and COAG (2004)

3 Bushfire Risk Identification

3.1 ASSET DESCRIPTION

In general terms, the assets requiring protection from bushfires include life, property and the environment. The protection of human life overrides that of the built and natural environment. These assets are recognised within the Project area as well as existing (and future) assets on the adjoining lands. Thus the assets requiring protection include people (workforce and local community), buildings and infrastructure, the proposed Project and the native biota.

The primary human settlement areas within 20km of the transmission line are the townships of Tenterfield and Casino, both of which are surrounded by farming lands. There are also many isolated farming settlements and a few small villages, such as Drake Village. However, much of the community and economic assets and infrastructure associated with Northern Tablelands and Northern Rivers regions are not close (i.e. within 20km) to the Project. The further an asset is located from the potential source of a fire then, in general terms, the greater the likelihood of the fire being controlled prior to reaching the asset.

In the western part of the alignment, the transmission line traverses hilly, vegetated terrain featuring many large and contiguous bushland reserves. The biota of these vegetated areas is both the bushfire hazard and an environmental asset requiring protection from inappropriate fire regimes, e.g. too frequent fire.

3.2 BUSHFIRE SETTING

3.2.1 Bush fire prone land

From assessment of the five local council bush fire prone land maps, approximately 60% of the length of the alignment occurs on mapped bushfire prone land. Bush fire prone land is land that is vegetated by bushland (i.e. excluding grassland), and is of at least 1 hectare in size, or within 100m of bushland.

3.2.2 Bushfire history

The Northern Rivers region has, on average, 140 bushfires per year (NRBFMC, 2010). Ten of which are considered to be major fires. Due to the similar climate, land uses and spatial distribution of bushfire hazard, it can be assumed that the Northern Tablelands region has a similar number of fires. Spatial mapping of bushfire history was unavailable for this assessment. Without this information it is assumed that a fire could be ignited and potentially develop into a worst-case bushfire within areas mapped as Bush Fire Prone Land. This assumption can be justified based upon climatic and vegetation data and nationally accepted fire behaviour formulae (e.g. McArthur, 1967).

3.2.3 Bushfire weather

An analysis of the fire weather experienced in the Project area and the surrounding region provides an insight into bushfire behaviour potential. The bushfire season coincides with strong southwest to northwest winds that prevail between late winter/spring until the onset of summer rains for the coastal areas and the end of summer for the tablelands (NRBFMC, 2010).

Typically, it is the hot, dry winds that flow across the continent that provide the problematic weather associated with most bushfires. It is the westerly or north-westerly winds which are associated with worsening fire weather (i.e. increase chance of fire escape and wildfire). The passage of cold fronts may also produce problematic fire behaviour through wind changes to the west-southwest, turning an eastern flank into a fire front. Wind changes, such as these, may result in a substantial increase in the fire area and increased danger to personnel and fire fighters.

3.2.4 Potential ignition causes

The NRBFMC (2010) Risk Plan identifies the primary sources of ignition to be:

- escaped hazard reduction burns including illegal burning off;
- arson; and
- lightning.

It is known that 330kV and 132kV transmission lines have caused bushfire through vegetation falling onto lines, asset failures, sagging of conductors with temperature which can spark fires if they clash together and broken overhead lines lying on the ground. Transmission lines, due to their very nature, are a bushfire risk. Electricity failures sparked five of the 'Black Saturday' fires in Victoria in February 2009. However, many of these historical faults have been found to be due to an ageing system, and electricity infrastructure cause less than 4% of fires nationally (Parliament of Victoria, 2009).

Extreme bushfire weather is always associated with high temperatures and strong winds (BOM, 2010). Very high temperatures expand conductors causing sagging; this increases their vulnerability to movement and damage from the strongest winds. Longer spans are also more vulnerable to these effects. Gale force winds may also have the potential to carry larger debris into conductors.

Extreme bushfire behaviour (particularly on very steep slopes) produces enormous atmospheric forces (e.g. wind turbulence) in the region of the fire front; these forces easily twist and break large trees. The risk of these forces impacting transmission lines is greatest on steep forested lands, particularly where these forested lands are expansive and located on a north to south-westerly aspect.

Regrowth vegetation growing into or within arcing distance of conductors is a cause of bushfire. This risk is managed through appropriate vegetation management regimes.

3.3 BUSHFIRE HAZARD AND INTENSITY

Bushfire hazard and intensity has been evaluated through analysis of a combination of fuel (vegetation), slope and aspect. A bushfire intensity model has been created in GIS to analyse the spatial patterns of these factors and provide a platform for the risk assessment of analysing the consequence and likelihood of bushfire damage.

The GIS bushfire intensity model has been used to map the potential fire intensity under extreme weather conditions across the landscape adjoining the transmission line. The potential fire intensity for each 25m GIS grid square over a 1km wide band (i.e. 500m either side of the transmission line) has been modelled.

The bushfire intensity map provides a quantifiable risk measure and has been used to rank the bushfire risk to and from the Project. The bushfire intensity model combines slope and vegetation data under a Fire Danger Index of 80 (the standard for building protection design in northern NSW) with the most problematic bushfire wind directions in the region (the north to southwest sector). The slope, vegetation and weather data is used with the formula *McArthur Meter Mach 5* to calculate the predicted fire intensity.

A map showing the actual fire intensity expected adjoining the transmission line not only provides a risk prioritisation measure, it can also be translated into radiant heat flux experienced by different components of the infrastructure. The predicted radiant heat flux enables selection of appropriate design for extreme risk sites. Flame lengths and fire rate of spread are also outputs of this modelling process; each of these provides important risk assessment and data for design and management decision making.

In addition to the risk of bushfire attack on the network, the risk of rapid fire spread and impact on 'downwind' built assets, e.g. a township, can be used to prioritise works to reduce these risks in a similar manner to that used to reduce risks to the asset (with the addition of a few other options).

The following subsections describe the inputs and outputs of the fire intensity modelling.

3.3.1 Fuels (vegetation)

Assessment of bushfire fuels is determined from an assessment of vegetation floristics and structure. Available vegetation mapping layers were analysed to determine the vegetation communities found throughout the Study Area and then assign them with a maximum or equilibrium fuel load as identified within AS 3959-2009 '*Construction of buildings in bushfire-prone areas*'. These fuel loads are used to assess new development in NSW under PBP.

From west to east, the Study Area traverses a mixture of grassy woodlands (e.g. New England Grassy Woodland), dry sclerophyll forests (e.g. Northern Escarpment, Northern Tableland, New England, Northern Gorge, Clarence and North Coast Dry Sclerophyll Forests), open pasture and some pockets of wet sclerophyll forest and rainforest.

Each ecological community has been categorised into 'fuel groups' and assigned the total fuel loadings listed in Table 1 below.

Table 1: Fuel groups as per AS 3959-2009 Table B.2

AS 3959 Fuel group	AS 3959 fuel load
Forest (includes wet and dry sclerophyll)	35 tonnes per hectare
Woodland	25 tonnes per hectare
Rainforest	12 tonnes per hectare

3.3.2 Slope

Steeper slopes significantly increase the rate of spread of fires, and with each 10° (degree) 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 hazard and intensity. Slope and wind are often the major factors determining the direction of fire spread.

The gradient of the local topography was derived from a Digital Terrain Model (DTM) with each DTM grid square being 25m.

3.3.3 Aspect

Aspect affects bushfire behaviour through the effects of sunlight and wind exposure on the topography and especially in the drying, heating and availability of fuels. The bushfire intensity model assumed fire running uphill on north to southwest aspects to assess a worst case wildfire within the region.

3.3.4 Bushfire intensity model

Figures 4 - 19 in Appendix 1 show the predicted fire intensity (in units of kiloWatts per meter of flame front (kW/m)) for the 1km wide corridor along the alignment using the six classes of fire intensity described in Table 2. The lowest predicted fire intensity class (numbered 6) identifies the only areas where bushfire can be expected to be controlled under extreme weather conditions. All other fire intensity classes (1 - 5) represent locations where the potential fire intensity will be well beyond the control capacity of any fire fighting resource, including the offensive attack strategy of backburning which would be unsafe for firefighters under these conditions.

The fire intensity model does not predict how often the weather conditions suitable for these extreme events will occur, but weather records suggest on average that these conditions can be experienced every year. Whilst the model predicts wildfire intensity under extreme weather conditions it also offers an excellent ranking system of bushfire risk based upon fire behaviour. Locations with higher ranking (e.g. 1 – 3) can be expected to have higher intensity fires more often than lower ranked sites and when these fires occur they are more likely to develop into fires with the potential to threaten lives and damage property.

Although it is impossible to lower the risk along the alignment to ensure all fires are within the controllable limits (as it would require mass removal of bushland), the ranking of predicted fire intensity provided by the model enables quality prioritisation and design of protection works.

Table 2: Fire Intensity Ranking

Fire Intensity (kW/m)	Intensity Class	Comment
0 – 4,000 kW/m	6	Intensity within the limit of fire fighter control
4,000 – 50,000 kW/m	5	Intensity beyond the limit of fire fighter control
50,000 – 100,000 kW/m	4	
100,000 – 150,000 kW/m	3	
150,000 – 200,000 kW/m	2	
>200,000 kW/m	1	

The following bullet points summarise the results of the Bushfire Intensity model:

- higher fire intensity is predicted in the steeper forested areas;
- the highest ranked fire intensity class is found on 28% of the study corridor. If a fire occurs in these areas, an extreme fire intensity is highly probable;
- the lowest ranked fire intensity class is found on 18% of the study corridor. If a fire occurs in these areas fire intensity will be relatively low and fire control more probable. Note: these areas may also include grasslands where fire spread may be rapid and difficult to control when grass is highly cured (i.e. fully dried) e.g. at the end of summer;
- the variation in predicted fire intensity and the subsequent ranking of this enables the selection of best practice bushfire risk reduction design and maintenance (which may be more expensive), to be applied to the higher risk locations.

4 Bushfire Risk Analysis and Evaluation

4.1 ASSESSMENT OF IMPACTS ON THE PROJECT

As outlined in Section 1.3 of this report, a primary objective of the Bushfire Risk Assessment is to assess the impact of bushfire on the Project. Therefore this assessment will:

- Assess the Project in accordance with PBP; and
- Recommend bushfire risk treatments to afford the Project an adequate level of protection from bushfire in accordance with PBP.

A PBP compliant assessment of the Project is included as a separate report in Appendix 2 of this report. In summary, the proposed Tenterfield 330kV Substation was the only building in bushfire prone land requiring assessment under PBP. The assessment concluded that the bushfire protection measures inherent in the proposed design for the new Tenterfield 330kV Substation (as required for all new substations in accordance with TransGrid's operational, maintenance and management plans) together with additional recommendations (consisting of a 15m and 20m Asset Protection Zone (APZ) and BAL[1] construction standard) are consistent with the aim and objectives of PBP. The inclusion of the APZ around sensitive areas of the Project allows for control to be maintained around the infrastructure in order to prevent damage from Bushfire. The requirements within the APZ include that the area must be clear of vegetation and other material, and grasses are to be kept at ground level.

Bushfires also have the potential to impact transmission lines. These impacts under extreme bushfire conditions could include triggering of line fuses, melting and breaking of conductors, and the damage/distortion of pylons. The level of bushfire-generated radiant heat required to result in these impacts will vary. However it is predicted that if any component of a transmission line was directly impacted by a fire of an intensity greater than 4,000 kW/m (see Table 2 and Figures 4 - 19), then the fuel management and width of the line easement would not be sufficient to prevent serious damage. The locations where extreme radiant heat levels are predicted (see Figures 4 – 19) are much more likely to sustain such damage.

It is noteworthy, that even in major bushfires only a relatively small percentage of the total burned area would burn at these extreme levels. These are typically places where the fire burns rapidly uphill toward the transmission line; the highest ranked areas in Figures 4 – 19 are a very good predictor of these most vulnerable locations.

[1] BAL is the acronym for Bushfire Attack Level which describes the radiant heat attack on a building under Australian Standard 3959-2009 *Construction of buildings in bushfire prone-areas*. Various BAL exist and AS3959 details the design of a building's façade to comply with these BAL. There are six BALs identified in AS3959 these are from lowest to highest (risk and construction standard) BAL Low, BAL 12.5, BAL 19, BAL 29, BAL 40 and BAL FZ. See http://www.rfs.nsw.gov.au/dsp_content.cfm?cat_id=1058 for further information.

4.2 ASSESSMENT OF IMPACTS FROM THE PROJECT

As outlined in Section 1.3 of this report, a primary objective of the Bushfire Risk Assessment is to assess the risk of the Project causing bushfires. Therefore this assessment will:

- assess the bushfire risk presented by the Project within a risk assessment and management framework recommended by the NSW Bush Fire Coordinating Committee Guidelines (BFCC, 2008) which are based on the National Inquiry on Bushfire Mitigation and Management (COAG, 2004) and principles within the Australian/New Zealand Standard AS/NZS ISO 31000:2009 '*Risk management – Principles and guidelines*'; and

- recommend and prioritise bushfire risk treatments to create an acceptable level of risk within regulatory limits and guidelines for bushfire risk management in NSW.

Section 3 identifies the risk factors and introduces the results of the Fire Intensity model as a platform to analyse and evaluate the risk. The following subsections assess the consequence of a bushfire caused by the Project impacting on the assets described in Section 3.1 and the likelihood of this occurring. This assessment is based on the analysis and evaluation of the Fire Intensity model.

4.2.1 Risk Management Priority from the bushfire intensity model

The bushfire intensity map for the bushfire study corridor has been broken into sections containing patterns of similar fire intensity. This was undertaken by the authors' expert judgment through visual assessment of the fire intensity patterns in Figures 4 -19 (Appendix 1). Sixty eight (68) individual sections were created and numbered to enable further ranking and analysis (see Figures 4 -19).

The fire intensity values for the cells within each section were added together and then averaged (using the area of the section). The average intensity score for each section was then sorted from highest to lowest and grouped into five Risk Management Priorities which are displayed in Figures 4 -19. The ranking of the Risk Management Priority sections can be used to guide the design and maintenance of the Project to address the bushfire risk.

An enhanced Risk Management Priority incorporating a value for Post Fire-ignition Spread (PFS) potential has occurred for the fourteen Priority 1 sections. The PFS assumes a fire ignition at or near transmission lines has occurred and an assessment of the likelihood of a major fire spreading (based on knowledge of the risk factors identified in Section 3) to impact on surrounding assets was made. A refined priority ranking was then assigned to the highest Risk Management Priority areas.

The PFS assessment was completed using a subjective visual assessment of the vegetation to the south east of the bushfire study corridor. Where the potential existed for large scale fire development (e.g. recognised by size, continuity and juxtaposition of the adjoining forested lands; steepness of terrain, availability of fire access, etc.) the section was ranked 1A; where a lesser risk occurred it was ranked 1B; and the remainder was ranked 1C. Ranking the different sections and identifying areas of high bushfire risk allows mitigation treatments to be prioritised in key areas. A summary of the results of the Risk Management Priority analysis (including the PFS refinement) is listed in Tables 3a and 3b.

4.2.2 Vulnerability of surrounding assets

The Risk Management Priority provides a ranking of both the bushfire risk to and from the Project. If the TransGrid assets located on the higher ranked sections are vulnerable to the highest intensity bushfires, there is some logic to suggest these sections, and the assets within them, may also receive a higher frequency of fire attack (e.g. because the ability to suppress the fire prior to reaching the transmission line is less). The ranking is therefore also a useful surrogate for assessing risk to surrounding assets from the Project.

Built and environmental assets adjoining the higher ranked sections of the transmission line are more likely to be subject to a higher intensity bushfire attack than lower ranked sections. If fire were to result from the transmission lines in the higher risk sections under extreme conditions, it is expected they would result in a very large fire which would have a greater impact on biodiversity and ultimately on vulnerable built assets.

Nearly all built assets are vulnerable to bushfire damage from extreme intensity bushfires. Built assets located in the higher risk sections should have protection measures compliant with PBP. However, some of these are older housing stock and retrospective upgrades to contemporary bushfire standards are unlikely unless the owners are proactive to their bushfire risk.

As there are few built assets in the bushfire study corridor, the overall vulnerability of built assets resulting from the Project is low. The nearby townships of Casino and Tenterfield have reasonable buffer areas of less flammable vegetation around their perimeter. Casino is located on the northern side of the Project with minimal intervening areas of hazardous vegetation and Tenterfield is located to the south and west of the Project, again with limited intervening hazardous vegetation.

It is not envisaged that the Project would increase fire frequency to an extent where it would adversely affect the native biota. That is, the potential frequency of fire resulting from the Project would be well below the thresholds for conservation of biodiversity even when added to other potential bushfire ignition causes in the region. The additional control line options associated with the proposed new establishment of easements and trails may in fact improve the controllability of lower intensity fires therefore reducing the frequency of fire in some areas.

Table 3: Summary results of Risk Management Priority analysis for each section shown in Figures 4 – 19

Table 3a: Risk Management Priority 1

Risk Management Priority (1)	Section number (Fig 4-19)	Average intensity (kW/m)	Sub-ranking of Priority 1
1	47	120,496	1A
1	3	120,126	1A
1	45	91,512	1A
1	14	85,735	1B
1	44	79,202	1B
1	31	73,857	1C
1	48	71,156	1A
1	61	69,458	1A
1	43	65,548	1B
1	51	62,120	1A
1	62	60,000	1A
1	55	54,893	1C
1	23	52,840	1B
1	57	50,825	1C

Table 3b: Risk Management Priority 2 - 5

Risk Management Priority (2-5)	Section number (Fig 4-19)	Average intensity (kW/m)
2	39	49,925
2	54	45,887
2	52	45,393
2	49	42,364
2	8	38,867
2	2	38,736

Risk Management Priority (2-5)	Section number (Fig 4-19)	Average intensity (kW/m)
2	17	36,407
2	60	34,099
2	37	33,483
2	24	32,485
2	19	27,824
2	58	24,524
2	35	24,120
2	15	23,723
3	42	22,843
3	21	22,645
3	66	20,774
3	38	20,593
3	34	19,999
3	63	19,729
3	7	19,040
3	5	19,019
3	68	18,579
3	65	18,028
3	32	17,880
3	29	17,857
3	30	17,061
3	67	16,721
4	27	13,167
4	13	12,833
4	59	12,116
4	11	11,319
4	9	10,686

Risk Management Priority (2-5)	Section number (Fig 4-19)	Average intensity (kW/m)
4	25	10,303
4	22	10,282
4	18	8,462
4	56	8,397
4	40	7,103
4	50	6,474
4	53	6,007
4	4	4,689
4	46	4,010
5	64	3,816
5	6	3,058
5	33	2,957
5	10	2,812
5	36	2,744
5	16	2,548
5	12	2,306
5	41	2,174
5	1	1,924
5	28	1,213
5	20	1,130
5	26	883

5 Bushfire Risk Treatments

5.1 INTRODUCTION

The purpose of implementing treatment options is to reduce the risks associated with bushfires in relation to this Project. As such, this section describes the bushfire risk treatment options to be considered as part of Project approval and ongoing operation of the Project.

5.2 INTEGRATING RISK TREATMENTS FOR IMPACTS TO THE PROJECT

The Bushfire Protection Assessment is a statutory responsibility required under the EP&A Act for the adequate protection of new development (and particularly buildings) in bush fire prone land of NSW. The bushfire protection measures are included in the suite of bushfire risk treatment options listed in Table 5. These also form part of the Project in accordance with the following TransGrid's operational, maintenance and management plans:

- *'Easement and Access Track Maintenance Policy'* (GM AS L1 002);
- *'Principals for Clearing'* (GD AS G3 015);
- *'Network Management Plan'* (GD AS G2 006);
- *'Electrical Design Standard'* (5-G-1 STD-169565);
- *'Substation Maintenance Policy'* (GM AS S1 001); and
- *'Fire Protection Manual Operations & Maintenance'* (GD HS G2 001).

The format of the recommended risk treatment options in Table 5 follow the groupings set-out within NSW Bush Fire Coordinating Committee Guidelines (BFCC, 2008) regardless of whether the mitigation measure is for the protection of the Project or protection of surrounding assets.

5.3 BUSHFIRE RISK TREATMENT OPTIONS

Bushfire risk treatment options aim to reduce both the likelihood and consequences of bushfires, and allow provisions for addressing the risk that remains, that is, the residual risk. There are six broad groups of risk treatment options for bushfire protection for all types of assets. These options, definitions and example treatments are summarised in Table 4 (i.e. the six recognised bushfire risk treatment option groups). Implementation of these strategies provide an effective way of minimising the risks associated with the Project.

Table 5 lists and describes those risk treatments to be implemented during the construction, operation and maintenance of the Project.

5.4 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 assessments. For example, there is no guarantee of 100% life and property protection when applying PBP to the new substation. The level of residual risk also depends on, if and how, the mitigation measures have been applied; it assumes their effective implementation.

The RMP mapping provides a good indicator of the level of residual risk along the network route. All but 18% of the bushfire study corridor, if exposed to bushfire under extreme weather conditions, will have fire intensity beyond the limits of control by firefighters and in the specific places where these intensities are realised, the flame lengths will extend well across the easement and impact conductors. Without enlargement of the width of the Project easement this residual risk will remain. Whilst an enlarged easement is not justifiable for a relatively low probability event, it is important to take action to minimise the residual risk by other means. These measures identified in Table 5.

Table 4: Six recognised* bushfire risk treatment option groups

Risk treatment option	Definition	Example treatment
Avoid the risk	By deciding not to proceed with the activity likely to generate the bushfire risk or relocate the activity to areas of low hazard.	• Ceasing or removing activities from threat.
Reduce the likelihood	Programs to reduce the number of deliberate and accidental human-induced ignitions.	• Deterrence; • Community education; • Access restrictions; • Regulation.
Reduce the consequence	Programs to reduce the level of fuel available to burn in a bushfire.	• Zoning such as Asset Protection Zones.
Accept the risk	After risks have been reduced, some residual risks may still exist, which may need to be managed with fire response strategies.	• Detection and warning; • Response planning; • Suppression activities.
Transfer the risk	Involves another party sharing some part of the risk by providing capabilities or resources.	• Insurance arrangements.
Retain the risk	After risk has been changed or shared, there may be residual risk without any specific immediate action being required.	• Recovery planning; • Evacuation planning.

* NSW Bush Fire Coordinating Committee Guidelines (BFCC, 2008)

Table 5: Recommended actions to treat bushfire risk

Risk treatment options and strategies		
Avoid the risk		
Limit or prohibit ignition creation activities	*What/who*	Site managers to limit or prohibit welding and other construction and maintenance activities that can produce sparks and/or embers on days of Total Fire Ban or days rated as either Extreme or Catastrophic Fire Danger.
	Where	All areas during construction in particular high risk areas.
	How	Monitor fire weather forecast on news media during construction. Follow the TransGrid Network Management Plan.
	When	During construction phases of the Project.
Reduce the likelihood		
Education with staff and contractors	*What/who*	Construction crew and maintenance staff should be briefed on bushfire risk management and the risks present at the site. This should also be included in any Construction and Operational Environmental Management Plans and all personnel induction activities.
	Where	Facilities buildings or field bases.
	How	Brief education session ('tool-box' meeting) presenting the Bushfire Risk Assessment.
	When	Prior to construction and during briefing of new contractors for work undertaken in the field.
Education with external stakeholders	*What/who*	Educate general community of the risks of overhead transmission lines, act on hazard complaints and liaise and consult with the NSW Rural Fire Service.
	Where	As required.

Risk treatment options and strategies		
	How	As above in accordance with TransGrid Network Management Plan.
	When	Regularly, but most importantly during the lead up to the bushfire season.
Training	*What/who*	Train construction crew and maintenance staff on basic first response fire fighting techniques including notification of fires and reporting. The training of selected personnel to include the use of 4WD striker unit which is to be available on site on days of Total Fire Ban or days of Catastrophic Fire Danger days, extinguishers, knap-sacks and rakehoes. All trained personnel are to be provided personal protective equipment suitable for the fire activities. Notification and reporting of fires to follow a procedure of notifying site manager and/or 000 immediately and providing a description of the fire location, size, proximity to assets and current access arrangements.
	Where	Project worksites.
	How	Appropriate training session including ‘tool-box’ meetings.
	When	Prior to construction activities in the field.
Inspection, testing and reporting	*What/who*	Ensure that the identified network assets located in bush fire prone areas are inspected, tested and maintained in accordance with the relevant maintenance schedule.
	Where	Project area.
	How	In accordance with the TransGrid Network Management Plan.
	When	During design, construction and maintenance phases.
Asset design	*What/who*	Strategically apply designs that minimise the potential for bushfire ignition from transmission lines during operational phase.

Risk treatment options and strategies		
	Where	Apply lowest risk designs to highest risk sections (See Table 3). Highest level protection design applied to Priority 1 sections and strategically in other higher risk areas.
	How	Consider strategic use of the following: insulating conductors; highest level safety fuses; wider conductor spacing, conductor separators, strategically located widening of the Project easement and/or position of conductors within the easement. Engage bushfire expertise to improve detailed design, construction and maintenance regimes.
	When	During design, construction and maintenance phases.
Reduce the consequence		
Fuel management for transmission line	*What/who*	Establish and maintain the easements required for the transmission line in accordance with TransGrid's *Easement and Access Track Maintenance Policy* (GM AS L1 002), *Principals for Clearing* (GD AS G3 015) and the *Network Management Plan*. These guidelines include clearing specifications.
	Where	Entire easement in particular areas of high risk.
	How	Methods within TransGrid's *Easement and Access Track Maintenance Policy* (GM AS L1 002), *Principals for Clearing* (GD AS G3 015) and the *Network Management Plan*.
	When	Clearing during construction and then ongoing maintenance and operation.
Fuel management for substation	*What/who*	Establish a 15m Asset Protection Zone (APZ) around buildings at the newly proposed Tenterfield 330kV Substation to provide protection from grassland fire; and 20m APZ around critical structures with components vulnerable to radiant heat attack, e.g. any components that include PVC, rubber, timber, glass, fibreglass visible from the hazard including seals, insulation etc. Follow 'Substation Maintenance Policy' (GM AS S1 001) and 'Fire Protection Manual Operations & Maintenance' (GD HS G2 001) regarding general fuel management of substations.
	Where	All buildings and substation facilities in bushfire prone land, specifically around the newly proposed Tenterfield

Risk treatment options and strategies		
		330kV Substation.
	How	TransGrid policies for general substation fuel management include: • Grass cutting and weed control on the substation site; • Routine inspection for any rubbish that may present a potential fire hazard, clean up and disposal of rubbish; • Routine inspection of perimeter fire breaks and removal of any perimeter bush fire material; • Routine inspections of control room gutters and removal of any combustible material; and • Removal of grass and or weeds near cable entries.
	When	Regularly during all phases of the Project.
Adequate access for response and evacuation	*What/who*	Ensure access roads comply with TransGrid's *Easement and Access Track Maintenance Policy* (GM AS L1 002) so as to ensure access for fire applicances. Provide higher standard of bushfire access wherever possible in higher priority sections (see Table 3).
	Where	All access roads and trails (enhancement in higher priority bushfire risk management sections).
	How	Appropriate design, location and planning controls and for all road/trail construction and maintenance activities such as grading surface and maintaining drainage controls. Engage a bushfire expert to guide design and implementation.
	When	During all phases of the Project including future maintenance.
Substation building protection	*What/who*	Any buildings within the newly proposed Tenterfield 330kV Substation are to comply with Bushfire Attack Level BAL-12.5 under AS3959 (see http://www.rfs.nsw.gov.au/dsp_content.cfm?cat_id=1058).
	Where	All enclosed buildings.

Risk treatment options and strategies		
	How	By sealing gaps with steel wire mesh with a maximum aperture of 2mm 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'.
	When	Consideration at the Project approval stage and application at construction stage.
Accept the risk		
Suppression and response for operations at substation	*What/who*	Provide water supply for emergency first response fire fighting. Routine inspection Notify fire authorities of any bushfire.
	Where	Water supply for the newly proposed Tenterfield 330kV Substation. Routine inspection of fire fighting equipment, transformer fire protection systems and control room fire protection systems.
	How	Water storage (120kL) connected to hydrants under a pressurised system to be provided at the Tenterfield 330kV Substation. Smoke and heat detectors connected to both local and remote alarms to be installed and handheld fire extinguishers to be provided in the services building. Other fire fighting equipment such as fire hoses and foam-making equipment to be housed in a fire equipment store room within the services building. Routine inspection as per 'Substation Maintenance Policy' (GM AS S1 001) and 'Fire Protection Manual Operations & Maintenance' (GD HS G2 001). Response and fire suppression by fire authorities (000).
	When	Fire notification.

Risk treatment options and strategies		
Suppression and response for construction activities in the field	*What/who*	Provide and maintain basic fire fighting equipment capable of controlling and suppressing small initial outbreaks of fire during higher risk activities and locations. Equipment should include, but not necessarily be limited to, 4WD striker with slip-on water unit equipped with pump and hoses, extinguishers, knap sacks, and hand tools. Notify fire authorities when fire occurs that cannot be controlled by first response techniques described above.
	Where	Consider all construction sites in bushfire prone areas.
	How	Initial response and suppression by construction crew followed by notification of fire authorities (000).
	When	During construction only for fire fighting capability, and all phases for notifying fire authorities.
Transfer the risk		
Adequate insurances	*What/who*	Ensure policy relevancy based on the understanding of bushfire risk presented in this assessment.
	Where	TransGrid administration.
	How	Review insurance policy.
	When	Prior to construction and could be reviewed again at completion of construction prior to operation phase.
Retain the risk		
Review and report on bushfire emergencies	*What/who*	Review the performance of the network during a fire emergency to implement improvement recommendations.
	Where	In areas affected by fire.
	How	In accordance with TransGrid Network Management Plan.
	When	Immediately after every fire event.

Risk treatment options and strategies		
Evacuation plan and residual risk	*What/who*	Understand the concept of residual risk described in Section 5.4. Prepare and execute a 'Bushfire Emergency and Evacuation Plan'.
	Where	To cover all construction, operation and maintenance areas in particular in high risk areas.
	How	Bushfire Emergency and Evacuation Plan to be prepared to satisfy the requirements of Australian Standards AS 3745-2002 – *Emergency control organisation and procedures for buildings, structures and workplaces* (Standards Australia 2002). The NSW Rural Fire Service document 'A Guide to Developing a Bushfire Evacuation Plan' (RFS, 2004) is a helpful document. The plan is to include, but not be limited to, roles and responsibilities of emergency control staff, evacuation guidelines including onsite refuge and offsite evacuation, recovery operations, and staff education and induction. Plans to be prepared as part of the CEMP.
	When	During all phases of the Project.

6 Conclusion

This report assesses the bushfire risk to and from the proposed construction of the Dumaresq – Lismore 330kV Transmission Line and associated works. The primary outcome of the report is a risk ranking system and a suite of bushfire risk treatment options to address the bushfire risk associated with the Project and satisfy the DGRs in order to gain Part 3A project approval.

It is concluded that the proposed Project would be exposed to varying levels of bushfire risk but these would be within acceptable limits. It is also concluded that the transmission lines may increase the risk of bushfire ignition in the region but with appropriate design measures for higher risk locations this can be reduced to an appropriate level.

The risk assessment is divided into two parts: firstly, the assessment of the project proposal against the NSW Rural Fire Service document '*Planning for Bushfire Protection 2006*' in relation to the protection of the Project against the impacts of bushfire; and secondly, a risk assessment of the impacts from the proposal on surrounding land uses and assets following a risk assessment process set out in the NSW Bush Fire Coordinating Committee Guidelines (BFCC, 2008) which are based on the National Inquiry on Bushfire Mitigation and Management (COAG, 2004) and principles within the Australian/New Zealand Standard AS/NZS ISO 31000:2009 '*Risk management – Principles and guidelines*'.

A bushfire intensity model was produced in GIS from a range of known risk factors (e.g. vegetation, topography, fire weather, ignition causes, etc.) for a 1km wide corridor along the transmission line. The model was then used to analyse the risk by assessing the consequence of a bushfire impacting on the assets identified and the likelihood of this occurring. A RMP map and table with 68 individual RMP sections was created with sub-ranking of the Priority 1 sections into a further three categories. These maps and table guide the risk management priorities and options. A suite of bushfire risk treatments applicable to the prioritised risks are provided to help reduce both the likelihood and consequences of bushfires. These are tabulated in six broad groups of risk treatment options of 'avoid the risk', 'reduce the likelihood', 'reduce the consequence', 'accept the risk', 'transfer the risk' and 'retain the risk'. Treatments include, but not limited to, ignition prevention, education of contractors, asset design, fuel management, substation building protection, and suppression and response strategies.

7 References

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Standards Australia (2009). *Australian/New Zealand Standard AS/NZS ISO 31000:2009 'Risk management – Principles and guidelines'*, Standards Australia International Ltd, Sydney.

TransGrid Documents and Policy:

- *'Easement and Access Track Maintenance Policy'* (GM AS L1 002);
- *'Principals for Clearing'* (GD AS G3 015);
- *'Network Management Plan'* (GD AS G2 006);
- *'Electrical Design Standard'* (5-G-1 STD-169565);
- *'Substation Maintenance Policy'* (GM AS S1 001); and
- *'Fire Protection Manual Operations & Maintenance'* (GD HS G2 001).

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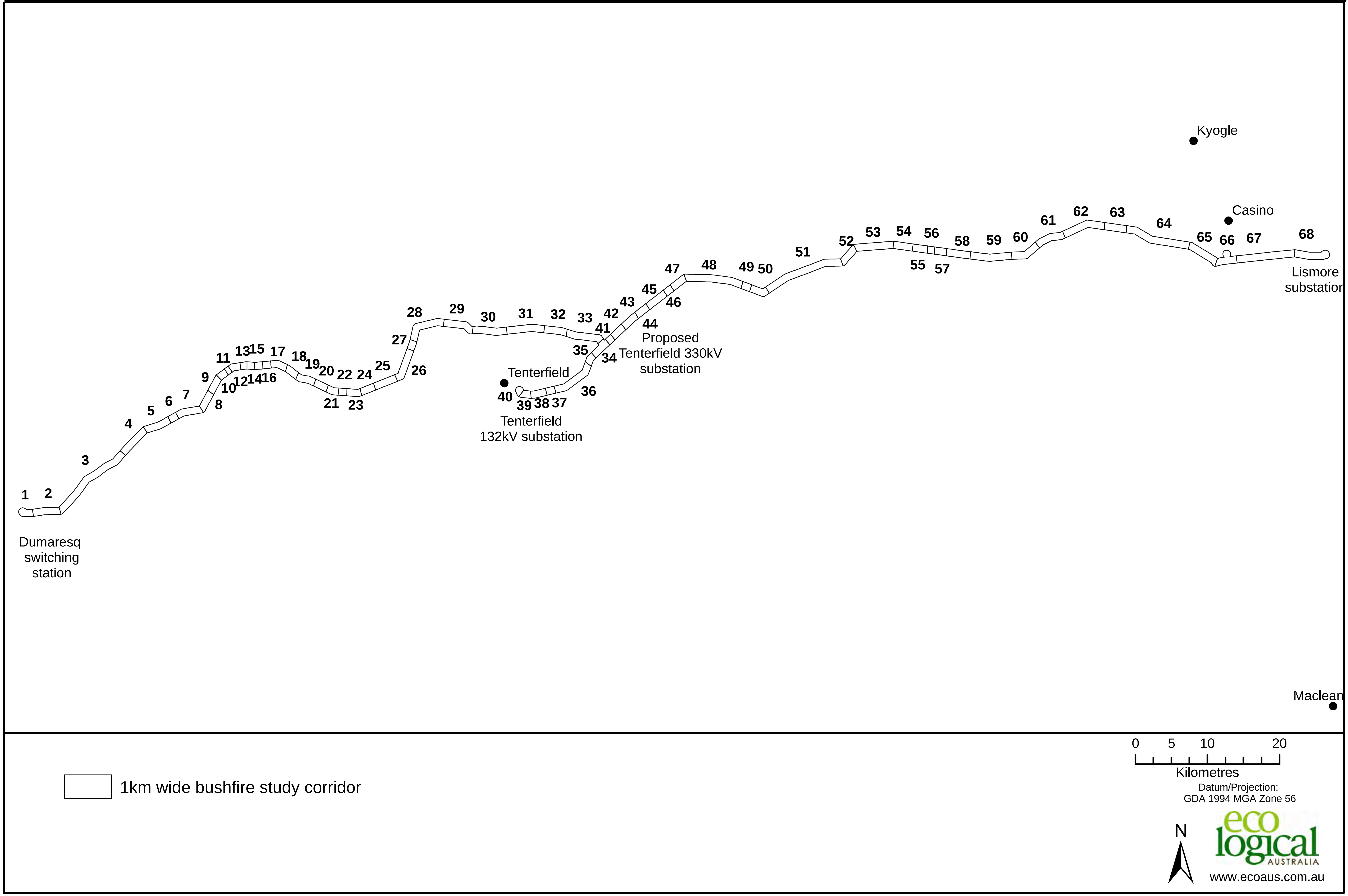
Appendix 1 – Figures 3 - 19

Figure 3: Key diagram for Risk Management Sections



Client: TransGrid
Project Number: 10GOSBUS-0080

Prepared by: SE
Approved by: RR
Status: Draft
Date: 14/12/10

Figure 4: Fire intensity in sections 1-3

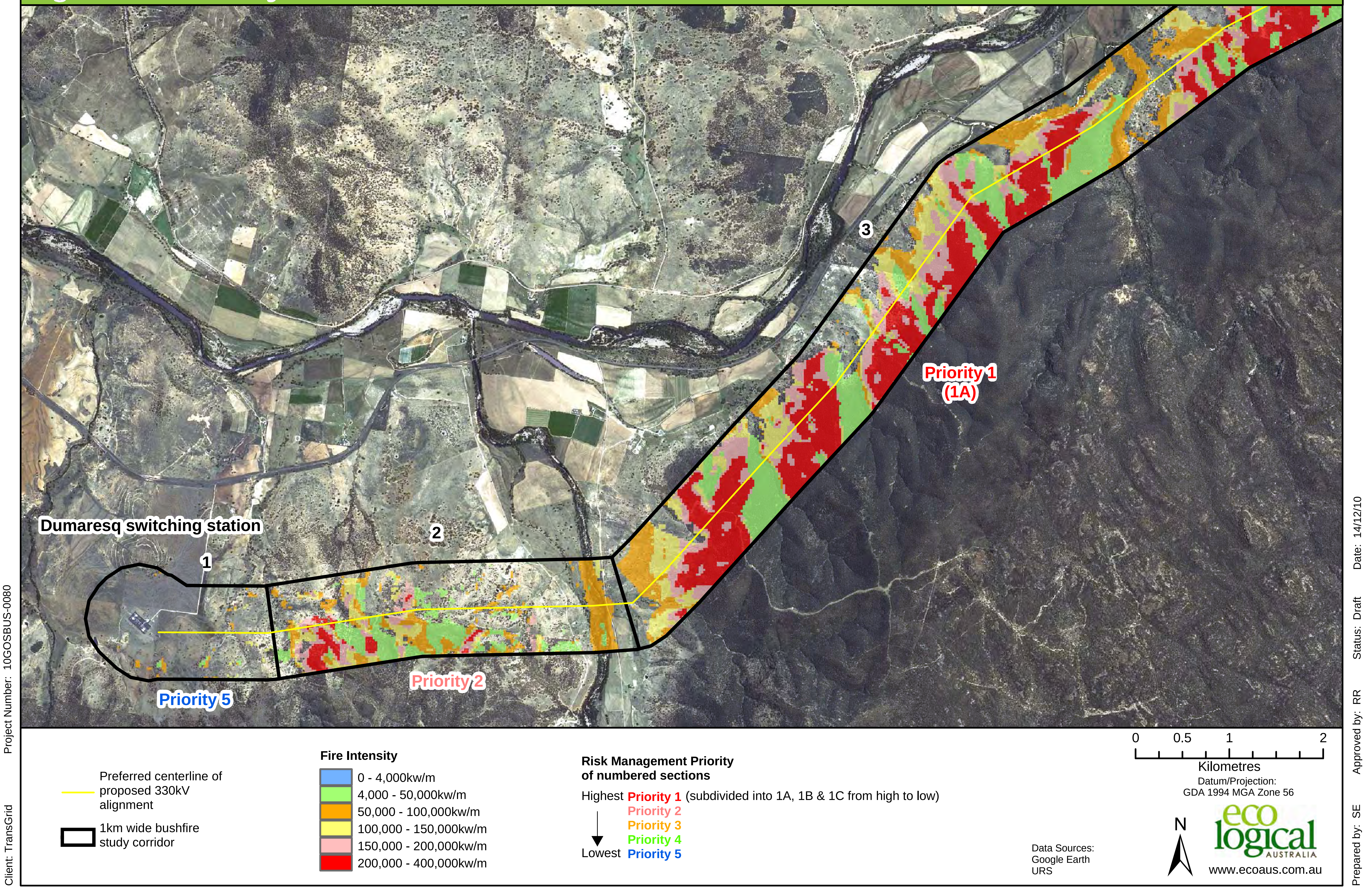
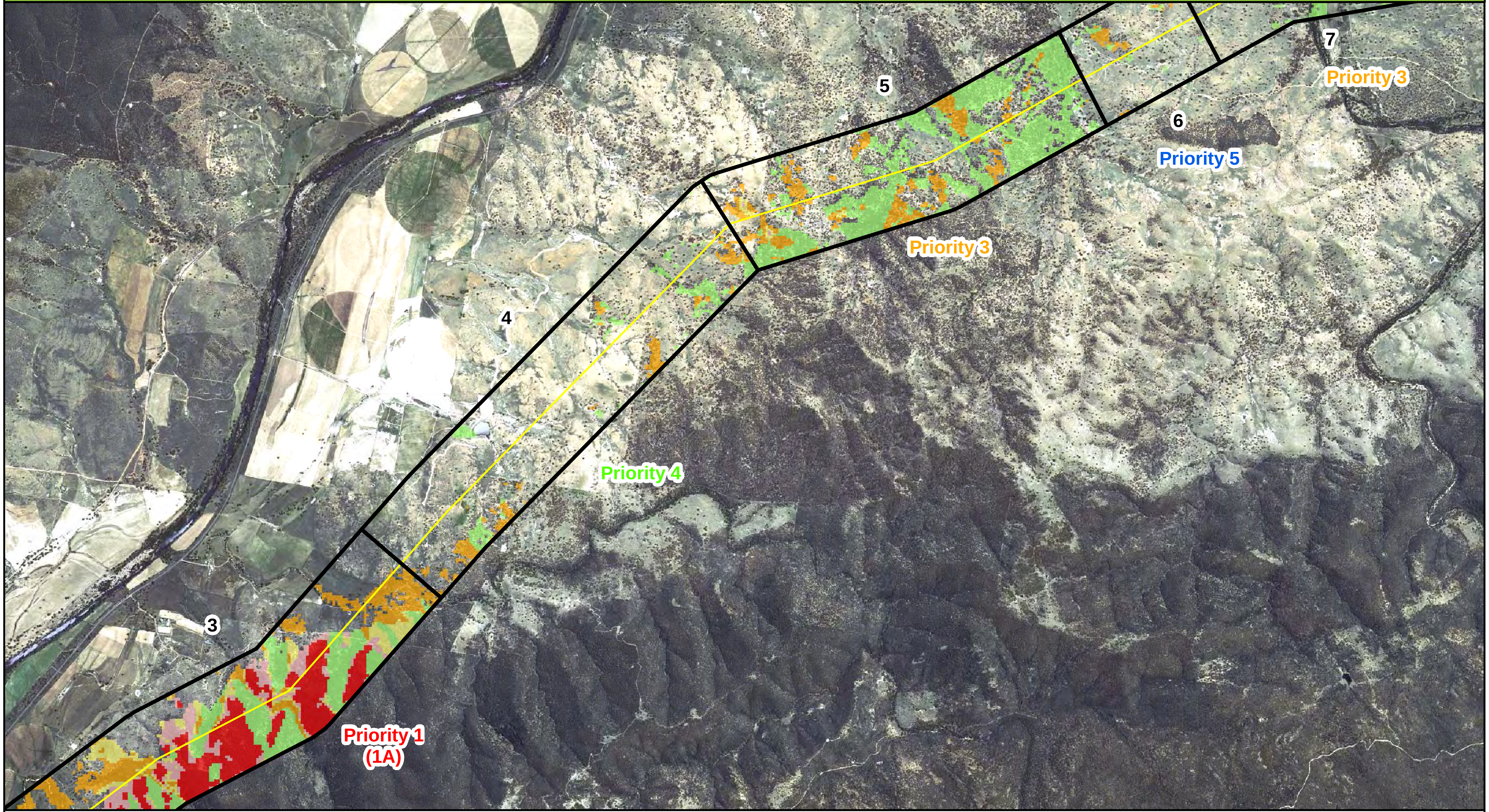


Figure 5: Fire intensity in sections 3-7



Preferred centerline of proposed 330kV alignment

1km wide bushfire study corridor

Fire Intensity

- 0 - 4,000kw/m
- 4,000 - 50,000kw/m
- 50,000 - 100,000kw/m
- 100,000 - 150,000kw/m
- 150,000 - 200,000kw/m
- 200,000 - 400,000kw/m

Risk Management Priority of numbered sections

Highest **Priority 1** (subdivided into 1A, 1B & 1C from high to low)
Priority 2
Priority 3
Priority 4
Lowest **Priority 5**

Data Sources:
Google Earth
URS

0 0.5 1 2
Kilometres

Datum/Projection:
GDA 1994 MGA Zone 56

N

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